This PDF is current as of August 2019. Updated subject information is available at catalog.mit.edu/subjects.

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Subjects</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeronautics and Astronautics (Course 16)</td>
<td>7</td>
</tr>
<tr>
<td>Aerospace Studies (AS)</td>
<td>30</td>
</tr>
<tr>
<td>Anthropology (Course 21A)</td>
<td>33</td>
</tr>
<tr>
<td>Architecture (Course 4)</td>
<td>44</td>
</tr>
<tr>
<td>Biological Engineering (Course 20)</td>
<td>87</td>
</tr>
<tr>
<td>Biology (Course 7)</td>
<td>100</td>
</tr>
<tr>
<td>Brain and Cognitive Sciences (Course 9)</td>
<td>117</td>
</tr>
<tr>
<td>Chemical Engineering (Course 10)</td>
<td>130</td>
</tr>
<tr>
<td>Chemistry (Course 5)</td>
<td>156</td>
</tr>
<tr>
<td>Civil and Environmental Engineering (Course 1)</td>
<td>167</td>
</tr>
<tr>
<td>Comparative Media Studies / Writing (CMS)</td>
<td>194</td>
</tr>
<tr>
<td>Comparative Media Studies / Writing (Course 21W)</td>
<td>216</td>
</tr>
<tr>
<td>Computational and Systems Biology (CSB)</td>
<td>229</td>
</tr>
<tr>
<td>Concourse (CC)</td>
<td>230</td>
</tr>
<tr>
<td>Data, Systems, and Society (IDS)</td>
<td>234</td>
</tr>
<tr>
<td>Earth, Atmospheric, and Planetary Sciences (Course 12)</td>
<td>246</td>
</tr>
<tr>
<td>Economics (Course 14)</td>
<td>286</td>
</tr>
<tr>
<td>Edgerton Center (EC)</td>
<td>304</td>
</tr>
<tr>
<td>Electrical Engineering and Computer Science (Course 6)</td>
<td>317</td>
</tr>
<tr>
<td>Engineering Management (EM)</td>
<td>367</td>
</tr>
<tr>
<td>Experimental Study Group (ES)</td>
<td>370</td>
</tr>
<tr>
<td>Global Studies and Languages (Course 21G)</td>
<td>376</td>
</tr>
<tr>
<td>Health Sciences and Technology (HST)</td>
<td>413</td>
</tr>
<tr>
<td>History (Course 21H)</td>
<td>434</td>
</tr>
<tr>
<td>Humanities (Course 21)</td>
<td>450</td>
</tr>
<tr>
<td>Linguistics and Philosophy (Course 24)</td>
<td>451</td>
</tr>
<tr>
<td>Literature (Course 21L)</td>
<td>469</td>
</tr>
<tr>
<td>Management (Course 15)</td>
<td>486</td>
</tr>
<tr>
<td>Materials Science and Engineering (Course 3)</td>
<td>558</td>
</tr>
<tr>
<td>Mathematics (Course 18)</td>
<td>578</td>
</tr>
<tr>
<td>Mechanical Engineering (Course 2)</td>
<td>602</td>
</tr>
<tr>
<td>Media Arts and Sciences (MAS)</td>
<td>647</td>
</tr>
<tr>
<td>Military Science (MS)</td>
<td>658</td>
</tr>
<tr>
<td>Music and Theater Arts (Course 21M)</td>
<td>660</td>
</tr>
<tr>
<td>Naval Science (NS)</td>
<td>683</td>
</tr>
<tr>
<td>Nuclear Science and Engineering (Course 22)</td>
<td>686</td>
</tr>
<tr>
<td>Physics (Course 8)</td>
<td>700</td>
</tr>
<tr>
<td>Political Science (Course 17)</td>
<td>719</td>
</tr>
<tr>
<td>Science, Technology, and Society (STS)</td>
<td>743</td>
</tr>
<tr>
<td>Special Programs</td>
<td>758</td>
</tr>
<tr>
<td>Supply Chain Management (SCM)</td>
<td>761</td>
</tr>
<tr>
<td>Urban Studies and Planning (Course 11)</td>
<td>767</td>
</tr>
<tr>
<td>Women’s and Gender Studies (WGS)</td>
<td>805</td>
</tr>
</tbody>
</table>
SUBJECTS

A course is a course, of course, except when it is a subject. At MIT course numbers and abbreviations refer to courses of study leading to specific academic degrees and, by extension, to the departments or programs offering those degrees. For example, Course 6 refers to the Department of Electrical Engineering and Computer Science. Subjects are what many people typically think of as courses, i.e., a series of classes offered during a given academic period.

These descriptions are current but are subject to change. For schedules, consult the Online Subject Listing and Schedule (http://student.mit.edu/catalog). Below is a list of the departments and programs that offer subjects at MIT.

- Aeronautics and Astronautics (Course 16) (p. 7)
- Aerospace Studies (AS) (p. 30)
- Anthropology (Course 21A) (p. 33)
- Architecture (Course 4) (p. 44)
- Biological Engineering (Course 20) (p. 87)
- Biology (Course 7) (p. 100)
- Brain and Cognitive Sciences (Course 9) (p. 117)
- Chemical Engineering (Course 10) (p. 130)
- Chemistry (Course 5) (p. 156)
- Civil and Environmental Engineering (Course 1) (p. 167)
- Comparative Media Studies / Writing (CMS) (p. 194)
- Comparative Media Studies / Writing (Course 21W) (p. 216)
- Computational and Systems Biology (CSB) (p. 229)
- Concourse (CC) (p. 230)
- Data, Systems, and Society (IDS) (p. 234)
- Earth, Atmospheric, and Planetary Sciences (Course 12) (p. 246)
- Economics (Course 14) (p. 286)
- Edgerton Center (EC) (p. 304)
- Electrical Engineering and Computer Science (Course 6) (p. 317)
- Engineering Management (EM) (p. 367)
- Experimental Study Group (ES) (p. 370)
- Global Studies and Languages (Course 21G) (p. 376)
- Health Sciences and Technology (HST) (p. 413)
- History (Course 21H) (p. 434)
- Humanities (Course 21) (p. 450)
- Linguistics and Philosophy (Course 24) (p. 451)
- Literature (Course 21L) (p. 469)
- Management (Course 15) (p. 486)
- Materials Science and Engineering (Course 3) (p. 558)
- Mathematics (Course 18) (p. 578)
- Mechanical Engineering (Course 2) (p. 602)
- Media Arts and Sciences (MAS) (p. 647)
- Military Science (MS) (p. 658)
- Music and Theater Arts (Course 21M) (p. 660)
- Naval Science (NS) (p. 683)
- Nuclear Science and Engineering (Course 22) (p. 686)
- Physics (Course 8) (p. 700)
- Political Science (Course 17) (p. 719)
- Science, Technology, and Society (STS) (p. 743)
- Special Programs (p. 758)
- Supply Chain Management (SCM) (p. 761)
- Urban Studies and Planning (Course 11) (p. 767)
- Women's and Gender Studies (WGS) (p. 805)

How to Read Subject Descriptions

A subject description consists of four parts:

- Subject name (p. 5)
- Subject information (p. 5)
- Subject content (p. 6)
- Instructor(s) (p. 6)

Examples:

11.003[J] Methods of Policy Analysis
Same subject as 17.303[J]
Prereq: 11.002[J]; Coreq: 14.01
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Provides students with an introduction to public policy analysis. Examines various approaches to policy analysis by considering the concepts, tools, and methods used in economics, political science, and other disciplines. Students apply and critique these approaches through case studies of current public policy problems.

Staff

20.110[J] Thermodynamics of Biomolecular Systems
Same subject as 2.772[J]
Prereq: Calculus II (GIR), Chemistry (GIR), and Physics I (GIR)
U (Fall)
5-0-7 units. REST


M. Birnbaum C. Voigt
**Subject Name**
The subject name consists of its number and title.

A "J" in brackets appears at the end of a subject number to indicate that it is jointly offered by or cross-listed with more than one department.

(New) Follows the subject number and title to indicate a subject that is new in the current academic year.

(####.####) If a subject has been renumbered, its former number appears after the title in parentheses.

**Subject Information**
The subject information section may include the following:

Same subject as Appears in parentheses, with the subject's other number(s), if a subject is jointly offered by or cross-listed with one or more departments.

Offered under Appears in parentheses, with all the cross-listed subject numbers that comprise a School-Wide Elective (SWE); this type of listing is unique to the School of Engineering.

Subject meets with Denotes a subject that is taught with one or more subjects at a different level, or with all or a significant part of one or more subjects at the same level.

Subjects that meet together have different coursework requirements.

Prereq: Introduces prerequisites (additional prereqs may be listed in the subject content). Students who have not completed the stated prerequisites must obtain the instructor's permission to register. Prerequisites are listed before corequisites, which are subjects that should be taken simultaneously with the subject described and are introduced by "Coreq:" and noted in italics. A list of prerequisites with no additional text denotes that all of the subjects in a series are required, for example:

- Prereq: 6.021[J], 6.034, 6.046[J], 18.417

The use of "or" denotes that just one of a series of prerequisites is required. When there are more than two options, commas are used, for example:

- Prereq: 7.03, 7.05, 7.06, or 7.28

Parentheses are used to separate individual prerequisites from one of a series of prerequisites, or to separate several series of prerequisites, for example:

- Prereq: 18.06 and (6.008 or 6.046[J])

Implicit prerequisites are not listed. For example, it is not necessary to list 7.05 as a prerequisite if 7.06 is already listed.

Because there are multiple versions of the subjects that satisfy General Institute Requirements (GiRs) in Science, those subjects are identified as GiRs when they appear as prerequisites and corequisites. The subjects that currently fulfill each requirement are listed below:

<table>
<thead>
<tr>
<th>Subject (GiR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology (GiR): 7.012, 7.013, 7.014, 7.015, 7.016</td>
</tr>
<tr>
<td>Calculus I (GiR): 18.01, 18.01A</td>
</tr>
<tr>
<td>Calculus II (GiR): 18.02, 18.02A, 18.022</td>
</tr>
<tr>
<td>Chemistry (GiR): 3.091, 5.111, 5.112</td>
</tr>
<tr>
<td>Physics I (GiR) 8.01, 8.01L, 8.011, 8.012</td>
</tr>
<tr>
<td>Physics II (GiR): 8.02, 8.021, 8.022</td>
</tr>
</tbody>
</table>

Acad Year May indicate "2019–2020: Not offered" or "2020–2021: Not offered." There is no comment if the subject is offered in both academic years.

U or G, plus (Fall, IAP, Spring, and/or Summer) Indicates a subject's level and the terms in which it is offered. U denotes an undergraduate subject; G denotes a graduate subject. IAP is MIT's Independent Activities Period, which takes place in January.

### # units or Units arranged Credit units (hours) indicate the total amount of time spent in class and laboratory, plus the estimated time that the average student spends on outside preparation, for one regular term subject. Credit hours are represented by three numbers separated by dashes (for example, 3-3-6). First is the number of units assigned for class time (lecture and/or recitation); second, the number of units for laboratory, design, or fieldwork; and third, the number of units for preparation. Each unit represents about 14 hours of work per term, or about one hour of work per week for a subject that spans an entire term. The total unit credit for a subject is obtained by adding together all the units shown. Units arranged indicates that units are specially arranged with the instructor.

BIOLOGY, PHYSICS I and II, etc. Subjects that fulfill the General Institute Requirements, such as BIOLOGY, PHYSICS I and II, CALCULUS I and II, CHEMISTRY, REST (Restricted Electives in Science and Technology), Institute LAB, Partial LAB, or HASS (Humanities, Arts, and Social Sciences) are so designated to the right of the credit units.

HASS-H, etc. Subjects that fulfill the HASS Requirement are designated HASS-H (Humanities), HASS-A (Arts), HASS-S (Social Sciences), or HASS-E (Elective).

CI-H or CI-HW Subjects fulfilling HASS component of the Communication Requirement are designated CI-H or CI-HW. See degree charts to identify communication-intensive subjects in each major (CI-M).

P/D/F Appears to the right of the credit units if the subject is graded on a P, D, or F basis (where P means C or better performance).

Can be repeated for credit Appears under the credit units if the subject can be taken more than once for academic credit.
Credit cannot also be received for indicates subjects whose content is substantively similar to the subject described. Interested students should take care to register for credit for only one of the subjects indicated.

Subject Content
If a description of the subject content is not given, the associated subject number under which the description can be found appears instead. Any subject open only to special groups is so noted at the end of its content description.

Instructor(s)
The name of the instructor(s) or department contact appears in italics at the end of the subject description.
AERONAUTICS AND ASTRONAUTICS (COURSE 16)

16.00 Introduction to Aerospace and Design
Prereq: None
U (Spring)
2-2-2 units
Highlights fundamental concepts and practices of aerospace engineering through lectures on aeronautics, astronautics, and the principles of project design and execution. Provides training in the use of Course 16 workshop tools and 3-D printers, and in computational tools, such as CAD. Students engage in teambuilding during an immersive, semester-long project in which teams design, build, and fly radio-controlled lighter-than-air (LTA) vehicles. Emphasizes connections between theory and practice and introduces students to fundamental systems engineering practices, such as oral and written design reviews, performance estimation, and post-flight performance analysis.
J. A. Hoffman, R. J. Hansman

16.001 Unified Engineering: Materials and Structures
Prereq: Calculus II (GIR) and Physics I (GIR); Coreq: 16.002 and 18.03
U (Fall)
5-1-6 units. REST
Presents fundamental principles and methods of materials and structures for aerospace engineering, and engineering analysis and design concepts applied to aerospace systems. Topics include statics; analysis of trusses; analysis of statically determinate and indeterminate systems; stress-strain behavior of materials; analysis of beam bending, buckling, and torsion; material and structural failure, including plasticity, fracture, fatigue, and their physical causes. Experiential lab and aerospace system projects provide additional aerospace context.
R. Radovitzky, D. L. Darmofal

16.002 Unified Engineering: Signals and Systems
Prereq: Calculus II (GIR); Coreq: Physics II (GIR), 16.001, and (18.03 or 18.032)
U (Fall)
5-1-6 units
Presents fundamental principles and methods of signals and systems for aerospace engineering, and engineering analysis and design concepts applied to aerospace systems. Topics include linear and time invariant systems; convolution; transform analysis; and modulation, filtering, and sampling. Experiential lab and aerospace system projects provide additional aerospace context.
J. How, D. L. Darmofal

16.003 Unified Engineering: Fluid Dynamics
Prereq: Calculus II (GIR), Physics II (GIR), and (18.03 or 18.032); Coreq: 16.004
U (Spring)
5-1-6 units
Presents fundamental principles and methods of fluid dynamics for aerospace engineering, and engineering analysis and design concepts applied to aerospace systems. Topics include aircraft and aerodynamic performance, conservation laws for fluid flows, quasi-one-dimensional compressible flows, shock and expansion waves, streamline curvature, potential flow modeling, an introduction to three-dimensional wings and induced drag. Experiential lab and aerospace system projects provide additional aerospace context.
D. L. Darmofal

16.004 Unified Engineering: Thermodynamics
Prereq: Calculus II (GIR), Physics II (GIR), and (18.03 or 18.032); Coreq: Chemistry (GIR) and 16.003
U (Spring)
5-1-6 units
Presents fundamental principles and methods of thermodynamics for aerospace engineering, and engineering analysis and design concepts applied to aerospace systems. Topics include thermodynamic state of a system, forms of energy, work, heat, the first law of thermodynamics, heat engines, reversible and irreversible processes, entropy and the second law of thermodynamics, ideal and non-ideal cycle analysis, two-phase systems, and introductions to thermochemistry and heat transfer. Experiential lab and aerospace system projects provide additional aerospace context.
C. Guerra-Garcia, D. L. Darmofal

Core Undergraduate Subjects

16.06 Principles of Automatic Control
Prereq: 16.002 and (16.003 or 16.004)
U (Fall)
3-1-8 units
Introduction to design of feedback control systems. Properties and advantages of feedback systems. Time-domain and frequency-domain performance measures. Stability and degree of stability. Root locus method, Nyquist criterion, frequency-domain design, and some state space methods. Strong emphasis on the synthesis of classical controllers. Application to a variety of aerospace systems. Hands-on experiments using simple robotic systems.
S. R. Hall
16.07 Dynamics
Prereq: (16.001 or 16.002) and (16.003 or 16.004)
U (Fall)
4-0-8 units
Fundamentals of Newtonian mechanics. Kinematics, particle dynamics, motion relative to accelerated reference frames, work and energy, impulse and momentum, systems of particles and rigid body dynamics. Applications to aerospace engineering including introductory topics in orbital mechanics, flight dynamics, inertial navigation and attitude dynamics.
D. W. Miller, S. E. Widnall

16.09 Statistics and Probability
Prereq: Calculus II (GIR)
U (Spring)
4-0-8 units
Introduction to statistics and probability with applications to aerospace engineering. Covers essential topics, such as sample space, discrete and continuous random variables, probability distributions, joint and conditional distributions, expectation, transformation of random variables, limit theorems, estimation theory, hypothesis testing, confidence intervals, statistical tests, and regression.
Y. M. Marzouk

Mechanics and Physics of Fluids

16.100 Aerodynamics
Prereq: 16.003 and 16.004
U (Fall)
3-1-8 units
Extends fluid mechanic concepts from Unified Engineering to aerodynamic performance of wings and bodies in sub/supersonic regimes. Addresses themes such as subsonic potential flows, including source/vortex panel methods; viscous flows, including laminar and turbulent boundary layers; aerodynamics of airfoils and wings, including thin airfoil theory, lifting line theory, and panel method/interacting boundary layer methods; and supersonic and hypersonic airfoil theory. Material may vary from year to year depending upon focus of design problem.
D. L. Darmofal

16.101 Topics in Fluids and Propulsion
Prereq: Permission of department
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Provides credit for work on material in fluids or propulsion outside of regularly scheduled subjects. Intended for transfer credit and study abroad. Credit may be used to satisfy specific degree requirements in the Course 16 program. Requires prior approval. Consult department.
N. Roy

16.110 Flight Vehicle Aerodynamics
Prereq: 16.100 or permission of instructor
G (Fall)
3-1-8 units
M. Drela

16.120 Compressible Internal Flow
Prereq: 2.25 or permission of instructor
Acad Year 2019-2020: G (Spring; first half of term)
Acad Year 2020-2021: Not offered
3-0-3 units
Internal compressible flow with applications in propulsion and fluid systems. Control volume analysis of compressible flow devices. Compressible channel flow and extensions, including effects of shock waves, momentum, energy and mass addition, swirl, and flow non-uniformity on Mach numbers, flow regimes, and choking.
E. M. Greitzer

16.121 Analytical Subsonic Aerodynamics
Prereq: 2.25, 18.085, or permission of instructor
G (Fall; second half of term)
3-0-3 units
W. L. Harris
16.122 Analytical High Speed Aerodynamics
Prereq: 2.25, 18.085, or permission of instructor
G (Spring; partial term)
3-0-3 units
W. L. Harris

16.13 Aerodynamics of Viscous Fluids
Prereq: 16.100, 16.110, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
M. Drela

Materials and Structures

16.20 Structural Mechanics
Prereq: 16.001
U (Spring)
5-0-7 units
P. A. Lagace

16.201 Topics in Materials and Structures
Prereq: Permission of department
U (Spring)
Units arranged
Can be repeated for credit.
Provides credit for work in materials and structures outside of regularly scheduled subjects. Intended for transfer credit and study abroad. Credit may be used to satisfy specific degree requirements in the Course 16 program. Requires prior approval. Consult department.
N. Roy

16.202 Manufacturing with Advanced Composite Materials
Prereq: None
U (Fall)
Not offered regularly; consult department
1-3-2 units
Introduces the methods used to manufacture parts made of advanced composite materials with work in the Technology Laboratory for Advanced Composites. Students gain hands-on experience by fabricating, machining, instrumenting, and testing graphite/epoxy specimens. Students also design, build, and test a composite structure as part of a design contest. Lectures supplement laboratory sessions with background information on the nature of composites, curing, composite machining, secondary bonding, and the testing of composites.
P. A. Lagace

16.221[J] Structural Dynamics
Same subject as 1.581[J], 2.060[J]
Subject meets with 1.058
Prereq: 18.03 or permission of instructor
G (Fall)
3-1-8 units
Examines response of structures to dynamic excitation: free vibration, harmonic loads, pulses and earthquakes. Covers systems of single- and multiple-degree-of-freedom, up to the continuum limit, by exact and approximate methods. Includes applications to buildings, ships, aircraft and offshore structures. Students taking graduate version complete additional assignments.
T. Cohen
Same subject as 2.076[J]
Prereq: 2.002, 3.032, 16.20, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Mechanical behavior of heterogeneous materials such as thin-film microelectro-mechanical systems (MEMS) materials and advanced filamentary composites, with particular emphasis on laminated structural configurations. Anisotropic and crystallographic elasticity formulations. Structure, properties and mechanics of constituents such as films, substrates, active materials, fibers, and matrices including nano- and micro-scale constituents. Effective properties from constituent properties. Classical laminated plate theory for modeling structural behavior including extrinsic and intrinsic strains and stresses such as environmental effects. Introduction to buckling of plates and nonlinear (deformations) plate theory. Other issues in modeling heterogeneous materials such as fracture/failure of laminated structures.
B. L. Wardle, S-G. Kim

Same subject as 2.099[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Formulation of numerical (finite element) methods for the analysis of the nonlinear continuum response of materials. The range of material behavior considered includes finite deformation elasticity and inelasticity. Numerical formulation and algorithms include variational formulation and variational constitutive updates; finite element discretization; constrained problems; time discretization and convergence analysis. Strong emphasis on the (parallel) computer implementation of algorithms in programming assignments. The application to real engineering applications and problems in engineering science are stressed throughout. Experience in either C++, C, or Fortran required.
R. Radovitzky

16.230[J] Plates and Shells: Static and Dynamic Analysis
Same subject as 2.081[J]
Prereq: 2.071, 2.080[J], or permission of instructor
G (Spring)
3-1-8 units
See description under subject 2.081[J].
T. Sapsis

Information and Control Engineering

16.30 Feedback Control Systems
Subject meets with 16.31
Prereq: 6.302 or 16.06
U (Fall)
4-1-7 units
Studies state-space representation of dynamic systems, including model realizations, controllability, and observability. Introduces the state-space approach to multi-input-multi-output control system analysis and synthesis, including full state feedback using pole placement, linear quadratic regulator, stochastic state estimation, and the design of dynamic control laws. Also covers performance limitations and robustness. Extensive use of computer-aided control design tools. Applications to various aerospace systems, including navigation, guidance, and control of vehicles. Laboratory exercises utilize a palm-size drone. Students taking graduate version complete additional assignments.
S. Karaman

16.301 Topics in Control, Dynamics, and Automation
Prereq: Permission of department
U (Fall, Spring)
Units arranged
Can be repeated for credit.
Provides credit for work on material in control and/or dynamics and/or automation outside of regularly scheduled subjects. Intended for transfer credit and study abroad. Credit may be used to satisfy specific degree requirements in the Course 16 program. Requires prior approval. Consult department.
N. Roy

16.31 Feedback Control Systems
Subject meets with 16.30
Prereq: 6.302 or 16.06
G (Fall)
3-1-8 units
Graduate-level version of 16.30; see description under 16.30. Includes additional homework questions, laboratory experiments, and a term project beyond 16.30 with a particular focus on the material associated with state-space realizations of MIMO transfer function (matrices); MIMO zeros, controllability, and observability; stochastic processes and estimation; limitations on performance; design and analysis of dynamic output feedback controllers; and robustness of multivariable control systems.
S. Karaman
16.32 Principles of Optimal Control and Estimation
Prereq: 16.31 and 18.0851
G (Spring)
3-0-9 units

Fundamentals of optimal control and estimation for discrete and continuous systems. Briefly reviews constrained function minimization and stochastic processes. Topics in optimal control theory include dynamic programming, variational calculus, Pontryagin’s maximum principle, and numerical algorithms and software. Topics in estimation include least-squares estimation, and the Kalman filter and its extensions for estimating the states of dynamic systems. May include an individual term project.
*S. R. Hall*

16.338[J] Dynamic Systems and Control
Same subject as 6.241[J]
Prereq: 6.003 and 18.06
G (Spring)
4-0-8 units

See description under subject 6.241[J].
*M. A. Dahleh, A. Megretski*

16.343 Spacecraft and Aircraft Sensors and Instrumentation
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Covers fundamental sensor and instrumentation principles in the context of systems designed for space or atmospheric flight. Systems discussed include basic measurement system for force, temperature, pressure; navigation systems (Global Positioning System, Inertial Reference Systems, radio navigation), air data systems, communication systems; spacecraft attitude determination by stellar, solar, and horizon sensing; remote sensing by incoherent and Doppler radar, radiometry, spectrometry, and interferometry. Also included is a review of basic electromagnetic theory and antenna design and discussion of design considerations for flight. Alternate years.
*K. Cahoy*

16.346 Astrodynamics
Prereq: 18.03
G (Spring)
3-0-9 units

Fundamentals of astrodynamics; the two-body orbital initial-value and boundary-value problems with applications to space vehicle navigation and guidance for lunar and planetary missions with applications to space vehicle navigation and guidance for lunar and planetary missions including both powered flight and midcourse maneuvers. Topics include celestial mechanics, Kepler’s problem, Lambert’s problem, orbit determination, multi-body methods, mission planning, and recursive algorithms for space navigation. Selected applications from the Apollo, Space Shuttle, and Mars exploration programs.
*S. E. Widnall*

16.35 Real-Time Systems and Software
Prereq: 1.00 or 6.0002
U (Spring)
3-0-9 units

Concepts, principles, and methods for specifying and designing real-time computer systems. Topics include concurrency, real-time execution implementation, scheduling, testing, verification, real-time analysis, and software engineering concepts. Additional topics include operating system architecture, process management, and networking.
*J. Shah*

Same subject as IDS.341[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Reading and discussion on issues in the engineering of software systems and software development project design. Includes the present state of software engineering, what has been tried in the past, what worked, what did not, and why. Topics may differ in each offering, but are chosen from the software process and life cycle; requirements and specifications; design principles; testing, formal analysis, and reviews; quality management and assessment; product and process metrics; COTS and reuse; evolution and maintenance; team organization and people management; and software engineering aspects of programming languages.
*N. G. Leveson*
16.36 Communication Systems and Networks
Subject meets with 16.363
Prereq: (6.003 or 16.002) and (16.09 or 6.041)
U (Spring)
3-0-9 units

Introduces the fundamentals of digital communications and networking. Topics include elements of information theory, sampling and quantization, coding, modulation, signal detection and system performance in the presence of noise. Study of data networking includes multiple access, reliable packet transmission, routing and protocols of the internet. Concepts discussed in the context of aerospace communication systems: aircraft communications, satellite communications, and deep space communications. Students taking graduate version complete additional assignments.

E. H. Modiano

16.363 Communication Systems and Networks
Subject meets with 16.36
Prereq: (6.003 or 16.004) and (16.09 or 6.041)
G (Spring)
3-0-9 units

Introduces the fundamentals of digital communications and networking, focusing on the study of networks, including protocols, performance analysis, and queuing theory. Topics include elements of information theory, sampling and quantization, coding, modulation, signal detection and system performance in the presence of noise. Study of data networking includes multiple access, reliable packet transmission, routing and protocols of the internet. Concepts discussed in the context of aerospace communication systems: aircraft communications, satellite communications, and deep space communications. Students taking graduate version complete additional assignments.

E. H. Modiano

16.37[J] Data-Communication Networks
Same subject as 6.263[J]
Prereq: 6.041 or 18.204
G (Fall)
3-0-9 units

See description under subject 6.263[J].

E. Modiano

16.391[J] Statistics for Engineers and Scientists
Same subject as 6.434[J]
Prereq: Calculus II (GIR), 6.431, 18.06, or permission of instructor
G (Fall)
3-0-9 units

See description under subject 6.434[J].

M. Win, J. N. Tsitsiklis

16.393 Statistical Communication and Localization Theory
Prereq: None
G (Spring)
3-0-9 units

Rigorous introduction to statistical communication and localization theory, covering essential topics such as modulation and demodulation of signals, derivation of optimal receivers, characterization of wireless channels, and devising of ranging and localization techniques. Applies decision theory, estimation theory, and modulation theory to the design and analysis of modern communication and localization systems exploring synchronization, diversity, and cooperation. Selected topics will be discussed according to time schedule and class interest.

M. Z. Win

16.395 Principles of Wide Bandwidth Communication
Prereq: 6.011, 16.36, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Introduction to the principles of wide bandwidth wireless communication, with a focus on ultra-wide bandwidth (UWB) systems. Topics include the basics of spread-spectrum systems, impulse radio, Rake reception, transmitted reference signaling, spectral analysis, coexistence issues, signal acquisition, channel measurement and modeling, regulatory issues, and ranging, localization and GPS. Consists of lectures and technical presentations by students.

M. Z. Win

Humans and Automation

16.400 Human Systems Engineering
Subject meets with 16.453[J], HST.518[J]
Prereq: 16.09, 6.041, or permission of instructor
U (Fall)
3-0-9 units

Provides a fundamental understanding of human factors that must be taken into account in the design and engineering of complex aviation, space, and medical systems. Focuses primarily on derivation of human engineering design criteria from sensory, motor, and cognitive sources. Includes principles of displays, controls and ergonomics, manual control, the nature of human error, basic experimental design, and human-computer interaction in supervisory control settings. Students taking graduate version complete a research project with a final written report and oral presentation.

L. A. Stirling
16.401 Topics in Communication and Software
Prereq: Permission of department
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Provides credit for student work on undergraduate-level material in communications and/or software outside of regularly scheduled subjects. Intended for transfer credit and study abroad. Credit may be used to satisfy specific degree requirements in the Course 16 program. Requires prior approval. Consult department.
N. Roy

16.405[J] Robotics: Science and Systems
Same subject as 6.141[J]
Prereq: ((1.00 or 6.0001) and (2.003[J], 6.006, 6.009, or 16.06)) or permission of instructor
U (Spring)
2-6-4 units. Institute LAB
See description under subject 6.141[J]. Enrollment limited.
L. Carlone, S. Karaman

Same subject as 6.817[J]
Subject meets with 6.877[J], 16.413[J]
Prereq: 6.0002 or 6.01
U (Fall)
4-0-8 units
Surveys decision making methods used to create highly autonomous systems and decision aids. Applies models, principles and algorithms taken from artificial intelligence and operations research. Focuses on planning as state-space search, including uninformed, informed and stochastic search, activity and motion planning, probabilistic and adversarial planning, Markov models and decision processes, and Bayesian filtering. Also emphasizes planning with real-world constraints using constraint programming. Includes methods for satisfiability and optimization of logical, temporal and finite domain constraints, graphical models, and linear and integer programs, as well as methods for search, inference, and conflict-learning. Students taking graduate version complete additional assignments.
B. C. Williams

16.412[J] Cognitive Robotics
Same subject as 6.834[J]
Prereq: (6.034 or 16.413[J]) and (6.042[J], 16.09, or 6.041)
G (Spring)
3-0-9 units
Highlights algorithms and paradigms for creating human-robot systems that act intelligently and robustly, by reasoning from models of themselves, their counterparts and their world. Examples include space and undersea explorers, cooperative vehicles, manufacturing robot teams and everyday embedded devices. Themes include architectures for goal-directed systems; decision-theoretic programming and robust execution; state-space programming, activity and path planning; risk-bounded programming and risk-bounded planners; self-monitoring and self-diagnosing systems, and human-robot collaboration. Student teams explore recent advances in cognitive robots through delivery of advanced lectures and final projects, in support of a class-wide grand challenge. Enrollment may be limited.
B. C. Williams

16.413[J] Principles of Autonomy and Decision Making
Same subject as 6.877[J]
Subject meets with 6.817[J], 16.410[J]
Prereq: 6.0002, 6.01, or permission of instructor
G (Fall)
3-0-9 units
Surveys decision making methods used to create highly autonomous systems and decision aids. Applies models, principles and algorithms taken from artificial intelligence and operations research. Focuses on planning as state-space search, including uninformed, informed and stochastic search, activity and motion planning, probabilistic and adversarial planning, Markov models and decision processes, and Bayesian filtering. Also emphasizes planning with real-world constraints using constraint programming. Includes methods for satisfiability and optimization of logical, temporal and finite domain constraints, graphical models, and linear and integer programs, as well as methods for search, inference, and conflict-learning. Students taking graduate version complete additional assignments.
B. C. Williams
16.420 Planning Under Uncertainty
Prereq: 16.413[J]
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Concepts, principles, and methods for planning with imperfect knowledge. Topics include state estimation, planning in information space, partially observable Markov decision processes, reinforcement learning and planning with uncertain models. Students will develop an understanding of how different planning algorithms and solutions techniques are useful in different problem domains. Previous coursework in artificial intelligence and state estimation strongly recommended.

Staff

16.422 Human Supervisory Control of Automated Systems
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-1-8 units
Principles of supervisory control and telerobotics. Different levels of automation are discussed, as well as the allocation of roles and authority between humans and machines. Human-vehicle interface design in highly automated systems. Decision aiding. Trade-offs between human control and human monitoring. Automated alerting systems and human intervention in automatic operation. Enhanced human interface technologies such as virtual presence. Performance, optimization, and social implications of the human-automation system. Examples from aerospace, ground, and undersea vehicles, robotics, and industrial systems.

J. A. Shah

16.423[J] Aerospace Biomedical and Life Support Engineering
Same subject as HST.515[J], IDS.337[J]
Prereq: 16.06, 16.400, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Fundamentals of human performance, physiology, and life support impacting engineering design and aerospace systems. Topics include effects of gravity on the muscle, skeletal, cardiovascular, and neurovestibular systems; human/pilot modeling and human/machine design; flight experiment design; and life support engineering for extravehicular activity (EVA). Case studies of current research are presented. Assignments include a design project, quantitative homework sets, and quizzes emphasizing engineering and systems aspects.

D. J. Newman

16.430[J] Sensory-Neural Systems: Spatial Orientation from End Organs to Behavior and Adaptation
Same subject as HST.514[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject HST.514[J].

K. Faisal, L. Young

Same subject as STS.470[J]
Prereq: 16.400, 16.453[J], or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examines relationships between human-occupied, remotely operated, and autonomous systems in the extreme environments of the deep ocean, air, and spaceflight. Uses a mix of historical, sociological, and engineering perspectives, examines different forms of human presence in each type of system and how they relate to each other in time and space, including: physical hand-on-the stick flying, supervisory control, remote operation, systems design, programming autonomous systems, management. Emphasis on networks of people interacting in networks of organizations through networks of machines.

D. A. Mindell

Same subject as HST.518[J]
Subject meets with 16.400
Prereq: 16.09, 6.041, or permission of instructor
G (Fall)
3-0-9 units
Provides a fundamental understanding of human factors that must be taken into account in the design and engineering of complex aviation, space, and medical systems. Focuses primarily on derivation of human engineering design criteria from sensory, motor, and cognitive sources. Includes principles of displays, controls and ergonomics, manual control, the nature of human error, basic experimental design, and human-computer interaction in supervisory control settings. Students taking graduate version complete a research project with a final written report and oral presentation.

L. A. Stirling
16.456[J] Biomedical Signal and Image Processing
Same subject as 6.555[J], HST.582[J]
Subject meets with 6.026[J], HST.482[J]
Prereq: (6.041 and (2.004, 6.003, 16.002, or 18.085)) or permission of instructor
G (Spring)
3-3-6 units
See description under subject HST.582[J].
J. Greenberg, E. Adalsteinsson, W. Wells

16.459 Bioengineering Journal Article Seminar
Prereq: None
G (Spring)
Not offered regularly; consult department
1-0-1 units
Can be repeated for credit.

Each term, the class selects a new set of professional journal articles on bioengineering topics of current research interest. Some papers are chosen because of particular content, others are selected because they illustrate important points of methodology. Each week, one student leads the discussion, evaluating the strengths, weaknesses, and importance of each paper. Subject may be repeated for credit a maximum of four terms. Letter grade given in the last term applies to all accumulated units of 16.459.
Staff

16.470 Statistical Methods in Experimental Design
Prereq: 16.09, 6.041, or permission of instructor
G (Spring)
3-0-9 units

Statistically based experimental design inclusive of forming hypotheses, planning and conducting experiments, analyzing data, and interpreting and communicating results. Topics include descriptive statistics, statistical inference, hypothesis testing, parametric and nonparametric statistical analyses, factorial ANOVA, randomized block designs, MANOVA, linear regression, repeated measures models, and application of statistical software packages.
Staff

16.475 Human-Computer Interface Design Colloquium
Prereq: None
G (Fall)
Not offered regularly; consult department
2-0-2 units

Provides guidance on design and evaluation of human-computer interfaces for students with active research projects. Roundtable discussion on developing user requirements, human-centered design principles, and testing and evaluating methodologies. Students present their work and evaluate each other’s projects. Readings complement specific focus areas. Team participation encouraged. Open to advanced undergraduates.
Staff

16.485 Visual Navigation for Autonomous Vehicles (New)
Prereq: 16.32 or permission of instructor
G (Fall)
3-2-7 units

Covers the mathematical foundations and state-of-the-art implementations of algorithms for vision-based navigation of autonomous vehicles (e.g., mobile robots, self-driving cars, drones). Topics include geometric control, 3D vision, visual-inertial navigation, place recognition, and simultaneous localization and mapping. Provides students with a rigorous but pragmatic overview of differential geometry and optimization on manifolds and knowledge of the fundamentals of 2-view and multi-view geometric vision for real-time motion estimation, calibration, localization, and mapping. The theoretical foundations are complemented with hands-on labs based on state-of-the-art mini race car and drone platforms. Culminates in a critical review of recent advances in the field and a team project aimed at advancing the state-of-the-art.
L. Carlone, J. How, K. Khosoussi

Propulsion and Energy Conversion

16.50 Aerospace Propulsion
Prereq: 16.003 and (2.005 or 16.004)
U (Spring)
3-0-9 units

Presents aerospace propulsive devices as systems, with functional requirements and engineering and environmental limitations. Requirements and limitations that constrain design choices. Both air-breathing and rocket engines covered, at a level which enables rational integration of the propulsive system into an overall vehicle design. Mission analysis, fundamental performance relations, and exemplary design solutions presented.
S. Barrett, J. Sabnis
16.511 Aircraft Engines and Gas Turbines
Prereq: 16.50 or permission of instructor
G (Fall)
3-0-9 units
Performance and characteristics of aircraft jet engines and industrial gas turbines, as determined by thermodynamic and fluid mechanic behavior of engine components: inlets, compressors, combustors, turbines, and nozzles. Discusses various engine types, including advanced turbofan configurations, limitations imposed by material properties and stresses. Emphasizes future design trends including reduction of noise, pollutant formation, fuel consumption, and weight.
E. M. Greitzer

16.512 Rocket Propulsion
Prereq: 16.50 or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
C. Guerra-Garcia

16.522 Space Propulsion
Prereq: 16.50 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-3-6 units
Reviews rocket propulsion fundamentals. Discusses advanced concepts in rocket propulsion ranging from chemical engines to electrical engines. Topics include advanced mission analysis, physics and engineering of microthrusters, solid propellant rockets, electrothermal, electrostatic, and electromagnetic schemes for accelerating propellant. Some coverage is given of satellite power systems and their relation to propulsion systems. Laboratory work emphasizes design and characterization of electric propulsion engines.
P. C. Lozano

16.540 Internal Flows in Turbomachines
Prereq: 2.25 or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Internal fluid motions in turbomachines, propulsion systems, ducts and channels, and other fluid machinery. Useful basic ideas, fundamentals of rotational flows, loss sources and loss accounting in fluid devices, unsteady internal flow and flow instability, flow in rotating passages, swirling flow, generation of streamwise vorticity and three-dimensional flow, non-uniform flow in fluid components.
E. M. Greitzer

16.55[ ] Ionized Gases
Same subject as 22.64[ ]
Prereq: 8.02 or permission of instructor
G (Fall)
3-0-9 units
C. Guerra Garcia

Other Undergraduate Subjects

16.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Undergraduate research opportunities in aeronautics and astronautics.
Consult M. A. Stuppard

16.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units
See description under subject 2.EPE.
Staff
16.621 Experimental Projects I
Prereq: None. Coreq: 16.06 or 16.07
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-1-3 units
First in a two-term sequence that addresses the conception and design of a student-defined or selected experimental research project carried out by two-person team under faculty advisement. Principles of research hypothesis formulation and assessment, experimental measurements and error analysis, and effective report writing and oral presentation, with instruction both in-class and on an individual and team basis. Selection and detailed planning of a research project, including in-depth design of experimental procedure that is then carried through to completion in 16.622.
S. R. Hall, J. L. Craig, P. C. Lozano, S. E. Widnall

16.622 Experimental Projects II
Prereq: 16.621
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
1-7-4 units. Institute LAB
Execution of research project experiments based on the plan developed in 16.621. Working with their faculty advisor and course staff, student teams construct their experiment, carry out measurements of the relevant phenomena, analyze the data, and then apply the results to assess the research hypothesis. Includes instruction on effective report writing and oral presentations culminating in a written final report and formal oral presentation.
S. R. Hall, J. L. Craig, P. C. Lozano, S. E. Widnall

16.63[J] System Safety
Same subject as IDS.045[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. REST
Introduces the concepts of system safety and how to analyze and design safer systems. Topics include the causes of accidents in general, and recent major accidents in particular; hazard analysis, safety-driven design techniques; design of human-automation interaction; integrating safety into the system engineering process; and managing and operating safety-critical systems. 
N. Leveson
16.632 NEET Sophomore Seminar: Autonomous Machines (New)
Prereq: None. Coreq: 2.086 or 6.0001
U (Fall)
1-1-1 units
Experiential seminar provides instruction on how to program an autonomous smart car using closed-loop control paradigms. Begins with an introduction to microcontrollers and proceeds with demonstrations on how to connect a variety of proximity and orientation sensors to a specific microcontroller. Students use sensory information to program the smart car to follow paths and to avoid obstacles. Students should have concurrent or prior programming experience. Limited to students in the NEET Autonomous Machines thread.
J. P. How, S. Karaman, G. Long

16.633 NEET Junior Seminar: Autonomous Machines (New)
Prereq: None
U (Fall)
1-1-1 units
Project-based seminar provides instruction on how to program basic autonomy algorithms for a micro aerial vehicle equipped with a camera. Begins by introducing the constituent hardware and components of a quadrotor drone. As this subject progresses, the students practice using simple signal processing, state estimation, control, and computer vision algorithms for mobile robotics. Students program the micro aerial vehicle to compete in a variety of challenges. Limited to students in the NEET Autonomous Machines thread.
J. P. How, S. Karaman, G. Long

16.64 Flight Measurement Laboratory
Prereq: 16.002
U (Spring)
2-2-2 units
Opportunity to see aeronautical theory applied in real-world environment of flight. Students assist in design and execution of simple engineering flight experiments in light aircraft. Typical investigations include determination of stability derivatives, verification of performance specifications, and measurement of navigation system characteristics. Restricted to students in Aeronautics and Astronautics.
R. J. Hansman

16.650 Engineering Leadership Lab
Engineering School-Wide Elective Subject.
Offered under: 6.911, 16.650
Subject meets with 6.913[J], 16.667[J]
Prereq: None. Coreq: 6.912; or permission of instructor
U (Fall, Spring)
0-2-1 units
Can be repeated for credit.
L. McGonagle, J. Feiler

16.651 Engineering Leadership
Engineering School-Wide Elective Subject.
Offered under: 6.912, 16.651
Prereq: None. Coreq: 6.911; or permission of instructor
U (Fall, Spring)
1-0-2 units
Can be repeated for credit.
J. Magarian, J. Schindall, L. McGonagle

16.653 Management in Engineering
Engineering School-Wide Elective Subject.
Offered under: 2.96, 6.930, 10.806, 16.653
Prereq: None
U (Fall)
3-1-8 units
See description under subject 2.96. Restricted to juniors and seniors.
H. S. Marcus, J.-H. Chun

16.66 MATLAB Skills for Aeronautics and Astronautics
Prereq: None
U (Fall; first half of term)
1-0-2 units
Introduction to basic MATLAB skills in programming, analysis, and plotting. Recommended for sophomores without previous MATLAB experience. Preference to Course 16 majors.
Staff
16.662 Engineering Innovation and Design
Engineering School-Wide Elective Subject.
Offered under: 2.723, 6.902, 16.662
Prereq: None
U (Fall, Spring)
2-1-3 units
See description under subject 6.902.
B. Kotelly

16.667 Engineering Leadership Lab
Engineering School-Wide Elective Subject.
Offered under: 6.913, 16.667
Subject meets with 6.911[J], 16.650[J]
Prereq: 6.902, 6.911, 6.912, or permission of instructor
U (Fall, Spring)
0-2-4 units
Can be repeated for credit.
L. McGonagle, J. Feiler

16.669 Project Engineering
Engineering School-Wide Elective Subject.
Offered under: 6.914, 16.669
Prereq: (6.902 and (6.911 or 6.912)) or permission of instructor
U (IAP)
1-2-1 units
O. de Weck, J. Feiler, L. McGonagle, R. Rahaman

16.671[J] Leading Innovation in Teams
Same subject as 6.915[J]
Prereq: None
U (Spring)
3-0-6 units
See description under subject 6.915[J]. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.
D. Nino, J. Schindall

16.676 Ethics for Engineers
Engineering School-Wide Elective Subject.
Offered under: 1.082, 2.900, 6.904, 10.01, 16.676, 22.014
Subject meets with 6.9041, 20.005
Prereq: None
U (Fall, Spring)
2-0-4 units
See description under subject 10.01.
D. Doneson, B. L. Trout

16.680 Project in Aeronautics and Astronautics
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity to work on projects related to aerospace engineering outside the department. Requires prior approval.
Consult M. A. Stuppard

16.681 Topics in Aeronautics and Astronautics
Prereq: None
U (Fall)
Units arranged
Can be repeated for credit.
Opportunity for study or laboratory project work not available elsewhere in the curriculum. Topics selected in consultation with the instructor.
Consult M. A. Stuppard

16.682 Selected Topics in Aeronautics and Astronautics
Prereq: None
U (IAP)
Units arranged
Can be repeated for credit.
Study by qualified students. Topics selected in consultation with the instructor. Prior approval required.
Consult M. A. Stuppard

16.683 Seminar in Aeronautics and Astronautics
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
2-0-0 units
Can be repeated for credit.
Speakers from campus and industry discuss current activities and advances in aeronautics and astronautics. Restricted to Course 16 students.
Consult M. A. Stuppard
16.687 Selected Topics in Aeronautics and Astronautics  
Prereq: None  
U (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Study by qualified students. Topics selected in consultation with the instructor. Prior approval required.  
Consult M. A. Stuppard

16.691 Practicum Experience  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
For Course 16 students participating in curriculum-related off-campus experiences in aerospace engineering and related areas. Before enrolling, a student must have an offer from a company or organization; must identify an appropriate supervisor in the AeroAstro department who, along with the off-campus supervisor, evaluate the student’s work; and must receive prior approval from the AeroAstro department. At the conclusion of the training, the student submits a substantive final report for review and approval by the MIT supervisor. Can be taken for up to 3 units. Contact the AeroAstro Undergraduate Office for details on procedures and restrictions.  
Consult M. Stuppard

Flight Transportation

16.707[J] The History of Aviation  
Same subject as STS.467[J]  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
See description under subject STS.467[J].  
D. Mindell

16.715 Aerospace, Energy, and the Environment  
Prereq: Chemistry (GIR) and (1.060, 2.006, 10.301, 16.003, 16.004, or permission of instructor)  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  
Addresses energy and environmental challenges facing aerospace in the 21st century. Topics include: aircraft performance and energy requirements, propulsion technologies, jet fuels and alternative fuels, lifecycle assessment of fuels, combustion, emissions, climate change due to aviation, aircraft contrails, air pollution impacts of aviation, impacts of supersonic aircraft, and aviation noise. Includes an in-depth introduction to the relevant atmospheric and combustion physics and chemistry with no prior knowledge assumed. Discussion and analysis of near-term technological, fuel-based, regulatory and operational mitigation options for aviation, and longer-term technical possibilities.  
S. Barrett
16.72 Air Traffic Control
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Introduces the various aspects of present and future Air Traffic Control systems. Descriptions of the present system: systems-analysis approach to problems of capacity and safety; surveillance, including NAS and ARTS; navigation subsystem technology; aircraft guidance and control; communications; collision avoidance systems; sequencing and spacing in terminal areas; future directions and development; critical discussion of past proposals and of probable future problem areas. Requires term paper.

H. Balakrishnan

16.767 Introduction to Airline Transport Aircraft Systems and Automation
Prereq: Permission of instructor
G (IAP)
3-2-1 units

Intensive one-week subject that uses the Boeing 767 aircraft as an example of a system of systems. Focuses on design drivers and compromises, system interactions, and human-machine interface. Morning lectures, followed by afternoon desktop simulator sessions. Critique and comparison with other transport aircraft designs. Includes one evening at Boston Logan International Airport aboard an aircraft. Enrollment limited.

C. M. Oman, B. Nield

16.763 Air Transportation Operations Research
Same subject as 1.233
Prereq: 6.431, 15.093, 16.71, or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Presents a unified view of advanced quantitative analysis and optimization techniques applied to the air transportation sector. Considers the problem of operating and managing the aviation sector from the perspectives of the system operators (e.g., the FAA), the airlines, and the resultant impacts on the end-users (the passengers). Explores models and optimization approaches to system-level problems, airline schedule planning problems, and airline management challenges. Term paper required.

H. Balakrishnan, C. Barnhart, P. P. Belobaba

16.75 Airline Management
Same subject as 1.234
Prereq: 16.71
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Overview of airline management decision processes, with a focus on economic issues and their relationship to operations planning models and decision support tools. Application of economic models of demand, pricing, costs, and supply to airline markets and networks. Examination of industry practice and emerging methods for fleet planning, route network design, scheduling, pricing and revenue management, with emphasis on the interactions between the components of airline management and profit objectives in competitive environments. Students participate in a competitive airline management simulation game as part of the subject requirements.

P. P. Belobaba

16.82 Flight Vehicle Engineering
Prereq: Permission of instructor
U (Spring)
3-3-6 units

Design of an atmospheric flight vehicle to satisfy stated performance, stability, and control requirements. Emphasizes individual initiative, application of fundamental principles, and the compromises inherent in the engineering design process. Includes instruction and practice in written and oral communication, through team presentations and a written final report. Course students are expected to complete two professional or concentration subjects from the departmental program before taking this capstone. Offered alternate Spring and Fall terms.

R. J. Hansman, M. Drela
16.821 Flight Vehicle Development
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
2-10-6 units. Institute LAB

Focuses on implementation and operation of a flight system. Emphasizes system integration, implementation, and performance verification using methods of experimental inquiry, and addresses principles of laboratory safety. Students refine subsystem designs and fabricate working prototypes. Includes component integration into the full system with detailed analysis and operation of the complete vehicle in the laboratory and in the field, as well as experimental analysis of subsystem performance, comparison with physical models of performance and design goals, and formal review of the overall system design. Knowledge of the engineering design process is helpful. Provides instruction in written and oral communication.

R. J. Hansman, M. Drela

16.831[J] Space Systems Development
Same subject as 12.431[J]
Prereq: Permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
2-10-6 units. Institute LAB

Students build a space system, focusing on refinement of subsystem designs and fabrication of full-scale prototypes. Subsystems are integrated into a vehicle and tested. Sub-system performance is verified using methods of experimental inquiry, and is compared with physical models of performance and design goals. Communication skills are honed through written and oral reports. Formal reviews include the Implementation Plan Review and the Acceptance Review. Knowledge of the engineering design process is helpful.

Staff

16.84 Advanced Autonomous Robotic Systems (New)
Prereq: None
U (Spring)
2-6-4 units

Students design an autonomous vehicle system to satisfy stated performance goals. Emphasizes both hardware and software components of the design and implementation. Entails application of fundamental principles and design engineering in both individual and group efforts. Practice in written and oral communication provided. Students showcase the final design to the public at the end of the term.

J. P. How, S. Karaman

16.842 Fundamentals of Systems Engineering
Prereq: Permission of instructor
G (Fall)
2-0-4 units

General introduction to systems engineering for aerospace and more general electro-mechanical-cyber systems. Built on the V-model as well as an agile approach. Topics include stakeholder analysis, requirements definition, system architecture and concept generation, trade-space exploration and concept selection, design definition and optimization, system integration and interface management, system safety, verification and validation, and commissioning and operations. Discusses the trade-offs between performance, life-cycle cost and system operability. Readings based on systems engineering standards. Individual homework assignments apply concepts from class. Prepares students for the systems field exam in the Department of Aeronautics and Astronautics.

E. F. Crawley
16.851 Satellite Engineering  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Fundamentals of satellite engineering design, including distributed satellite. Studies orbital environment. Analyzes problems of station keeping, attitude control, communications, power generation, structural design, thermal balance, and subsystem integration. Considers trade-offs among weight, efficiency, cost, and reliability. Discusses choice of design parameters, such as size, weight, power levels, temperature limits, frequency, and bandwidth. Examples taken from current satellite systems.  
K. Cahoy

16.855[J] Systems Architecting Applied to Enterprises  
Same subject as IDS.336[J]  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  
See description under subject IDS.336[J].  
D. Rhodes

16.861 Engineering Systems Analysis for Design  
Engineering School-Wide Elective Subject.  
Offered under: 1.146, 16.861, IDS.332  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Credit cannot also be received for IDS.333  
See description under subject IDS.332. Enrollment limited.  
R. de Neufville

Same subject as IDS.340[J]  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Covers important concepts and techniques in designing and operating safety-critical systems. Topics include the nature of risk, formal accident and human error models, causes of accidents, fundamental concepts of system safety engineering, system and software hazard analysis, designing for safety, fault tolerance, safety issues in the design of human-machine interaction, verification of safety, creating a safety culture, and management of safety-critical projects. Includes a class project involving the high-level system design and analysis of a safety-critical system.  
N. G. Leveson

16.885 Aircraft Systems Engineering  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-1-8 units  
Holistic view of the aircraft as a system, covering basic systems engineering, cost and weight estimation, basic aircraft performance, safety and reliability, life cycle topics, aircraft subsystems, risk analysis and management, and system realization. Small student teams retrospectively analyze an existing aircraft covering: key design drivers and decisions; aircraft attributes and subsystems; operational experience. Oral and written versions of the case study are delivered. Focuses on a systems engineering analysis of the Space Shuttle. Studies both design and operations of the shuttle, with frequent lectures by outside experts. Students choose specific shuttle systems for detailed analysis and develop new subsystem designs using state of the art technology.  
R. J. Hansman, W. Hoburg

16.886 Air Transportation Systems Architecting  
Prereq: Permission of instructor  
Acad Year 2019-2020: G (Fall)  
Acad Year 2020-2021: Not offered  
3-2-7 units  
Addresses the architecting of air transportation systems. Focuses on the conceptual phase of product definition including technical, economic, market, environmental, regulatory, legal, manufacturing, and societal factors. Centers on a realistic system case study and includes a number of lectures from industry and government. Past examples include the Very Large Transport Aircraft, a Supersonic Business Jet and a Next Generation Cargo System. Identifies the critical system level issues and analyzes them in depth via student team projects and individual assignments. Overall goal is to produce a business plan and a system specifications document that can be used to assess candidate systems.  
R. J. Hansman
Same subject as EM.427[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Provides a review of the principles, methods and tools of technology management for organizations and technologically-enabled systems including technology forecasting, scouting, roadmapping, strategic planning, R&D project execution, intellectual property management, knowledge management, partnering and acquisition, technology transfer, innovation management, and financial technology valuation. Topics explain the underlying theory and empirical evidence for technology evolution over time and contain a rich set of examples and practical exercises from aerospace and other domains, such as transportation, energy, communications, agriculture, and medicine. Special topics include Moore’s law, S-curves, the singularity and fundamental limits to technology. Students develop a comprehensive technology roadmap on a topic of their own choice.
O. L. de Weck

Same subject as IDS.338[J]
Prereq: 18.085 or permission of instructor
G (Spring)
3-1-8 units
See description under subject IDS.338[J].
O. de Weck

16.89[J] Space Systems Engineering
Same subject as IDS.339[J]
Prereq: 16.851 or permission of instructor
G (Spring)
4-2-6 units
Focus on developing space system architectures. Applies subsystem knowledge gained in 16.851 to examine interactions between subsystems in the context of a space system design. Principles and processes of systems engineering including developing space architectures, developing and writing requirements, and concepts of risk are explored and applied to the project. Subject develops, documents, and presents a conceptual design of a space system including a preliminary spacecraft design.
E. F. Crawley, J. A. Hoffman

16.895[J] Engineering Apollo: The Moon Project as a Complex System
Same subject as STS.471[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
4-0-8 units
See description under subject STS.471[J].
D. Mindell

Computation

16.90 Computational Modeling and Data Analysis in Aerospace Engineering
Prereq: 16.001, 16.002, 16.003, 16.004, or permission of instructor; Coreq: 16.09 or 6.041
U (Spring)
4-0-8 units
Introduces principles, algorithms, and applications of computational techniques arising in aerospace engineering. Techniques include numerical integration of systems of ordinary differential equations; numerical discretization of partial differential equations; probabilistic modeling; and computational aspects of estimation and inference. Example applications will include modeling, design, and data analysis.
Q. Wang

16.910[J] Introduction to Numerical Simulation
Same subject as 2.096[J], 6.336[J]
Prereq: 18.03 or 18.06
G (Fall)
3-6-3 units
See description under subject 6.336[J].
L. Daniel
Same subject as 2.097[J], 6.339[J]
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 units
Covers the fundamentals of modern numerical techniques for a wide range of linear and nonlinear elliptic, parabolic, and hyperbolic partial differential and integral equations. Topics include mathematical formulations; finite difference, finite volume, finite element, and boundary element discretization methods; and direct and iterative solution techniques. The methodologies described form the foundation for computational approaches to engineering systems involving heat transfer, solid mechanics, fluid dynamics, and electromagnetics. Computer assignments requiring programming.
Q. Wang, S. Groth

**16.930 Advanced Topics in Numerical Methods for Partial Differential Equations**
Prereq: 16.920[J]
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Covers advanced topics in numerical methods for the discretization, solution, and control of problems governed by partial differential equations. Topics include the application of the finite element method to systems of equations with emphasis on equations governing compressible, viscous flows; grid generation; optimal control of PDE-constrained systems; a posteriori error estimation and adaptivity; reduced basis approximations and reduced-order modeling. Computer assignments require programming.
J. Peraire

**16.940 Numerical Methods for Stochastic Modeling and Inference**
Prereq: (6.431 and 16.920[J]) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Y. M. Marzouk

**Other Graduate Subjects**

**16.THG Graduate Thesis**
Prereq: Permission of department
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to an SM, EAA, PhD, or ScD thesis; to be arranged by the student with an appropriate MIT faculty member, who becomes thesis supervisor. Restricted to students who have been admitted into the department.
Y. M. Marzouk

**16.971 Practicum Experience**
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For Course 16 students participating in curriculum-related off-campus experiences in aerospace engineering and related areas. Before enrolling, a student must have an offer from a company or organization; must identify an appropriate supervisor in the AeroAstro department who, along with the off-campus supervisor, evaluate the student’s work; and must receive prior approval from the AeroAstro department. At the conclusion of the training, the student submits a substantive final report for review and approval by the MIT supervisor. Can be taken for up to 3 units. Contact the AeroAstro Graduate Office for details on procedures and restrictions.
Consult B. Marois
16.980 Advanced Project
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Study, original investigation, or lab project work level by qualified students. Topics selected in consultation with instructor. Prior approval required.
Consult M. A. Stuppard

16.981 Advanced Project
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Study, original investigation, or lab project work by qualified students. Topics selected in consultation with instructor. Prior approval required.
Consult M. A. Stuppard

16.984 Seminar
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
2-0-o units
Can be repeated for credit.
Discussion of current interest topics by staff and guest speakers. Prior approval required. Restricted to Course 16 students.
Consult M. A. Stuppard

Same subject as 2.890[J], 10.792[J], 15.792[J]
Prereq: None
G (Fall, Spring)
2-0-o units
Can be repeated for credit.
See description under subject 15.792[J]. Preference to LGO students.
T. Roemer

16.990[J] Leading Creative Teams
Same subject as 6.928[J], 15.674[J]
Prereq: None
G (Fall, Spring)
3-0-6 units
See description under subject 6.928[J].
D. Nino, J. Schindall

16.995 Doctoral Research and Communication Seminar
Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 units
Presents fundamental concepts of technical communication. Addresses how to articulate a research problem, as well as the communication skills necessary to reach different audiences. The primary focus is on technical presentations, but includes aspects of written communication. Students give two technical talks during the term, and provide oral and written feedback to each other. Enrollment may be limited.
Staff

16.999 Teaching in Aeronautics and Astronautics
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit.
For qualified students interested in gaining teaching experience. Classroom, tutorial, or laboratory teaching under the supervision of a faculty member. Enrollment limited by availability of suitable teaching assignments. Consult department.
E. H. Modiano

16.S198 Advanced Special Subject in Mechanics and Physics of Fluids
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled fluids subjects. Prior approval required.
Consult M. A. Stuppard

16.S199 Advanced Special Subject in Mechanics and Physics of Fluids
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled fluids subjects. Prior approval required.
Consult M. A. Stuppard
16.5298 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled materials and structures subjects. Prior approval required.
Consult M. A. Stuppard

16.5299 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled materials and structures subjects. Prior approval required.
Consult B. L. Wardle

16.5398 Advanced Special Subject in Information and Control
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required.
Consult M. A. Stuppard

16.5399 Advanced Special Subject in Information and Control
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required.
Consult M. A. Stuppard

16.5498 Advanced Special Subject in Humans and Automation
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required.
Consult M. A. Stuppard

16.5499 Advanced Special Subject in Humans and Automation
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required.
Consult M. A. Stuppard

16.5598 Advanced Special Subject in Propulsion and Energy Conversion
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required.
Consult M. A. Stuppard

16.5599 Advanced Special Subject in Propulsion and Energy Conversion
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required.
Consult M. A. Stuppard
16.5798 Advanced Special Subject in Flight Transportation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. Consult M. A. Stuppard

16.5799 Advanced Special Subject in Flight Transportation
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. Consult M. A. Stuppard

16.5890 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. M. A. Stuppard

16.5893 Advanced Special Subject in Aerospace Systems
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. M. A. Stuppard

16.5896 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. Consult M. A. Stuppard

16.5897 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. M. A. Stuppard

16.5898 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. Consult D. Miller

16.5899 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. Consult M. A. Stuppard

16.5948 Advanced Special Subject in Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. Consult M. A. Stuppard

16.5949 Advanced Special Subject in Computation
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. Consult M. A. Stuppard
16.S982 Advanced Special Subject
Prereq: Permission of department
G (Fall)
Units arranged
Can be repeated for credit.

Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required.
Staff

16.S983 Advanced Special Subject
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required.
Consult M. A. Stuppard
AEROSPACE STUDIES (AS)

ROTC subjects do not carry academic credit at MIT, but they can be counted toward the PE Requirement. Up to two points per year with a maximum of four points.

Aerospace Studies

AS.101 Heritage and Values of the United States Air Force
Prereq: None. Coreq: AS.111
U (Fall)
1-0-1 units
Survey course designed to introduce students to the United States Air Force. Provides an overview of the basic characteristics, missions, and organizations of the Air Force.
T. Hubbard

AS.102 Heritage and Values of the United States Air Force
Prereq: AS.101 or permission of instructor; Coreq: AS.112
U (Spring)
1-0-1 units
Survey course designed to introduce students to the United States Air Force. Provides an overview of the basic characteristics, missions, and organizations of the Air Force. AS.102 is a continuation of AS.101.
T. Hubbard

AS.111 Leadership Laboratory
Prereq: None. Coreq: AS.112
U (Fall)
0-2-2 units
First-year General Military Course. Includes a study of Air Force customs and courtesies, drill and ceremonies, and military commands. Also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers, as well as interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets. AS.112 is a continuation of AS.111.
A. Dimitruk

AS.112 Leadership Laboratory
Prereq: AS.111 or permission of instructor; Coreq: AS.102
U (Spring)
0-2-2 units
Includes a study of Air Force customs and courtesies, drill and ceremonies, and military commands. Also includes studying the environment of an Air Force officer and learning about areas of opportunity available to commissioned officers, as well as interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets. AS.112 is a continuation of AS.111.
A. Dimitruk

AS.201 Team and Leadership Fundamentals
Prereq: AS.102 or permission of instructor; Coreq: AS.211
U (Fall)
1-0-1 units
Focuses on laying the foundation for teams and leadership. Topics center on skills that allow cadets to improve their leadership on a personal level and within a team. Prepares cadets for their field training experience where they have the opportunity to put the concepts covered in to practice. Aims to instill a leadership mindset and motivate sophomore students to transition from AFROTC cadet to AFROTC officer candidate.
T. Hubbard

AS.202 Team and Leadership Fundamentals
Prereq: AS.201 or permission of instructor; Coreq: AS.212
U (Spring)
1-0-1 units
Focuses on laying the foundation for teams and leadership. Topics center on skills that allow cadets to improve their leadership on a personal level and within a team. Prepares cadets for their field training experience where they have the opportunity to put the concepts covered in to practice. Aims to instill a leadership mindset and motivate sophomore students to transition from AFROTC cadet to AFROTC officer candidate.
T. Hubbard

AS.211 Leadership Laboratory
Prereq: AS.112 or permission of instructor; Coreq: AS.201
U (Fall)
0-2-2 units
Emphasizes development of techniques used to direct and inform. Students are assigned leadership and management positions in the AS.111 programs. AS.212 is a continuation of AS.211.
A. Dimitruk
**AS.212 Leadership Laboratory**  
Prereq: AS.211 or permission of instructor; Coreq: AS.202  
U (Spring)  
0-2-2 units  
Emphasizes development of techniques used to direct and inform. Students are assigned leadership and management positions in the AS.111 programs described above. AS.212 is a continuation of AS.211.  
A. Dimitruk

**AS.301 Leading People and Effective Communication**  
Prereq: AS.202 or permission of instructor; Coreq: AS.311  
U (Fall)  
3-0-6 units  
Covers advanced skills and knowledge in management and leadership, with special emphasis on enhancing cadets' leadership skills and communication. Cadets have an opportunity to try out these leadership and management techniques in a supervised environment as juniors and seniors.  
Staff

**AS.302 Leading People and Effective Communication**  
Prereq: AS.301 or permission of instructor; Coreq: AS.312  
U (Spring)  
3-0-3 units  
Covers advanced skills and knowledge in management and leadership, with special emphasis on enhancing cadets' leadership skills and communication. Cadets have an opportunity to try out these leadership and management techniques in a supervised environment as juniors and seniors.  
Staff

**AS.311 Leadership Laboratory**  
Prereq: AS.212 or permission of instructor; Coreq: AS.301  
U (Fall)  
0-2-4 units  
Consists of activities classified as advanced leadership experiences that involve the planning and controlling of military activities of the cadet corps and the preparation and presentation of briefings and other oral and written communications. Also includes interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets. AS.312 is a continuation of AS.311.  
A. Dimitruk

**AS.312 Leadership Laboratory**  
Prereq: AS.311 or permission of instructor; Coreq: AS.302  
U (Spring)  
0-2-4 units  
Consists of activities classified as advanced leadership experiences that involve the planning and controlling of military activities of the cadet corps and the preparation and presentation of briefings and other oral and written communications. Also includes interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets. AS.312 is a continuation of AS.311.  
A. Dimitruk

**AS.401 National Security Affairs/Preparation for Active Duty**  
Prereq: AS.302 or permission of instructor; Coreq: AS.411  
U (Fall)  
3-0-9 units  
Designed for college seniors, providing them the foundation to understand their role as military officers in American society. Includes an overview of the complex social and political issues facing the military profession and requires a measure of sophistication commensurate with the senior college level.  
Staff

**AS.402 National Security Affairs/Preparation for Active Duty**  
Prereq: AS.401 or permission of instructor; Coreq: AS.412  
U (Spring)  
3-0-3 units  
Designed for college seniors, providing them the foundation to understand their role as military officers in American society. Includes an overview of the complex social and political issues facing the military profession and requires a measure of sophistication commensurate with the senior college level. Provides information that prepares cadets for active duty.  
Staff

**AS.411 Leadership Laboratory**  
Prereq: AS.312 or permission of instructor; Coreq: AS.401  
U (Fall)  
0-2-4 units  
Consists of activities classified as advanced leadership experiences that involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. Also includes interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets. AS.412 is a continuation of AS.411.  
A. Dimitruk
AS.412 Leadership Laboratory
Prereq: AS.411 or permission of instructor; Coreq: AS.402
U (Spring)
0-2-4 units
Consists of activities classified as advanced leadership experiences that involve the planning and controlling of military activities of the cadet corps, and the preparation and presentation of briefings and other oral and written communications. Also includes interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets. AS.412 is a continuation of AS.411.
A. Dimitruk

AS.511 Leadership Laboratory
Prereq: AS.412 or permission of instructor
U (Fall)
Not offered regularly; consult department
0-2-4 units
Consists of activities classified as advanced leadership experiences to continue developing critical leadership, managerial and communication skills along with maintaining an active, physical lifestyle needed in today's Air Force. AS.512 is a continuation of AS.511.
A. Dimitruk

AS.512 Leadership Laboratory
Prereq: AS.511 or permission of instructor
U (Spring)
Not offered regularly; consult department
0-2-4 units
Consists of activities classified as advanced leadership experiences to continue developing critical leadership, managerial and communication skills along with maintaining an active, physical lifestyle needed in today's Air Force. AS.512 is a continuation of AS.511.
A. Dimitruk

AS.811 Leadership Laboratory
Prereq: AS.411 or permission of instructor
U (Fall)
0-2-4 units
Consists of activities classified as advanced leadership experiences to continue developing critical leadership, managerial and communication skills, along with maintaining an active, physical lifestyle needed in today's Air Force.
P. Dela Cruz

AS.812 Leadership Laboratory
Prereq: Permission of instructor
U (Spring)
0-2-4 units
Cadets develop critical leadership, managerial and communication skills while maintaining an active, physical lifestyle needed in today's Air Force. Consists of activities classified as advanced leadership experiences that involve mentoring the cadet corps, special projects, and event planning.
A. Dimitruk
**ANTHROPOLOGY (COURSE 21A)**

The anthropology subjects described below are grouped within seven areas: Core Subjects; Culture and Identity; Global Health; Environment, Development, and Conflict; Science, Technology, and Media; Cross-cultural Dialog and Investigations; and Independent Study, Special Subjects, and Thesis.

**Core Subjects**

**21A.00 Introduction to Anthropology: Comparing Human Cultures**
Prereq: None
U (Spring)
3-0-9 units. HASS-S

Through the comparative study of different cultures, anthropology explores fundamental questions about what it means to be human. Seeks to understand how culture shapes societies, from the smallest island in the South Pacific to the largest Asian metropolis, and affects the way institutions work, from scientific laboratories to Christian mega-churches. Provides a framework for analyzing diverse facets of human experience, such as gender, ethnicity, language, politics, economics, and art.

_G. Jones_

**21A.01 How Culture Works**
Prereq: None
U (Fall)
3-0-9 units. HASS-S

Introduces diverse meanings and uses of the concept of culture with historical and contemporary examples from scholarship and popular media around the globe. Includes first-hand observations, synthesized histories and ethnographies, quantitative representations, and visual and fictionalized accounts of human experiences. Students conduct empirical research on cultural differences through the systematic observation of human interaction, employ methods of interpretative analysis, and practice convincing others of the accuracy of their findings.

_M. Buyandelger_

**21A.104 Memory, Culture, and Forgetting**
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
2-0-7 units. HASS-S

Introduces scholarly debates about the sociocultural practices through which individuals and societies create, sustain, recall, and erase memories. Emphasis is given to the history of knowledge, construction of memory, the role of authorities in shaping memory, and how societies decide on whose versions of memory are more "truthful" and "real." Other topics include how memory works in the human brain, memory and trauma, amnesia, memory practices in the sciences, false memory, sites of memory, and the commodification of memory.

_M. Buyandelger_

**21A.103[J] The Science of Race, Sex, and Gender**
Same subject as STS.046[J], WGS.225[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S

Cross-cultural case studies introduce students to the anthropological study of the social institutions and symbolic meanings of family, gender, and sexuality. Investigates the different forms families and households take and considers their social, emotional, and economic dynamics. Analyzes how various expectations for, and experiences of, family life are rooted in or challenged by particular conceptions of gender and sexuality. Addresses questions surrounding what it means to be a "man" or a "woman," as well as a family member, in different social contexts.

_H. Paxson_

**21A.120 American Dream: Exploring Class in the US**
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Explores the experiences and understandings of class among Americans positioned at different points along the US social spectrum. Considers a variety of classic frameworks for analyzing social class and uses memoirs, novels and ethnographies to gain a sense of how class is experienced in daily life and how it intersects with other forms of social difference such as race and gender.

_C. Walley_

See description under subject WGS.225[J].

_A. Sur_
21A.130[J] Introduction to Latin American Studies
Same subject as 17.55[J], 21G.084[J], 21H.170[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S; CI-H
See description under subject 17.55[J].
T. Padilla, P. Duong

21A.132[J] Race and Migration in Europe (New)
Same subject as 21G.058[J]
Subject meets with 21G.418
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
See description under subject 21G.058[J]. Limited to 18.
B. Stoetzer

21A.140[J] Cultures of East Asia
Same subject as 21G.047[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
Explores diverse cultures, everyday experiences, and political economies in East Asian countries, such as China, Japan, Korea, and Singapore, with additional examples from the surrounding regions. Examines the different ways people in these regions experience and understand globalization, as well as the changing structures of kinship and family, work and organizational culture, media, consumption, and the role of government. Readings cover ethnographic studies of the world’s largest seafood market in Tokyo, the effect of the Asian financial crisis on South Korea, the role of science in formulating China’s one child policy and its economic and social implications, and the state and ethnic diversity in Singapore.
M. Buyandelger

21A.131[J] Images of Asian Women: Dragon Ladies and Lotus Blossoms
Same subject as 21G.048[J], WGS.274[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Explores some of the forces and mechanisms through which stereotypes are built and perpetuated. In particular, examines stereotypes associated with Asian women in colonial, nationalist, state-authoritarian, and global/diasporic narratives about gender and power. Students read ethnography, fiction, and history, and view films to examine the politics and circumstances that create and perpetuate the representation of Asian women as dragon ladies, lotus blossoms, despotic tyrants, desexualized servants, and docile subordinates. Students are introduced to debates about Orientalism, gender, and power.
M. Buyandelger

21A.141[J] Gender and Japanese Popular Culture
Same subject as 21G.039[J], WGS.154[J]
Subject meets with 21G.591
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
See description under subject 21G.039[J].
I. Condry

21A.150 Teaching and Learning: Cross-Cultural Perspectives
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Explores the diverse ways that people teach and learn in different countries, disciplines, and subcultures (computer gamers, magicians, jazz musicians, etc.). Compares schooling to other forms of knowledge transmission, from initiation and apprenticeship to recent innovations in online education. Students discuss various learning theories and apply them to a variety of in-class activities using qualitative methods to conduct original research on topics of their choice. Limited to 15.
G. Jones
21A.151 Language, Communication, and Culture (New)
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Provides an introduction to linguistic anthropology, which deals with the role of language in social, cultural, and political processes. Considers language as more than just a neutral conduit for exchanging information, but rather as a factor shaping and shaped by interpersonal relationships, national identity, and perception of the world. Drawing on case studies and first-hand observations, students apply methods for analyzing communication and miscommunication in everyday conversation, professional discourse, verbal performance, online interaction, political rhetoric, and more.
G. Jones

21A.155 Food, Culture, and Politics
Prereq: None
U (Fall)
3-0-9 units. HASS-S
Explores connections between what we eat and who we are through cross-cultural study of how personal identities and social groups are formed via food production, preparation, and consumption. Organized around critical discussion of what makes "good" food good (healthy, authentic, ethical, etc.). Uses anthropological and literary classics as well as recent writing and films on the politics of food and agriculture. Instruction and practice in written and oral communication provided.
H. Paxson

21A.157 The Meaning of Life
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Examines how a variety of cultural traditions propose answers to the question of how to live a meaningful life. Considers the meaning of life, not as a philosophical abstraction, but as a question that individuals grapple with in their daily lives, facing difficult decisions between meeting and defying cultural expectations. Provides tools for thinking about moral decisions as social and historical practices, and permits students to compare and contextualize the ways people in different times and places approach fundamental ethical concerns.
S. Helmreich, H. Paxson

Global Health

21A.300[J] Research Methods in Global Health and Development
Same subject as 11.143[J]
Subject meets with 11.243[J], 21A.329[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
3-3-6 units. HASS-S
See description under subject 11.143[J].
E. C. James

21A.301 Disease and Health: Culture, Society, and Ethics
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
From a cross cultural and global perspective, examines how medicine is practiced, with particular emphasis on biomedicine. Analyzes medical practice as a cultural system, focusing on the human and social side of things. Considers how people in different societies think of disease, health, body, and mind. Enrollment limited.
A. Moran-Thomas

21A.302[J] Dilemmas in Biomedical Ethics: Playing God or Doing Good?
Same subject as 11.133[J], WGS.271[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
See description under subject 11.133[J].
E. C. James
21A.303[J] The Anthropology of Biology
Same subject as STS.060[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

Applies the tools of anthropology to examine biology in the age of genomics, biotechnological enterprise, biodiversity conservation, pharmaceutical bioprospecting, and synthetic biology. Examines such social concerns such as bioterrorism, genetic modification, and cloning. Offers an anthropological inquiry into how the substances and explanations of biology — ecological, organic, cellular, molecular, genetic, informatic — are changing. Examines such artifacts as cell lines, biodiversity databases, and artificial life models, and using primary sources in biology, social studies of the life sciences, and literary and cinematic materials, asks how we might answer Erwin Schrodinger's 1944 question, "What Is Life?", today.
S. Helmreich

21A.305[J] Drugs, Politics, and Culture
Same subject as STS.062[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

Explores the relationship between drugs and society in a cross-cultural perspective, looking at intersections between drugs and phenomena such as poverty, religion, technology, colonialism, conflict, and global capitalism. Examines histories behind the use and abuse of various substances, including opium, cocaine, and prescription pharmaceuticals. Considers why different societies prohibit and sanction different drugs; the politics of markets and clinical trials; and how social conditions affect the circulation of medicines in global health. Limited to 25.
A. Moran-Thomas

21A.308[J] Global Mental Health (New)
Same subject as 11.136[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

E. James

21A.311 The Social Lives of Medical Objects
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S

Explores the theories and assumptions built into objects meant to improve health. Students read and discuss case studies that follow the often unexpected ways intended intervention objects are designed and developed, globally travel, and at times become part of people's everyday lives. Studies include a broad range of medical materials and development technologies, such as penicillin, antimalarial drugs, water pumps, air filters, prosthetic limbs, glucose meters, scales, DDT insecticides, bednets, and micro-nutrient pills. Limited to 20.
A. Moran-Thomas

21A.319[J] History and Anthropology of Medicine and Biology
Same subject as STS.330[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Explores recent historical and anthropological approaches to the study of medicine and biology. Topics might include interaction of disease and society; science, colonialism, and international health; impact of new technologies on medicine and the life sciences; neuroscience and psychiatry; race, biology and medicine. Specific emphasis varies from year to year.
S. Helmreich

21A.329[J] Research Methods in Global Health and Development
Same subject as 11.243[J]
Subject meets with 11.143[J], 21A.300[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
3-3-6 units

See description under subject 11.243[J].
E. C. James

21A.331[J] Infections and Inequalities: Interdisciplinary Perspectives on Global Health
Same subject as 11.134[J], HST.431[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

E. James, A. Chakraborty
Environment, Development, and Conflict

21A.400 The Stakes of International Development
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

Offers an anthropological perspective on international development. Students consider development, not in policy or technical terms, but through its social and political dynamics and its impacts on daily life. Examines the various histories of, and meanings given to, international development as well as the social organization of aid agencies and projects. Follows examples of specific projects in various parts of the world. Examples: water projects for pastoralists in Africa, factory development in Southeast Asia, and international nature parks in Indonesia.

C. Walley

21A.409[J] Ethics of Intervention
Same subject as 11.238[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

See description under subject 11.238[J].

E. C. James

21A.410 Environmental Struggles
Prereq: None
U (Spring)
3-0-9 units. HASS-S

Offers an international perspective on the environment. Using environmental conflict to consider the stakes that groups in various parts of the world have in nature, while also exploring how ecological and social dynamics interact and change over time, subject considers such controversial environmental issues as: nuclear contamination in Eastern Europe; genetic bioprospecting in Mexico; toxic run-off in the rural US; the Bhopal accident in India; and the impact of population growth in the Third World.

C. Walley

21A.411[J] People and Other Animals
Same subject as 21H.380[J]
Subject meets with 21A.419[J], 21H.380[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
2-0-10 units. HASS-S

See description under subject 21H.380[J].

H. Ritvo

21A.419[J] People and Other Animals
Same subject as 21H.380[J]
Subject meets with 21A.411[J], 21H.380[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
2-0-10 units

See description under subject 21H.380[J].

H. Ritvo

21A.429[J] Environmental Conflict
Same subject as STS.320[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Explores the complex interrelationships among humans and natural environments, focusing on non-western parts of the world in addition to Europe and the United States. Use of environmental conflict to draw attention to competing understandings and uses of “nature” as well as the local, national and transnational power relationships in which environmental interactions are embedded. In addition to utilizing a range of theoretical perspectives, subject draws upon a series of ethnographic case studies of environmental conflicts in various parts of the world.

C. Walley

21A.461 What Is Capitalism?
Prereq: None
U (Fall)
3-0-9 units. HASS-S; CI-H

Introduces academic debates on the nature of capitalism, drawing upon the ideas of scholars as diverse as Adam Smith and Karl Marx. Examines anthropological studies of how contemporary capitalism plays out in people’s daily lives in a range of geographic and social settings, and implications for how we understand capitalism today. Settings range from Wall Street investment banks to auto assembly plants, from family businesses to consumer shopping malls. Enrollment limited.

C. Walley
Science, Technology, and Media

21A.500[J] Technology and Culture
Same subject as STS.075[J]
Prereq: None
U (Fall, Spring)
2-0-7 units. HASS-S
Examine the intersections of technology, culture, and politics in a variety of social and historical settings ranging from 19th-century factories to 21st-century techno dance floors, from Victorian London to anything-goes Las Vegas. Discussions and readings organized around three questions: what cultural effects and risks follow from treating biology as technology; how computers have changed the way we think about ourselves and others; and how politics are built into our infrastructures. Explores the forces behind technological and cultural change; how technological and cultural artifacts are understood and used by different communities; and whether, in what ways, and for whom technology has produced a better world. Limited to 40.
S. Helmreich

21A.501[J] Art, Craft, Science
Same subject as STS.074[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Credit cannot also receive for 21A.509[J], STS.474[J]
Examine how people learn, practice, and evaluate traditional and contemporary craft techniques. Social science theories of design, embodiment, apprenticeship learning, skill, labor, expertise, and tacit knowledge are used to explore distinctions among art, craft, and science. Also discusses the commodification of craft into market goods, collectible art, and tourism industries. Ethnographic and historical case studies include textiles, Shaker furniture, glassblowing, quilting, cheesemaking, industrial design, home and professional cooking, factory and laboratory work, CAD/CAM. Demonstrations, optional field trips, and/or hands-on craft projects may be included. Students taking graduate version complete additional assignments.
H. Paxson

21A.502 Fun and Games: Cross-Cultural Perspectives
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Consider the cultural organization of play in different communities and societies. Explores why all people play, how different cultures experience fun, and what particular games mean, if anything. Surveys major theories of play in relation to a variety of play phenomena, such as jokes, video games, children’s fantasies, sports, and entertainment spectacles. As a final project, students develop their own case study.
G. Jones

21A.504[J] Cultures of Computing
Same subject as STS.086[J], WGS.276[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-S
Examine computers anthropologically, as artifacts revealing the social orders and cultural practices that create them. Students read classic texts in computer science along with cultural analyses of computing history and contemporary configurations. Explores the history of automata, automation and capitalist manufacturing; cybernetics and WWII operations research; artificial intelligence and gendered subjectivity; robots, cyborgs, and artificial life; creation and commodification of the personal computer; the growth of the Internet as a military, academic, and commercial project; hackers and gamers; technobodies and virtual sociality. Emphasis is placed on how ideas about gender and other social differences shape labor practices, models of cognition, hacking culture, and social media.
Staff

21A.505[J] The Anthropology of Sound
Same subject as STS.065[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Examine the ways humans experience sound and how perceptions and technologies of sound emerge from cultural, economic, and historical worlds. Consider how the sound/noise/music boundaries have been imagined, created, and modeled across sociocultural and historical contexts. Learn how environmental, linguistic, and musical sounds are construed cross-culturally as well as the rise of telephony, architectural acoustics, sound recording, multi-channel and spatial mix performance, and the globalized travel of these technologies. Questions of sound ownership, property, authorship, remix, and copyright in the digital age are also addressed.
S. Helmreich
21A.506 The Anthropology of Politics: Persuasion and Power
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S

Introduces the ethnographic study of politics, i.e., what anthropologists understand to be “political” in various social and economic systems, from small-scale societies to liberal democratic states. Examines politics across three contemporary contexts: electoral politics, public spheres, and bureaucracies and humanitarian governance. Students consider and analyze how questions of authority, coercion, and violence have been theorized to relate to the political, and how some aspects of social life are regimented in explicitly non-political ways.

21A.507[J] Resonance: Sonic Experience, Science, and Art
Same subject as 4.648[J]
Subject meets with 4.649[J], 21A.519[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A

See description under subject 4.648[J].
S. Helmreich, C. Jones

21A.508 Culture and Ethics in Science Fiction Worlds
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Examines the ethical and controversial aspects of technology's impacts on society, as approached through the lens of science fiction and media. From novels such as *Kindred* to films like *Sleep Dealer*, the social inequalities and political complexities portrayed in science fiction worlds offer a launch point to discuss the uneasy aspects and uneven reach of science, technology, and medicine. Covers issues including gene editing, data privacy, border surveillance, human experimentation, environmental crises, war industries, and the impacts of AI.
A. Moran-Thomas

21A.509[J] Art, Craft, Science
Same subject as STS.474[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Credit cannot also be received for 21A.501[J], STS.074[J]

Examines how people learn, practice, and evaluate traditional and contemporary craft techniques. Social science theories of design, embodiment, apprenticeship learning, skill, labor, expertise, and tacit knowledge are used to explore distinctions among art, craft, and science. Also discusses the commoditization of craft into market goods, collectible art, and tourism industries. Ethnographic and historical case studies include textiles, Shaker furniture, glassblowing, quilting, cheesemaking, industrial design, home and professional cooking, factory and laboratory work, CAD/CAM. Demonstrations, optional field trips, and/or hands-on craft projects may be included. Students taking graduate version complete additional assignments.
H. Paxson

21A.519[J] Resonance: Sonic Experience, Science, and Art
Same subject as 4.649[J]
Subject meets with 4.648[J], 21A.507[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 4.649[J].
S. Helmreich, C. Jones

21A.520 Magic, Science, and Religion
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

Explores the origins of magic, science, and religion as forms of belief within and across cultures. Addresses the place of rationality and belief in competing sociocultural theories, with a focus on analyzing modern perspectives. Examines how cases of overlap between magic, science, and religion raise new questions about modernity and human nature.
G. Jones
21A.529 Virtual and Other Realities (New)
Prereq: None
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Explores virtual worlds created in cyberspace, non-internet ritual spaces, science laboratories, tech companies, and artistic performances from an anthropological perspective. Students acquire analytical tools for thinking about immersive experiences of being someone else, and the socio-economic, political, and technological contexts behind creating specific types of parallel worlds. Examines and contextualizes the ways in which scientists, designers, shamans, ritual specialists, and corporations imagine, respond to, and steer people's desires and needs. Considers debates on the future of imagination, sensory experiences, and creativity in technology. Limited to 20. This class is designed as a seminar class for graduate and advanced undergraduate students.
M. Buyandelger

21A.550[J] DV Lab: Documenting Science through Video and New Media
Same subject as STS.064[J]
Subject meets with 21A.559
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-3-6 units. HASS-A; CI-H
Uses documentary video making as a tool to explore everyday social worlds (including those of science and engineering), and for thinking analytically about media itself. Students make videos and engage in critical analysis. Provides students with instruction on how to communicate effectively and creatively in a visual medium, and how to articulate their own analyses of documentary images in writing and spoken word. Readings drawn from documentary film theory, anthropology, and social studies of science. Students view a wide variety of classic documentaries and explore different styles. Lab component devoted to digital video production. Includes a final video project. Students taking graduate version complete additional assignments. Limited to 12.
C. Walley, C. Boebel

Cross-cultural Dialog and Investigations
21A.801[J] Cross-Cultural Investigations: Technology and Development
Same subject as EC.702[J], STS.071[J]
Subject meets with EC.792[J], 21A.839[J], STS.481[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
Enhances cross-cultural understanding through discussion of practical, ethical, and epistemological issues in conducting social science and applied research in foreign countries or unfamiliar communities. Includes research practicum to help students develop interviewing, participant-observation, and other qualitative research skills, as well as critical discussion of case studies. Open to all interested students, but intended particularly for those planning to undertake exploratory research or applied work abroad. Students taking graduate version complete additional assignments.
C. Walley
21A.802 Seminar in Ethnography and Fieldwork
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
Introduction to ethnographic practices: the study of and communicating about culture. Subject provides instruction and practice in writing, revision of fieldnotes, and a final paper. Preference to Anthropology majors and minors.
Staff

21A.809 Designing Empirical Research in the Social Sciences
Subject meets with 15.347
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Foundations of good empirical research in the social sciences. Introduction to the basic assumptions and underlying logic of both qualitative and quantitative methodologies. Explores a variety of approaches to research design, evaluates the products of empirical research, and practices several common techniques. Discusses several major theoretical paradigms used as interpretive frameworks for social science research. Students develop a proposal for their own research project.
S. Silbey

21A.819[J] Qualitative Research Methods
Same subject as 15.349[J]
Prereq: Permission of instructor
G (Spring)
3-6-3 units
Training in the design and practice of qualitative research. Organized around illustrative texts, class exercises, and student projects. Topics include the process of gaining access to and participating in the social worlds of others; techniques of observation, fieldnote-taking, researcher self-monitoring and reflection; methods of inductive analysis of qualitative data including conceptual coding, grounded theory, and narrative analysis. Discussion of research ethics, the politics of fieldwork, modes of validating researcher accounts, and styles of writing up qualitative field research.
S. Silbey

21A.829[J] Ethnography
Same subject as STS.360[J]
Prereq: None. Coreq: 21A.859[J]; permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject STS.360[J]. Preference to HASTS, CMS, HTC and Sloan graduate students.
M. Fischer

21A.839[J] Cross-Cultural Investigations: Technology and Development
Same subject as EC.792[J], STS.481[J]
Subject meets with EC.702[J], 21A.801[J], STS.071[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units
Enhances cross-cultural understanding through discussion of practical, ethical, and epistemological issues in conducting social science and applied research in foreign countries or unfamiliar communities. Includes research practicum to help students develop interviewing, participant-observation, and other qualitative research skills, as well as critical discussion of case studies. Open to all interested students, but intended particularly for those planning to undertake exploratory research or applied work abroad. Students taking graduate version complete additional assignments.
C. Walley

21A.859[J] Social Theory and Analysis
Same subject as STS.250[J]
Prereq: None
G (Fall)
3-0-9 units
Major theorists and theoretical schools since the late 19th century. Marx, Weber, Durkheim, Bourdieau, Levi-Strauss, Geertz, Foucault, Gramsci, and others. Key terms, concepts, and debates.
M. Fischer
Independent Study, Special Subjects, and Thesis

21A.901 Independent Study in Anthropology
Prereq: Two subjects in Anthropology
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Opportunity for independent study, guided research, practicum, or field work under regular supervision by a faculty member. Projects require prior approval of the instructor and Head of the Anthropology Program. Normal maximum is 6 units; exceptional 9- or 12-unit projects occasionally approved.
Consult Program Head

21A.902 Independent Study in Anthropology
Prereq: Two subjects in Anthropology
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Opportunity for independent study, guided research, practicum, or field work under regular supervision by a faculty member. Projects require prior approval of the instructor and Head of the Anthropology Program. Normal maximum is 6 units; exceptional 9- or 12-unit projects occasionally approved.
Consult Program Head

21A.929 Graduate Independent Study
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Opportunity for study or projects at an advanced level with an Anthropology faculty member.
Consult Program Head

21A.939 Graduate Independent Study
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Opportunity for study or projects at an advanced level with an Anthropology faculty member.
Consult Program Head

21A.949 Graduate Independent Study
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Opportunity for study or projects at an advanced level with an Anthropology faculty member.
Consult Program Head

21A.950 Teaching Anthropology
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
For qualified graduate students serving as either a teaching assistant or instructor for subjects in Anthropology. Enrollment limited by availability of suitable teaching assignments.
Staff

21A.S01-21A.S02 Special Subject in Anthropology
Prereq: None
U (Fall)
Units arranged
Seminar or lecture on a topic in anthropology that is not covered in the regular curriculum.
Staff

21A.S10-21A.S11 Special Graduate Subject in Anthropology
Prereq: None
G (Fall, IAP, Summer)
Units arranged
Seminar or lecture on a topic in anthropology that is not covered in the regular curriculum.
Staff

21A.THT Anthropology Pre-Thesis Tutorial
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Students writing a thesis work with an advisor to develop research topics, review relevant research and scholarship, frame research questions, choose an appropriate methodology for data collection and analysis, and draft the introductory and methodology sections of their theses. Includes substantial practice in writing (with revision) and oral presentations.
Consult Program Head
21A.THU Undergraduate Thesis in Anthropology
Prereq: 21A.THT
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Completion of work on the senior major thesis under supervision of a faculty thesis advisor. Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and a final meeting with a committee of faculty evaluators to discuss the successes and limitations of the project.

Staff

21A.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.

Staff

21A.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.

Staff
ARCHITECTURE (COURSE 4)

Architecture Design

4.001 Where Is and What Is Architecture and Design?
Prereq: None
U (Fall)
1-1-1 units

Facilitates the exploration of architecture, art and design majors and minors at MIT. Also points to the presence of design in a variety of careers. A selection of MIT faculty and alumni from various disciplines lecture and lead discussions on the role of design in their respective area of expertise. To help students understand the breadth of design thinking, there will be visits to local architecture and design firms, as well as companies in various disciplines with design departments. Students interview an MIT alumni currently working as an architect or designer at their office, then present what they discovered to the class. Subject can count toward the 9-unit discovery-focused credit limit for first year students. Preference to first-year students.
Consult P. Pettigrew

4.021 Design Studio: How to Design
Prereq: None
U (Fall, Spring)
3-3-6 units. HASS-A
Credit cannot also be received for 4.02A

Introduces fundamental design principles as a way to demystify design and provide a basic introduction to all aspects of the process. Stimulates creativity, abstract thinking, representation, iteration, and design development. Equips students with skills to have more effective communication with designers, and develops their ability to apply the foundations of design to any discipline. Limited to 25; preference to Course 4 and 4B majors and Design and Architecture minors, and first- and second-year students.
Consult W. O’Brien, S. Tibbits

4.022 Design Studio: Introduction to Design Techniques and Technologies
Prereq: 4.02A or 4.021
U (Fall, Spring)
3-3-6 units

Introduces the tools, techniques and technologies of design across a range of projects in a studio environment. Explores concepts related to form, function, materials, tools, and physical environments through project-based exercises. Develops familiarity with design process, critical observation, and the translation of design concepts into digital and physical reality. Utilizing traditional and contemporary techniques and tools, faculty across various design disciplines expose students to a unique cross-section of inquiry. Limited to 25; preference to Course 4 and 4B majors, Design and Architecture minors, and first- and second-year students.
Consult W. O’Brien, S. Tibbits

4.023 Architecture Design Studio I
Prereq: 4.022
U (Fall)
0-12-12 units

Provides instruction in architectural design and project development within design constraints including architectural program and site. Students engage the design process through various 2-dimensional and 3-dimensional media. Working directly with representational and model making techniques, students gain experience in the conceptual, formal, spatial and material aspects of architecture. Instruction and practice in oral and written communication provided. Preference to Course 4 majors and minors.
Consult W. O’Brien

4.024 Architecture Design Studio II
Prereq: 4.023, 4.401, and 4.500
U (Spring)
0-12-12 units

Provides instruction in architectural design and project development with an emphasis on social, cultural, or civic programs. Builds on foundational design skills with more complex constraints and contexts. Integrates aspects of architectural theory, building technology, and computation into the design process. Preference to Course 4 majors.
Consult W. O’Brien
4.025 Architecture Design Studio III  
Prereq: 4.024 and 4.440[J]  
U (Fall)  
0-12-12 units  
Provides instruction in more advanced architectural design projects. Students develop integrated design skills as they negotiate the complex issues of program, site, and form in a specific cultural context. Focuses on how architectural concepts and ideas translate into built environments that transform the public sphere. Studio designed to prepare students for graduate studies in the field. Preference to Course 4 majors.  
Consult W. O’Brien

4.02A Design Studio: How to Design Intensive  
Prereq: None  
U (IAP)  
2-5-2 units. HASS-A  
Credit cannot also be received for 4.021  
Introduces fundamental design principles as a way to demystify design and provide a basic introduction to all aspects of the process. Stimulates creativity, abstract thinking, representation, iteration, and design development. Equips students with skills to have more effective communication with designers, and develops their ability to apply the foundations of design to any discipline. Lab fee. Limited to 30; preference to Course 4 and 4B majors and Design and Architecture minors, and first- and second-year students.  
Consult W. O’Brien, S. Tibbits

4.031 Design Studio: Objects and Interaction  
Prereq: 4.022  
U (Fall)  
3-3-6 units  
Overview of design as the giving of form, order, and interactivity to the objects that define our daily life. Follows the path from project to interactive product. Covers the overall design process, preparing students for work in a hands-on studio learning environment. Emphasizes design development and constraints. Topics include the analysis of objects; interaction design and user experience; design methodologies, current dialogues in design; economies of scale vs. means; and the role of technology in design. Provides a foundation in prototyping skills such as carpentry, casting, digital fabrication, electronics, and coding. Limited to 15; preference to Course 4-B majors and Design Minors.  
Consult M. Coelho

4.032 Design Studio: Information and Visualization  
Subject meets with 4.033  
Prereq: 4.022  
U (Spring)  
3-3-6 units  
Provides an introduction to working with information, data and visualization in a hands-on studio learning environment. Studies the history and theory of information, followed by a series of projects in which students apply the ideas directly. Progresses through basic data analysis, visual design and presentation, and more sophisticated interaction techniques. Topics include storytelling and narrative, choosing representations, understanding audiences, and the role of designers working with data. Graduate students are expected to complete additional assignments.  
Consult S. Tibbits

4.033 Design Studio: Information and Visualization  
Subject meets with 4.032  
Prereq: None  
G (Spring)  
Units arranged  
Provides an introduction to working with information, data and visualization in a hands-on studio learning environment. Studies the history and theory of information, followed by a series of projects in which students apply the ideas directly. Progresses through basic data analysis, visual design and presentation, and more sophisticated interaction techniques. Topics include storytelling and narrative, choosing representations, understanding audiences, and the role of designers working with data. Graduate students are expected to complete additional assignments.  
Consult S. Tibbits

4.041 Design Studio: Advanced Product Design  
Prereq: 4.031 or permission of instructor  
U (Spring)  
3-3-6 units  
Focuses on producing a small series of manufactured products. Students develop products that address specific user needs, propose novel design concepts, iteratively prototype, test functionality, and ultimately exhibit their work in a retail context. Stemming from new research and technological developments around MIT, students try to imagine the future products that emerge from new materials and machine intelligence. Provides an in-depth exploration of the design and manufacturing of products, through narrative, form, function, fabrication, and their relationship to customers. Enrollment limited to 15; preference to Course 4B majors and Design Minors.  
Consult S. Tibbits
4.043 Design Studio: Advanced Interactions
Subject meets with 4.044
Prereq: 4.031 or permission of instructor
U (Spring)
3-3-6 units
Overview of core principles and methodologies for the design of interaction and behavior across objects and spaces. Students develop high-fidelity, interactive prototypes that can be deployed and experienced by real users. Topics include the history of human-computer interaction, behavior prototyping, augmented and virtual reality, haptics, internet of things, and wearables. Provides a foundation in technical skills, such as physical prototyping, 2D and 3D animation, Unity, coding, and electronics. Graduate students are expected to complete additional assignments. Limited to 16; preference to 4B majors and Design minors.
M. Coelho

4.044 Design Studio: Advanced Interactions (New)
Subject meets with 4.043
Prereq: Permission of instructor
G (Spring)
Units arranged
Overview of core principles and methodologies for the design of interaction and behavior across objects and spaces. Students develop high-fidelity, interactive prototypes that can be deployed and experienced by real users. Topics include the history of human-computer interaction, behavior prototyping, augmented and virtual reality, haptics, internet of things, and wearables. Provides a foundation in technical skills, such as physical prototyping, 2D and 3D animation, Unity, coding, and electronics. Graduate students are expected to complete additional assignments. Limited to 16; preference to 4B majors and Design minors.
Consult M. Coelho

4.051 The Human Factor in Innovation and Design Strategy
Prereq: None
U (Fall)
3-3-6 units
Focuses on understanding the emerging field of human-centered design and its approach to real-world design challenges. Through group working sessions, design reviews, and presentations by leading design practitioners, thinkers, and business leaders, the class explores core methodologies on how design brings value to human experiences and to the contemporary marketplace. Limited to 20.
Consult L. Moreau

4.053 Visual Communication Fundamentals
Prereq: None
U (Fall)
3-3-6 units
Provides an introduction to visual communication, emphasizing the development of a visual and verbal vocabulary. Presents the fundamentals of line, shape, color, composition, visual hierarchy, word/image relationships and typography as building blocks for communicating with clarity, emotion, and meaning. Students develop their ability to analyze, discuss and critique their work and the work of the designed world. Limited to 15; preference to Course 4-B majors and Design minors.
Consult S. Tibbits

4.091 Independent Study in Design
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Staff

4.092 Independent Study in Design
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Staff

4.093 Independent Study in Design
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Staff
4.094 Independent Study in Design
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Staff

4.105 Geometric Disciplines and Architecture Skills
Prereq: Permission of instructor
G (Fall)
2-2-5 units
Intensive introduction to architectural design tools and process, taught through a series of short exercises. Covers a broad range of topics relating to the discourse of geometry as the basis of architectural design process. Focuses on projective drawings, explicit 3D modeling, and the reciprocity between representation and materialization. Lectures, workshops, and pin-ups address the architectural arguments intrinsic to geometry and its representation. Restricted to level one MArch students.
Consult B. Clifford

4.109 Materials and Fabrication for Architecture
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (IAP)
0-3-3 units
Provides the material system knowledge and fabrication process skills to successfully engage with all areas of the shop, from precision handwork to multi-axis computer numerically controlled (CNC) machining. Progresses through a series of basic exercises that introduce the material and workflow, concluding with more complex problems that explore opportunities and issues specific to architecture. Lab fee. Limited to 12; preference to first-year MArch students.
Consult J. O’Brien

4.110 Design Across Scales and Disciplines
Prereq: None
U (Spring)
2-0-10 units. HASS-A
Inspired by Charles and Ray Eames’ canonical <em>Powers of Ten</em>, explores the relationship between science and engineering through the lens of design. Examines how transformations in science and technology have influenced design thinking and vice versa. Provides interdisciplinary skills and methods to represent, model, design and fabricate objects, machines, and systems using new computational and fabrication tools. Aims to develop methodologies for design research of interdisciplinary problems. Enrollment limited; preference to Course 4-B majors and Course 4 minors.
Consult S. Tibbits

4.117 Creative Computation
Subject meets with 4.118
Prereq: Permission of instructor
G (Spring)
Units arranged
Dedicated to bridging the gap between the virtual and physical world, the subject embraces modes of computation that hold resonance with materials and methods that beg to be computed. Students engage in bi-weekly exercises to solve complex design problems. Each exercise is dedicated to a different computation approach (recursion, parametric, genetic algorithms, particle-spring systems, etc.) that is married to a physical challenge, thereby learning the advantages and disadvantages to each approach while verifying the results in physical and digitally fabricated prototypes. Through the tools of computation and fabrication, it empowers students to design as architects, engineers and craftsmen. Additional work required of student taking for graduate credit. Preference to students in the MArch, BSAD, and Design Minor programs.
B. Clifford
4.118 Creative Computation
Subject meets with 4.117
Prereq: 4.500 or permission of instructor
U (Spring)
3-0-9 units

Dedicated to bridging the gap between the virtual and physical world, the subject embraces modes of computation that hold resonance with materials and methods that beg to be computed. Students engage in bi-weekly exercises to solve complex design problems. Each exercise is dedicated to a different computation approach (recursion, parametric, genetic algorithms, particle-spring systems, etc.) that is married to a physical challenge, thereby learning the advantages and disadvantages to each approach while verifying the results in physical and digitally fabricated prototypes. Through the tools of computation and fabrication, it empowers students to design as architects, engineers, and craftpeople. Additional work required of student taking for graduate credit. Preference to Course 4-B majors and Design minors.
B. Clifford

4.119 Preparation for Undergraduate Architecture Design Thesis
Prereq: 4.024
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-0-10 units

Selection of thesis topic, defining method of approach, and preparation of thesis proposal for BSA degree in architecture. Weekly class meeting as well as individual conference with faculty.
Consult W. O'Brien

4.120 Furniture Making Workshop
Prereq: Permission of instructor
G (Spring)
2-2-5 units
Credit cannot also be received for 4.125

Provides instruction in designing and building a functional piece of furniture from an original design. Develops woodworking techniques from use of traditional hand tools to digital fabrication. Gives students the opportunity to practice design without using a building program or code. Surveys the history of furniture making and includes site visits to local collections and artists/craftsmen. Additional work required of students taking for graduate credit. Limited to 12; preference to graduate Course 4 students.
C. Dewart

4.123 Architectural Assemblies
Prereq: None
G (Spring)
2-2-5 units

Fosters a holistic understanding of the architectural-building cycle, enabling students to build upon the history of design and construction to make informed decisions towards developing innovative building systems. Includes an overview of materials, processing methods, and their formation into building systems across cultures. Looks at developing innovative architectural systems focusing on the building envelope. Seeks to adapt processes from the aerospace and automotive industries to investigate buildings as prefabricated design and engineering assemblies. Synthesizes knowledge in building design and construction systems, environmental and structural design, and geometric and computational approaches.
Consult A. Miljacki

4.125 Furniture Making Workshop
Prereq: None
U (Fall)
2-2-5 units
Credit cannot also be received for 4.120

Provides instruction in designing and building a functional piece of furniture from an original design. Develops woodworking techniques from use of traditional hand tools to digital fabrication. Gives students the opportunity to practice design without using a building program or code. Surveys the history of furniture making and includes site visits to local collections and artists/craftsmen. Additional work required of students taking for graduate credit. Limited to 12; preference to undergraduate Course 4 and 4B majors and Design and Architecture minors.
C. Dewart

4.130 Architectural Design Theory and Methodologies
Prereq: None
G (Fall)
3-3-6 units
Can be repeated for credit.

Studies design as an interrogative technique to examine material sciences, media arts and technology, cultural studies, computation and emerging fabrication protocols. Provides in-depth, theoretical grounding to the notion of ‘design’ in architecture, and to the consideration of contemporary design methodologies, while encouraging speculation on emerging design thinking. Topical focus varies with instructor. May be repeated for credit with permission of department.
Consult S. Kennedy
4.140[J] How to Make (Almost) Anything
Same subject as 6.943[J], MAS.863[J]
Prereq: Permission of instructor
G (Fall)
3-9-6 units
See description under subject MAS.863[J].
N. Gershenfeld, J. DiFrancesco, J. Lavallee, G. Darcey

4.151 Architecture Design Core Studio I
Prereq: Permission of instructor
G (Fall)
0-12-9 units
Establishes foundational processes, techniques and attitudes towards architectural design. Includes projects of increasing scope and complexity engaging issues of structure, circulation, program, organization, building systems, materiality and tectonics. Develops methods of representation that incorporate both analogue and digital drawings and models. First in a sequence of design subjects, which must be taken in order. Limited to first-year MArch students.
Consult A. Miljacki

4.152 Architecture Design Core Studio II
Prereq: 4.151
G (Spring)
0-12-9 units
Builds on Core I skills and expands the constraints of the architectural problem to include issues of urban site logistics, cultural and programmatic material (inhabitation and human factors), and long span structures. Two related projects introduce a range of disciplinary issues, such as working with precedents, site, sectional and spatial proposition of the building, and the performance of the outer envelope. Emphasizes the clarity of intentions and the development of appropriate architectural and representational solutions. Limited to first-year MArch students.
Consult A. Miljacki

4.153 Architecture Design Core Studio III
Prereq: 4.152
G (Fall)
0-12-9 units
Interdisciplinary approach to design through studio design problems that engage the domains of building technology, computation, and the cultural/historical geographies of energy. Uses different modalities of thought to examine architectural agendas for 'sustainability'; students position their work with respect to a broader understanding of the environment and its relationship to society and technology. Students develop a project with a comprehensive approach to programmatic organization, energy load considerations, building material assemblies, exterior envelope and structure systems. Limited to second-year MArch students.
Consult A. Miljacki

4.154 Architecture Design Option Studio
Prereq: 4.153
G (Fall, Spring)
0-10-11 units
Can be repeated for credit.
Offers a broad range of advanced-level investigations in architectural design in various contexts, including international sites. Integrates theoretical and technological discourses into specific topics. Studio problems may include urbanism and city scale strategies, habitation and urban housing systems, architecture in landscapes, material investigations and new production technologies, programmatic and spatial complex building typologies, and research centered studies. Mandatory lottery process.
Consult A. Miljacki

4.163[J] Urban Design Studio
Same subject as 11.332[J]
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
The design of urban environments. Strategies for change in large areas of cities, to be developed over time, involving different actors. Fitting forms into natural, man-made, historical, and cultural contexts; enabling desirable activity patterns; conceptualizing built form; providing infrastructure and service systems; guiding the sensory character of development. Involves architecture and planning students in joint work; requires individual designs or design and planning guidelines.
Consult R. Segal
4.173[J] China Urban Design Studio
Same subject as 11.307[J]
Prereq: Permission of instructor
G (Spring)
0-21-0 units
B. Ryan

4.180 Design Workshop
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Subject in design inquiry taught in studio format treating selected issues of the built world in depth. The problem may be prototypical or a particular aspect of a whole project, but always interdisciplinary in nature.
Consult A. Miljacki

4.181 Architectural Design Workshop
Prereq: Permission of instructor
G (Fall, IAP)
Units arranged
Can be repeated for credit.
Addresses design inquiry in a studio format. In-depth consideration of selected issues of the built world. The problem may be prototypical or a particular aspect of a whole project, but is always interdisciplinary in nature.
Consult A. Miljacki

4.182 Architectural Design Workshop
Prereq: Permission of instructor
G (Fall, IAP)
Units arranged
Can be repeated for credit.
Addresses design inquiry in a studio format. In-depth consideration of selected issues of the built world. The problem may be prototypical or a particular aspect of a whole project, but is always interdisciplinary in nature.
Consult A. Miljacki

4.183-4.185 Architectural Design Workshop
Prereq: Permission of instructor
G (Fall, IAP)
Units arranged
Can be repeated for credit.
Addresses design inquiry in a studio format. In-depth consideration of selected issues of the built world. The problem may be prototypical or a particular aspect of a whole project, but is always interdisciplinary in nature.
Consult A. Miljacki

4.189 Preparation for MArch Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-1-5 units
Can be repeated for credit.
Preparatory research development leading to a well-conceived proposition for the MArch design thesis. Students formulate a cohesive thesis argument and critical project using supportive research and case studies through a variety of representational media, critical traditions, and architectural/artistic conventions. Group study in seminar and studio format, with periodic reviews supplemented by conference with faculty and a designated committee member for each individual thesis. Restricted to MArch students.
Consult A. Miljacki

4.190 Practical Experience in Architecture
Prereq: Permission of instructor
G (IAP, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Practical experience through summer and January IAP internships secured by the student in the field of architecture, urbanism, digital design, art, or building technology. Before registering for this subject, students must have an employment offer and complete an application signed by the advisor. Upon completion of the internship, students must submit an employer evaluation form available from the departmental academic office. Registration limited to two summers and one IAP. Restricted to Course 4 students. Limited to two summers and one IAP.
Consult P. Pettigrew
4.191 Independent Study in Architecture Design  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.  
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
Architecture Design Staff

4.192 Independent Study in Architecture Design  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
Architecture Design Staff

4.193 Independent Study in Architecture Design  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.  
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
Architecture Design Staff

4.194 Independent Study in Architecture Design  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
Architecture Design Staff

4.500 Special Subject: Design  
Prereq: Permission of instructor  
U (Fall, Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Seminar or lecture on a topic in design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
Consult Architecture Staff

4.501 Special Subject: Design (New)  
Prereq: Permission of instructor  
U (Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Seminar or lecture on a topic in design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
Consult Architecture Staff

4.502 Special Subject: Design  
Prereq: None  
G (Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Seminar or lecture on a topic in design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
Staff

4.503 Special Subject: Design (New)  
Prereq: None  
G (Fall, IAP, Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Seminar or lecture on a topic in design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
Staff
**4.510 Special Subject: Architecture Design**  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.

Seminar or lecture on a topic in architecture design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
*Architecture Design Staff*

**4.511 Special Subject: Architecture Design**  
Prereq: None  
U (IAP, Spring)  
Not offered regularly; consult department  
Units arranged [P/D/F]  
Can be repeated for credit.

Seminar or lecture on a topic in architecture design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
*Architecture Design Staff*

**4.512 Special Subject: Architecture Design**  
Prereq: Permission of instructor  
G (Fall)  
Units arranged  
Can be repeated for credit.

Seminar or lecture on a topic in architecture design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
*Consult Architecture Design Staff*

**4.513 Special Subject: Architecture Design**  
Prereq: Permission of instructor  
G (Fall)  
Units arranged  
Can be repeated for credit.

Seminar or lecture on a topic in architecture design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
*Consult Architecture Design Staff*

**4.514 Special Subject: Architecture Design**  
Prereq: Permission of instructor  
G (Fall, IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.

Seminar or lecture on a topic in architecture design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
*Staff*

**Architecture Studies**

**4.210 Precedents in Critical Practice**  
Prereq: None  
G (Fall)  
3-0-6 units  
Through formal analysis and discussion of historical and theoretical texts, seminar produces a map of contemporary architectural practice. Examines six pairs of themes in terms of their recent history: city and global economy, urban plan and map of operations, program and performance, drawing and scripting, image and surface, and utopia and projection. Restricted to year-one MArch students.  
*A. Miljacki*

**4.211[J] The Once and Future City**  
Same subject as 11.016[J]  
Prereq: None  
U (Spring)  
3-0-9 units. HASS-H; CI-H  
See description under subject 11.016[J]. Enrollment limited.  
*A. Spirn*

**4.213[J] Ecological Urbanism Seminar**  
Same subject as 11.308[J]  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
See description under subject 11.308[J]. Enrollment limited.  
*A. Spirn*
4.214[J] Water, Landscape and Urban Design
Same subject as 11.314[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-3-6 units
Can be repeated for credit.

Workshop surveys how water affects the design of buildings, landscapes and cities in aesthetic, functional and symbolic ways. Combines the systematic study of water issues with urban design projects in South Asia and the US. Covers topics such as rainwater harvesting, water use efficiency, wastewater reuse, stormwater management, floodplain design, constructed wetlands, and waterfront development. Students work together to integrate these design concepts at the site, urban, and international scales. Limited to 15.

J. Wescoat

4.215[J] Sensing Place: Photography as Inquiry
Same subject as 11.309[J]
Prereq: None
G (Fall)
3-0-9 units
See description under subject 11.309[J]. Enrollment limited.

A. Spirn

4.217[J] Disaster Resilient Design
Same subject as 11.315[J]
Subject meets with 4.218
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units

Seminar examines the linkages between natural hazards and environmental design. Engages theoretical debates about landscapes of risk, vulnerability, and resilience. Participants generate proposals for disaster resilience through combinations of retrofit, reconstruction, resettlement, commemorative, and anticipatory design. Methods include rapid bibliographic search, risk analysis, landscape synthesis, and comparative international methods. Projects vary and may focus on current crises or involve collaboration with the Aga Khan Development Network and other humanitarian organizations. Additional work required of students taking the graduate version. Limited to 15; preference to Course 4 majors and minors.

J. Wescoat

4.218 Disaster Resilient Design
Subject meets with 4.217[J], 11.315[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units

Seminar examines the linkages between natural hazards and environmental design. Engages theoretical debates about landscapes of risk, vulnerability, and resilience. Participants generate proposals for disaster resilience through combinations of retrofit, reconstruction, resettlement, commemorative, and anticipatory design. Methods include rapid bibliographic search, risk analysis, landscape synthesis, and comparative international methods. Projects vary and may focus on current crises or involve collaboration with the Aga Khan Development Network and other humanitarian organizations. Additional work required of students taking the graduate version. Limited to 15; preference to Course 4 majors and minors.

J. Wescoat

4.221 Architecture Studies Colloquium
Prereq: Permission of instructor
G (Fall)
2-0-1 units

Series of open lectures, presented as an introduction to the diverse academic and creative community of MIT and the region, at which discipline groups of the SMArchS program converge and exchange ideas. Organized thematically, guest speakers from cultural and scientific fields present viewpoints in areas of emerging interest within design, building technology, architectural computation, history, and art. Encourages discourse with speakers and among students from different disciplines. Students initiate online debates among their peers and respond to an evolving series of discussions resulting in publication.

Consult S. Tibbits

4.222 Professional Practice
Prereq: Permission of instructor
G (Fall)
3-0-3 units

Gives a critical orientation towards a career in architectural practice. Uses historical and current examples to illustrate the legal, ethical and management concepts underlying the practice of architecture. Emphasis on facilitating design excellence and strengthening connections between the profession and academia.

Consult A. Miljacki
4.227 Landscapes of Energy
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Spatializes large technological systems of energy, analyzes existing and speculative energy visions, and imagines energy futures in relation to concerns of ecology, politics, and aesthetics. Identifies different scales of thinking about the territory of energy from that of environmental systems, to cities, regions, and global landscapes. Readings and students’ research projects draw on critical geography, history of technology, environmental history to synthesize energy attributes within the design disciplines. Limited to 10.
Consult R. Ghosn

4.228 Contemporary Urbanism Proseminar: Theory and Representation
Prereq: Permission of instructor
G (Fall)
Units arranged
Critical introduction to key contemporary positions in urbanism to the ends of researching, representing, and designing territories that respond to the challenges of the 21st century. Provides an overview of contemporary urban issues, situates them in relation to a genealogy of urban precedents, and constructs a theoretical framework that engages the allied fields of architecture, landscape architecture, political ecology, geography, territorial planning, and environmental humanities. Comprised of three sections, first section articulates a framework on the urban as both process and form, shifting the emphasis from city to territory. Second section engages a series of related urban debates, such as density/sprawl, growth/shrinkage, and codes/exception. Third section calls upon urban agency in the age of environment through the object of infrastructures of trash, water, oil, and food. Limited to 25.
R. Ghosn

Same subject as 11.228[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Considers ways in which collaborative approaches to living can reshape architecture and the city. Students investigate how accessibility over ownership, community-based exchange and collaborative platforms are transforming both economic and social patterns. Explores the viability of co-housing, co-living and other models operating within the market economy, and examines the relationship between user, designer, and developer. Includes design projects and field trips. Limited to 12.
Consult R. Segal

4.230[J] SIGUS Workshop
Same subject as 11.468[J]
Subject meets with 4.231
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Interdisciplinary projects and interactive practices in urban settlement issues as investigated by MIT’s SIGUS (Special Interest Group in Urban Settlements), with a focus on developing countries throughout the world. Participation by guest practitioners. Additional work required of students taking the graduate version.
R. Goethert

4.231 SIGUS Workshop
Subject meets with 4.230[J], 11.468[J]
Prereq: Permission of instructor
U (Fall)
Units arranged
Can be repeated for credit.
Interdisciplinary projects and interactive practices in urban settlement issues as investigated by MIT’s SIGUS (Special Interest Group in Urban Settlements), with a focus on developing countries throughout the world. Participation by guest practitioners. Additional work required of students taking the graduate version.
R. Goethert
Same subject as 11.444[J]
Prereq: Permission of instructor
G (Spring)
3-0-6 units

Considers a new interdisciplinary paradigm of practice that regards dialogue among practitioners and users essential for efficacious and creative design and planning process. Focuses on non-traditional client groups: communities, the poor, and the generally excluded middle-income. Explores key issues confronting development practitioners, with stress on practical exercises drawn from current national and international case studies; e.g., an investigative comparison of cities or tools in coping with impending rapid and massive growth and expansion. Engages those with a design and community service orientation.
R. Goethert

4.236[J] Structuring Low-Income Housing Projects in Developing Countries
Same subject as 11.463[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Examines dynamic relationship among key actors: beneficiaries, government, and funder. Emphasis on cost recovery, affordability, replicability, user selection, and project administration. Extensive case examples provide basis for comparisons.
R. Goethert

4.240[J] Urban Design Skills: Observing, Interpreting, and Representing the City
Same subject as 11.328[J]
Prereq: None
G (Fall)
4-2-9 units

See description under subject 11.328[J].
E. Ben-Joseph

Same subject as 11.330[J]
Prereq: 11.001[J], 11.301[J], or permission of instructor
G (Spring)
Units arranged

Examines the complex development of cities through history by tracing a diachronic accumulation of forms and spaces in specific cities, and showing how significant ideas were made manifest across distinct geographies and cultures. Emphasizes how economic, spiritual, political, geographic and technological forces have simultaneously shaped and, in turn, been influenced by the city. Additional work required of students taking graduate version.
L. Jacobi, R. Segal

4.244[J] Urban Design Seminar: Perspectives on Contemporary Practice
Same subject as 11.333[J]
Prereq: None
G (Spring)
2-0-7 units

See description under subject 11.333[J].
Staff

4.245[J] DesignX Entrepreneurship
Same subject as 11.245[J]
Prereq: Permission of instructor
G (IAP)
6-0-0 units

See description under subject 11.245[J]. Limited to 30; preference to students in DesignX Program.
D. Frenchman and G. Rosenzweig

4.246[J] DesignX Accelerator
Same subject as 11.246[J]
Prereq: Permission of instructor
G (Spring)
2-4-6 units

See description under subject 11.246[J]. Limited to 30; preference to students in DesignX Program.
D. Frenchman, G. Rosenzweig

4.247[J] Urban Design Ideals and Action
Same subject as 11.337[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-0-7 units

See description under subject 11.337[J].
B. Ryan
4.250[J] Introduction to Urban Design and Development
Same subject as 11.001[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H
Examines the evolving structure of cities and the way that cities, suburbs, and metropolitan areas can be designed and developed. Surveys the ideas of a wide range of people who have addressed urban problems. Stresses the connection between values and design. Demonstrates how physical, social, political and economic forces interact to shape and reshape cities over time.
L. Vale

4.252[J] Introduction to Urban Design and Development
Same subject as 11.301[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Examines the physical and social structure of cities and ways they can be changed. Includes historical forces that have produced cities, models of urban form, contemporary theories of urban design, implementation strategies. Core lectures are supplemented by student projects analyzing the evolution of urban place, and factors of high quality urban design and development. Guest speakers present cases involving current projects illustrating the scope and methods of urban design practice.
D. Frenchman

4.253[J] Urban Design Politics
Same subject as 11.302[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
See description under subject 11.302[J].
L. Vale

4.254[J] Real Estate Development Studio
Same subject as 11.303[J]
Prereq: Permission of instructor
G (Spring)
6-0-12 units
See description under subject 11.303[J].
D. Frenchman, K. Shen

4.255[J] Site and Environmental Systems Planning
Same subject as 11.304[J]
Prereq: Permission of instructor
G (Spring)
6-0-9 units
See description under subject 11.304[J].
M. A. Ocampo

4.264[J] Advanced Seminar in Landscape and Urbanism
Same subject as 11.334[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
See description under subject 11.334[J].
A. Berger

4.270 Innovation for Disaster Relief and Preparedness
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-3-6 units
Explores innovative solutions for disaster relief and preparedness through both design and engineering. Interactive exercises provide an overview of large-scale disaster relief issues, including response communities, operating environments, logistics and technical challenges. Projects will be developed through hands-on prototyping, emphasizing the importance of system-oriented, sustainable design. Speakers from organizations such as FEMA and The Red Cross will contribute.
M. Mazereeuw

4.275[J] Advanced Urbanism Colloquium (New)
Same subject as 11.912[J]
Prereq: Permission of instructor
G (Fall, Spring)
1-1-1 units
Can be repeated for credit.
Introduces principal issues in the field of advanced urbanism for discussion and exploration. Includes theoretical linkages between ideas about the culture of cities, processes of urbanization, and urban design. Involves events co-organized by faculty and doctoral students to further engage and inform research. Preference to doctoral students in the Advanced Urbanism concentration.
Consult J. Wescoat
4.286 SMArchS Urbanism Pre-Thesis Preparation
Prereq: None
G (Spring)
3-0-0 units
Explores initial thesis ideas and bases for choosing among multiple interests. Assessment of design research strengths and weaknesses. Overview of conceptual frameworks and research methods. Preparation for summer field research and proposal development.
J. Wescoat

4.288 Preparation for SMArchS Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Students select thesis topic, define method of approach, and prepare thesis proposal for SMArchS degree. Faculty supervision on an individual or group basis. Intended for SMArchS program students prior to registration for 4.ThG.
Consult Architecture Staff

4.291 Independent Study in Architecture Studies
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Architecture Studies Staff

4.292 Independent Study in Architecture Studies
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Architecture Studies Staff

4.293 Independent Study in Architecture Studies
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Architecture Studies Staff

4.294 Independent Study in Architecture Studies
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Architecture Studies Staff

4.299 Summer Research Topics
Prereq: Permission of instructor
G (Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Supplementary summer work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Staff

4.520 Special Subject: Architecture Studies
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic in architecture studies that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
Architecture Staff
4.S21 Special Subject: Architecture Studies
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Seminar or lecture on a topic in architecture studies that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
Architecture Staff

4.S22 Special Subject: Architecture Studies
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in architecture studies that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

4.S23 Special Subject: Architecture Studies
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in architecture studies that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

S. Kennedy

4.S24 Special Subject: Architecture Studies
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]
Can be repeated for credit.

Seminar or lecture on a topic in architecture studies that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

S. Tibbits

4.S25 Special Subject: Urban Housing
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in urban housing that is not covered in the regular architecture curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
R. Goethert

4.S26 Special Subject: City Form
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in city form that is not covered in the regular architecture curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Architecture Staff

4.S27 Special Subject: Urban Design
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in urban design that is not covered in the regular Architecture curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
R. Ghosn
Art, Culture and Technology

4.301 Introduction to Artistic Experimentation
Prereq: None
U (Fall, Spring)
3-3-6 units. HASS-A

Introduces artistic practice and critical visual thinking through three studio-based projects using different scales and media, for instance, “Body Extension,” “Shaping Time,” “Public Making,” and/or “Networked Cultures.” Each project concludes with a final presentation and critique. Students explore sculptural, architectural, performative artistic methods; video and sound art; site interventions and strategies for artistic engagement in the public realm. Lectures, screenings, guest presentations, field trips, readings, and debates supplement studio practice. Also introduces students to the historic, cultural, and environmental forces affecting both the development of an artistic vision and the reception of a work of art. Lab fee required. Limited to 20.

Consult J. Barry

4.302 Foundations in Art, Design, and Spatial Practices
Prereq: 4.02A or 4.021
U (Spring)
3-3-6 units

Develops an introductory foundation in artistic practice and its critical analysis, and develops artistic approaches and methods by drawing analogies to architectural thinking, urbanism, and design practice. Covers how to communicate ideas and experiences on different scales and through two-dimensional, three-dimensional, and time-based media in new genres. Uses artistic methods that engage the public realm through spatial, sculptural, performative, and process-oriented practices. Instruction components include video screenings, guest lectures, visiting artist presentations, and field trips. Instruction and practice in written and oral communication provided. Lab fee required. Limited to 18; preference to Course 4 majors and minors.

Consult J. Barry

4.307 Art, Architecture, and Urbanism in Dialogue
Subject meets with 4.308
Prereq: 4.301, 4.302, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-3-6 units. HASS-A

Initiates a dialogue between architecture, urbanism, and contemporary art by focusing on the work of practitioners who intertwine the three disciplines in a critical spatial practice. Investigates themes and works ranging from early modernist practices to the contemporary and research based. Lectures, screenings, readings, and discussions with guests and faculty contribute to the development of group and individual projects and their presentation. Additional work required of students taking graduate version. Lab fee required. Limited to 20.

Consult J. Barry

4.308 Art, Architecture, and Urbanism in Dialogue
Subject meets with 4.307
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
Units arranged

Initiates a dialogue between architecture, urbanism, and contemporary art by focusing on the work of practitioners who intertwine the three disciplines in a critical spatial practice. Investigates themes and works ranging from early modernist practices to the contemporary and research based. Lectures, screenings, readings, and discussions with guests and faculty contribute to the development of group and individual projects and their presentation. Additional work required of students taking graduate version. Lab fee required. Limited to 20.

Consult J. Barry
4.312 Advanced Studio on the Production of Space
Subject meets with 4.313
Prereq: 4.301, 4.302, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-3-6 units. HASS-A
Can be repeated for credit.

Introduces historical and contemporary spatial concepts from various cultures and geo-political settings, and examines how they relate to artistic process and production. Explores the relational qualities of spatial concepts and reflects on their producers and proponents; investigates the notion of utopian, dystopian and heterotopian space, inner and outer space, the void, the vacuum, the in-between, and "real" versus "virtual" space. Lectures, readings, screenings, presentations, and guest speakers from various disciplines support the development of individual and collective projects. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.

Consult J. Barry

4.313 Advanced Studio on the Production of Space
Subject meets with 4.312
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
Units arranged
Can be repeated for credit.

Introduces historical and contemporary spatial concepts from various cultures and geo-political settings, and examines how they relate to artistic process and production. Explores the relational qualities of spatial concepts and reflects on their producers and proponents; investigates the notion of utopian, dystopian and heterotopian space, inner and outer space, the void, the vacuum, the in-between, and "real" versus "virtual" space. Lectures, readings, screenings, presentations, and guest speakers from various disciplines support the development of individual and collective projects. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.

Consult J. Barry

4.314 Advanced Workshop in Artistic Practice and Transdisciplinary Research
Subject meets with 4.315
Prereq: 4.301, 4.302, or permission of instructor
U (Fall, Spring)
3-3-6 units. HASS-A
Can be repeated for credit.

Examines artistic practice as a form of critical inquiry and knowledge production. Offers opportunity to develop art as a means for addressing the social, cultural, and ecological consequences of technology, to build bridges between industry and culture, and to challenge the boundaries between public and private, and human and non-human. Provides instruction in evaluating models of experimentation, individual research, and collaboration with other disciplines in the arts, culture, science, and technology. Supports the development of individual and collective artistic research projects. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.

Consult J. Barry

4.315 Advanced Workshop in Artistic Practice and Transdisciplinary Research
Subject meets with 4.314
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.

Examines artistic practice as a form of critical inquiry and knowledge production. Offers opportunity to develop art as a means for addressing the social, cultural, and ecological consequences of technology, to build bridges between industry and culture, and to challenge the boundaries between public and private, and human and non-human. Provides instruction in evaluating models of experimentation, individual research, and collaboration with other disciplines in the arts, culture, science, and technology. Supports the development of individual and collective artistic research projects. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.

Consult J. Barry
4.320 Introduction to Sound Creations
Subject meets with 4.321
Prereq: None
U (Fall)
3-3-6 units. HASS-A

Develops a critical awareness of how sound art as a field for artistic exploration is performed, produced, and distributed. Explores contemporary and historical practices that emerge outside of purely musical environments and investigates specific compositional developments of post-war modernity and electro-acoustic music, as well as non-musical disciplines related to the psychophysics of hearing and listening. Lectures, screenings, readings, and discussions with guests and faculty contribute to the development of group and individual projects. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry

4.321 Introduction to Sound Creations
Subject meets with 4.320
Prereq: None
G (Fall)
Units arranged

Develops a critical awareness of how sound art as a field for artistic exploration is performed, produced, and distributed. Explores contemporary and historical practices that emerge outside of purely musical environments and investigates specific compositional developments of post-war modernity and electro-acoustic music, as well as non-musical disciplines related to the psychophysics of hearing and listening. Lectures, screenings, readings, and discussions with guests and faculty contribute to the development of group and individual projects. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry

4.322 Introduction to Three-Dimensional Art Work
Subject meets with 4.323
Prereq: None
U (Fall)
3-3-6 units. HASS-A

Explores three-dimensional art work, including sculptures and installations, from design to model to finished piece. Addresses challenges associated with design and fabrication, process, context, and relationships between objects, the body, and physical or cultural environments. Lectures, screenings, field trips, readings, and debates supplement studio practice. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry

4.323 Introduction to Three-Dimensional Art Work
Subject meets with 4.322
Prereq: None
G (Fall)
Units arranged

Explores three-dimensional art work, including sculptures and installations, from design to model to finished piece. Addresses challenges associated with design and fabrication, process, context, and relationships between objects, the body, and physical or cultural environments. Lectures, screenings, field trips, readings, and debates supplement studio practice. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry

4.341 Introduction to Photography and Related Media
Subject meets with 4.342
Prereq: None
U (Fall, Spring)
3-3-6 units. HASS-A

Introduces history and contemporary practices in artistic photography through projects, lectures, artist visits, group discussions, readings, and field trips. Fosters visual literacy and aesthetic appreciation of photography/digital imaging, as well as critical awareness of how images in our culture are produced and constructed. Provides instruction in the fundamentals of different camera formats, film exposure and development, lighting, black and white darkroom printing, and digital imaging. Assignments allow for incorporation of a range of traditional and experimental techniques, development of technical skills, and personal exploration. Throughout the term, present and discuss projects in a critical forum. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry
4.342 Introduction to Photography and Related Media
Subject meets with 4.341
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Introduces history and contemporary practices in artistic photography through projects, lectures, artist visits, group discussions, readings, and field trips. Fosters visual literacy and aesthetic appreciation of photography/digital imaging, as well as critical awareness of how images in our culture are produced and constructed. Provides instruction in the fundamentals of different camera formats, film exposure and development, lighting, black and white darkroom printing, and digital imaging. Assignments allow for incorporation of a range of traditional and experimental techniques, development of technical skills, and personal exploration. Throughout the term, present and discuss projects in a critical forum. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry

4.344 Advanced Photography and Related Media
Subject meets with 4.345
Prereq: 4.341 or permission of instructor
U (Fall, Spring)
3-3-6 units. HASS-A
Fosters critical awareness of how images in our culture are produced and constructed. Covers a range of experimental techniques and camera formats, advanced traditional and experimental black-and-white darkroom printing, and digital imaging. Includes individual and group reviews, field trips, and visits from outside professionals. Topical focus changes each term; coursework centers on student-initiated project with emphasis on conceptual, theoretical, and technical development. Additional work required of students taking the graduate version. Equipment available for checkout. Lab fee required. Limited to 20.
Consult J. Barry

4.345 Advanced Photography and Related Media
Subject meets with 4.344
Prereq: 4.342 or permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Fosters critical awareness of how images in our culture are produced and constructed. Covers a range of experimental techniques and camera formats, advanced traditional and experimental black-and-white darkroom printing, and all aspects of digital imaging and output. Includes individual and group reviews, field trips, and visits from outside professionals. Topical focus changes each term; coursework centers on student-initiated project with emphasis on conceptual, theoretical, and technical development. Additional work required of students taking the graduate version. Equipment available for checkout. Lab fee required. Limited to 20.
Consult J. Barry

4.352 Advanced Video and Related Media
Subject meets with 4.353
Prereq: 4.354 or permission of instructor
U (Fall, Spring)
3-3-6 units. HASS-A
Introduces advanced strategies of image and sound manipulation, both technical and conceptual. Covers pre-production planning (storyboards and scripting), refinement of digital editing techniques, visual effects such as chroma-keying, post-production, as well as audio and sonic components. Context provided by regular viewings of contemporary video artworks and other audio-visual formats. Students work individually and in groups to develop skills in media literacy and communication. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry

4.353 Advanced Video and Related Media
Subject meets with 4.352
Prereq: 4.355 or permission of instructor
G (Fall, Spring)
Units arranged
Introduces advanced strategies of image and sound manipulation, both technical and conceptual. Covers pre-production planning (storyboards and scripting), refinement of digital editing techniques, visual effects such as chroma-keying, post-production, as well as audio and sonic components. Context provided by regular viewings of contemporary video artworks and other audio-visual formats. Students work individually and in groups to develop skills in media literacy and communication. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry
4.354 Introduction to Video and Related Media
Subject meets with 4.355
Prereq: None
U (Fall, Spring)
3-3-6 units. HASS-A

Examines the technical and conceptual variables and strategies inherent in contemporary video art practice. Analyzes structural concepts of time, space, perspective, and sound within the art form. Building upon the historical legacy of the moving image, students render self-exploration, performance, social critique, and manipulation of raw experience into an aesthetic form. Emphasizes practical knowledge of lighting, video capturing and editing, and montage. Presentation and critique of student work, technical workshops, screenings, and reading discussions assist students with final project. Additional work required of students taking the graduate version. Lab fee required. Limited to 20.
Consult J. Barry

R. Green

4.355 Introduction to Video and Related Media
Subject meets with 4.354
Prereq: None
G (Fall, Spring)
Units arranged

Explores ideas and contexts behind moving images through a multifaceted look at cinema's transmutations, emergence on local and national levels, and global migrations. Examines the transformation caused by online video, television, spatial installations, performances, dance, and many formats and portable devices, as well as the theory and context of film's categorization, dissemination, and analysis. Presentations, screenings, field trips, readings, visiting artists, and experimental transdisciplinary projects broaden the perception of present cinema. Additional work required of students taking the graduate version. Lab fee required. Limited to 12.

R. Green

4.356 Cinematic Migrations
Subject meets with 4.357
Prereq: 4.301, 4.302, 4.354, or permission of instructor
U (Spring)
3-3-6 units. HASS-A

Explores ideas and contexts behind moving images through a multifaceted look at cinema's transmutations, emergence on local and national levels, and global migrations. Examines the transformation caused by online video, television, spatial installations, performances, dance, and many formats and portable devices, as well as the theory and context of film's categorization, dissemination, and analysis. Presentations, screenings, field trips, readings, visiting artists, and experimental transdisciplinary projects broaden the perception of present cinema. Additional work required of students taking the graduate version. Lab fee required. Limited to 12.

R. Green

4.357 Cinematic Migrations
Subject meets with 4.356
Prereq: 4.355 or permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Explores ideas and contexts behind moving images through a multifaceted look at cinema's transmutations, emergence on local and national levels, and global migrations. Examines the transformation caused by online video, television, spatial installations, performances, dance, and many formats and portable devices, as well as the theory and context of film's categorization, dissemination, and analysis. Presentations, screenings, field trips, readings, visiting artists, and experimental transdisciplinary projects broaden the perception of present cinema. Additional work required of students taking the graduate version. Lab fee required. Limited to 12.

R. Green
4.361 Performance Art Workshop
Subject meets with 4.362
Prereq: 4.301, 4.302, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-3-6 units. HASS-A

Surveys performance in relation to media and to spatial structures imagined as settings for narrative movements, and uses video to explore the perception of sounds and images and how they are altered by various devices. Students design visual forms and performative actions, and make props or objects that embody aspects of their narratives. Activities include readings and screenings on the theoretical and historical background of performance art. Assignments lead to a final performance project. Additional work required of students taking graduate version. Lab fee required. Limited to 20.

Consult J. Barry

4.362 Performance Art Workshop
Subject meets with 4.361
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged

Surveys performance in relation to media and to spatial structures imagined as settings for narrative movements, and uses video to explore the perception of sounds and images and how they are altered by various devices. Students design visual forms and performative actions, and make props or objects that embody aspects of their narratives. Activities include readings and screenings on the theoretical and historical background of performance art. Assignments lead to a final performance project. Additional work required of students taking graduate version. Lab fee required. Limited to 20.

Consult J. Barry

4.368 Studio Seminar in Art and the Public Sphere
Subject meets with 4.369
Prereq: 4.301 or 4.302
U (Spring)
3-3-6 units. HASS-A

Focuses on the production of artistic interventions in public space. Explores ideas, situations, objects, and materials that shape public space and inform the notion of publicness, with an emphasis on coproduction and cooperative ethics. Examines forms of environmental art in comparison to temporal and critical forms of art and action in the public sphere. Historical models include the Russian Constructivists, the Situationists International, ecosystematic aesthetics, conceptual art, and contemporary interventionist tactics and artistic strategies. Helps students develop an initial concept for a publicly-situated project. Includes guest lectures, visiting artist presentations, and optional field trips. Additional work required of students taking graduate version. Lab fee required. Limited to 12.

Consult J. Barry

4.369 Studio Seminar in Art and the Public Sphere
Subject meets with 4.368
Prereq: None
G (Spring)
Units arranged

Focuses on the production of artistic interventions in public space. Explores ideas, situations, objects, and materials that shape public space and inform the notion of publicness, with an emphasis on coproduction and cooperative ethics. Examines forms of environmental art in comparison to temporal and critical forms of art and action in the public sphere. Historical models include the Russian Constructivists, the Situationists International, ecosystematic aesthetics, conceptual art, and contemporary interventionist tactics and artistic strategies. Helps students develop an initial concept for a publicly-situated project. Includes guest lectures, visiting artist presentations, and optional field trips. Additional work required of students taking graduate version. Lab fee required. Limited to 12.

Consult J. Barry
4.373 Advanced Projects in Art, Culture and Technology
Subject meets with 4.374
Prereq: 4.301, 4.302, or permission of instructor
U (Spring)
3-3-6 units. HASS-A
Can be repeated for credit.
Investigates conceptual and formal issues in a variety of media. Explores representation, interpretation and meaning, and how these relate to historical, social and cultural contexts. Helps students develop an initial concept for a publicly situated project. Includes guest lectures and visiting artist presentations. Additional work required of students taking graduate version. Lab fee required. Limited to 20.
Consult J. Barry

4.374 Advanced Projects in Art, Culture and Technology
Subject meets with 4.373
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.
Investigates conceptual and formal issues in a variety of media. Explores representation, interpretation and meaning, and how these relate to historical, social and cultural contexts. Helps students develop an initial concept for a publicly situated project. Includes guest lectures and visiting artist presentations. Additional work required of students taking graduate version. Lab fee required. Limited to 20.
Consult J. Barry

4.387 Art, Culture and Technology Theory and Criticism Colloquium (New)
Prereq: None
G (Fall, IAP)
3-0-6 units
Introduces foundational texts in contemporary theory and criticism at the intersection of art, culture, and technology. Through presentations and discussions, students explore the necessary methodological perspectives required of an interdisciplinary approach to artistic practices. Limited to SMACT students.
Consult J. Barry

4.388 Preparation for SMACT Thesis
Prereq: Permission of instructor
G (Spring, Summer)
3-0-6 units
Can be repeated for credit.
Aids students in the selection of a thesis topic, development of an approach method, preparation of a proposal that includes an outline for their thesis. Explores artistic practice as a method of critical inquiry and knowledge production/dissemination. Students examine artist writings and consider academic formats and standards. Regular group meetings, including peer reviews, are supplemented by independent study and individual conferences with faculty. Restricted to first-year SMACT students.
Consult J. Barry

4.389 Tutorial for SMACT Thesis
Prereq: 4.388
G (Fall)
3-0-6 units
Can be repeated for credit.
Series of tutorials that includes regular presentations of student writing in group critiques and supports independent thesis research and development by providing guidance on research strategy and written presentation. Sessions supplemented by regular individual conferences with thesis committee members. Restricted to second-year SMACT students.
Consult J. Barry

4.390 Art, Culture and Technology Studio
Prereq: Permission of instructor
G (Fall, Spring)
3-3-12 units
Can be repeated for credit.
Explores the theory and criticism of intersections between art, culture, and technology in relation to contemporary artistic practice, critical design, and media. Students consider methods of investigation, documentation, and display and explore modes of communication across disciplines. Students develop projects in which they organize research methods and goals, engage in production, cultivate a context for their practice, and explore how to compellingly communicate, display, and document their work. Regular presentation and peer-critique sessions, as well as reviews involving ACT faculty and fellows, and external guest reviewers provide students with ample feedback as their projects develop. Restricted to SMACT students.
Consult J. Barry
4.391 Independent Study in Art, Culture and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Art, Culture and Technology Staff

4.392 Independent Study in Art, Culture and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Art, Culture and Technology Staff

4.393 Independent Study in Art, Culture and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Art, Culture and Technology Staff

4.394 Independent Study in Art, Culture and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Art, Culture and Technology Staff

4.531 Special Subject: Art, Culture and Technology
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Seminar or lecture on a topic in visual arts that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Art, Culture & Technology Staff

4.532 Special Subject: Art, Culture and Technology
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in visual arts that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Consult Art, Culture & Technology Staff

4.533 Special Subject: Art, Culture and Technology
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in visual arts that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Consult Art, Culture & Technology Staff

4.534 Special Subject: Art, Culture and Technology
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in visual arts that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Consult Art, Culture and Technology Staff
Building Technology

4.401 Environmental Technologies in Buildings
Subject meets with 4.464
Prereq: None
U (Fall)
3-2-7 units

Introduction to the study of the thermal and luminous behavior of buildings. Examines the basic scientific principles underlying these phenomena and introduces students to a range of technologies and analysis techniques for designing comfortable indoor environments. Challenges students to apply these techniques and explore the role energy and light can play in shaping architecture. Additional work required of students taking the graduate version.

C. Reinhart

4.411[J] D-Lab Schools: Building Technology Laboratory
Same subject as EC.713[J]
Prereq: Calculus I (GIR) and Physics I (GIR)
U (Fall)
2-3-7 units. Institute LAB

Focuses on the design, analysis, and application of technologies that support the construction of less expensive and better performing schools in developing countries. Prepares students to design or retrofit school buildings in partnership with local communities and NGOs. Strategies covered include daylighting, passive heating and cooling, improved indoor air quality via natural ventilation, appropriate material selection, and structural design. Investigations are based on application of engineering fundamentals, experiments and simulations. Case studies illustrate the role of technologies in reducing barriers to improved education.

L. K. Norford

4.421 Space-Conditioning Systems for Low-Carbon Buildings
Prereq: None
G (Spring)
Units arranged

Studies the thermofluid principles of, and design strategies for, natural and mechanical systems for conditioning high-performance buildings that are needed to reduce anthropogenic emissions of greenhouse gases in coming decades. Topics include the dynamics of airflow in buildings in urban areas and the design of natural and mixed-mode ventilation systems, low-energy strategies and systems for dehumidification and sensible cooling, and thermal storage at diurnal and seasonal time scales. System design in leading commercial practice is presented and critiqued by invited practitioners and students. Through a group project, students assess climate- and building-specific systems on the basis of energy consumption, carbon emissions, and resilience to climate change.

L. Norford

Same subject as 2.52[J]
Prereq: 2.51
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

See description under subject 2.52[J].

L. R. Glicksman

4.430 High Performance Facades: Daylighting
Prereq: 4.464 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged

Studies natural and electric lighting in an architectural context. Promotes the integration of occupant comfort, energy efficiency and daylight availability throughout the design process, with an emphasis on the role light can play in shaping architecture. Through group and individual projects, students practice design techniques, from rule of thumb simulations to high dynamic range photography and physical model building. Offered for 9 or 12 units.

Consult C. Reinhart

4.431 Architectural Acoustics
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
Units arranged

Describes interactions between people and sound, indoors and outdoors, and uses this information to develop acoustical design criteria for architecture and planning. Principles of sound generation, propagation, and reception. Properties of materials for sound absorption, reflection, and transmission. Design implications for performance and gathering spaces. Use of computer modeling techniques.

Building Technology Staff
4.432 Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods
Subject meets with 4.433
Prereq: Permission of instructor
U (Spring)
3-2-7 units
Studies energy flows in and around groups of buildings from individual buildings to complete large-scale neighborhoods. Students use emerging digital techniques to analyze and influence building design interventions in relation to energy use for construction (embodied energy) and operation, access to daylight, and assessing walkability and outdoor comfort at the neighborhood scale. Additional work required of students taking the graduate version.
Consult C. Reinhart

4.433 Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods
Subject meets with 4.432
Prereq: Permission of instructor
G (Spring)
3-2-4 units
Studies energy flows in and around groups of buildings from individual buildings to complete large-scale neighborhoods. Students use emerging digital techniques to analyze and influence building design interventions in relation to energy use for construction (embodied energy) and operation, access to daylight, and assessing walkability and outdoor comfort at the neighborhood scale. Additional work required of students taking the graduate version.
Consult C. Reinhart

4.440[J] Introduction to Structural Design
Same subject as 1.056[J]
Subject meets with 4.462
Prereq: Calculus II (GIR)
U (Spring)
3-3-6 units. REST
Introduces the design and behavior of large-scale structures and structural materials. Emphasizes the development of structural form and the principles of structural design. Presents design methods for timber, masonry, concrete and steel applied to long-span roof systems, bridges, and high-rise buildings. Includes environmental assessment of structural systems and materials. In laboratory sessions, students solve structural problems by building and testing simple models. Graduate and undergraduate students have separate lab sections.
Consult J. Carstensen

4.450[J] Computational Structural Design and Optimization
Same subject as 1.575[J]
Subject meets with 4.451
Prereq: ((1.000 or (6.0001 and 6.0002)) and (1.050, 2.001, or 4.440[J])) or permission of instructor
G (Fall)
Units arranged
Research seminar focusing on emerging applications of computation for creative, early-stage structural design and optimization for architecture. Incorporates computational design fundamentals, including problem parameterization and formulation; design space exploration strategies, including interactive, heuristic, and gradient-based optimization; and computational structural analysis methods, including the finite element method, graphic statics, and approximation techniques. Programming experience and familiarity with structural mechanics necessary. Additional work required of students taking for graduate credit. Enrollment limited to 30.
Consult C. Mueller

4.451 Computational Structural Design and Optimization
Subject meets with 1.575[J], 4.450[J]
Prereq: ((1.000 or (6.0001 and 6.0002)) and (1.050, 2.001, or 4.440[J])) or permission of instructor
U (Fall)
3-0-9 units
Research seminar focusing on emerging applications of computation for creative, early-stage structural design and optimization for architecture. Incorporates computational design fundamentals, including problem parameterization and formulation; design space exploration strategies, including interactive, heuristic, and gradient-based optimization; and computational structural analysis methods, including the finite element method, graphic statics, and approximation techniques. Programming experience and familiarity with structural mechanics necessary. Additional work required of students taking for graduate credit. Limited to 30.
Consult C. Mueller
4.462 Introduction to Structural Design
Subject meets with 1.056[J], 4.440[J]
Prereq: Permission of instructor
G (Spring)
3-2-4 units
Introduces the design and behavior of large-scale structures and structural materials. Emphasizes the development of structural form and the principles of structural design. Introduces design methods for timber, masonry, concrete, and steel applied to long-span roof systems, bridges, and high-rise buildings. Includes environmental assessment of structural systems and materials. Laboratory to solve structural problems by building and testing simple models. Graduate and undergraduate students have separate lab sections.
Consult J. Carstensen

4.463 Building Technology Systems: Structures and Envelopes
Prereq: 4.440[J], 4.462, or permission of instructor
G (Fall)
3-2-4 units
Addresses advanced structures, exterior envelopes, and contemporary production technologies. Continues the exploration of structural elements and systems, expanding to include more complex determinate, indeterminate, long-span, and high-rise systems. Topics include reinforced concrete, steel and engineered-wood design, and an introduction to tensile systems. The contemporary exterior envelope is discussed with an emphasis on the classification of systems, performance attributes, and analysis techniques, material specifications and novel construction technologies.
C. Mueller

4.464 Environmental Technologies in Buildings
Subject meets with 4.401
Prereq: None
G (Fall)
3-2-4 units
Introduction to the study of the thermal and luminous behavior of buildings. Examines the basic scientific principles underlying these phenomena and introduces students to a range of technologies and analysis techniques for designing comfortable indoor environments. Challenges students to apply these techniques and explore the role energy and light can play in shaping architecture. Additional work required of students taking the graduate version.
C. Reinhart

4.481 Building Technology Seminar
Prereq: Permission of instructor
G (Fall)
2-0-1 units
Fundamental research methodologies and ongoing investigations in building technology to support the development of student research projects. Topics drawn from low energy building design and thermal comfort, building systems analysis and control, daylighting, structural design and analysis, novel building materials and construction techniques and resource dynamics. Organized as a series of two- and three-week sessions that consider topics through readings, discussions, design and analysis projects, and student presentations.

4.488 Preparation for S.M.B.T. Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Building Technology Staff

4.489 Preparation for Building Technology Ph.D. Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Building Technology Staff

4.491 Independent Study in Building Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Building Technology Staff
4.492 Independent Study in Building Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Building Technology Staff

4.493 Independent Study in Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Building Technology Staff

4.494 Independent Study in Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.

Building Technology Staff

4.S40 Special Subject: Building Technology
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in building technology that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Building Technology Staff

4.S41 Special Subject: Building Technology
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Seminar or lecture on a topic in building technology that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Building Technology Staff

4.S42 Special Subject: Building Technology
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in building technology that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Consult Building Technology Staff

4.S43 Special Subject: Building Technology
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in building technology that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Architecture Building Technology Staff

4.S44 Special Subject: Building Technology
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Seminar or lecture on a topic in building technology that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Building Technology Staff
4.S45 Special Subject: Building Construction
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in building construction that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Building Technology Staff

4.S46 Special Subject: Energy in Buildings
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in energy in buildings that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Building Technology Staff, L. K. Norford

4.S47 Special Subject: Architectural Lighting
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in architectural lighting that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Building Technology Staff

4.S48 Special Subject: Structural Design
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in structural design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Consult Building Technology Staff

Computation

4.500 Design Computation: Art, Objects and Space
Prereq: None
U (Fall)
2-2-8 units

Introduces 3-D CAD modeling to students with little or no experience in design or computation. Teaches surface, solid and mesh modeling techniques combined with a variety of modeling applications, from 3D printing to CNC fabrication and 3D rendering. Includes weekly modeling assignments leading up to a final project. Lab fee. Limited to 12; preference to Course 4 and 4-B majors, and Design and Architecture minors.

L. Sass

4.501 Advanced Design Projects in Digital Fabrication
Subject meets with 4.511
Prereq: 4.500
U (Spring)
2-3-7 units

Integrates iterative design on paper with physical prototyping across many scales, thereby addressing digital fabrication and online presentation as a single design process. Begins with machine learning and moves on to stepped design and production process using 3-D printing, laser cutting, and CNC machining. Students complete a final project in which they individually design and fabricate a functional piece of furniture. Additional work required of students taking graduate version. Preference to MArch and Department of Architecture majors and minors.

L. Sass

4.502 Advanced Visualization: Architecture in Motion Graphics
Subject meets with 4.562
Prereq: 4.500 or permission of instructor
U (Fall)
3-2-7 units

Advanced projects in architectural visualization with an emphasis on the use of computer graphics animation, interactive media, and video production tools. Introduces advanced visualization software and teaches exploration of spatial expressions in motion graphics format. Review and discussion of selected literature and video materials on architecture and film. Additional work required of students taking the graduate version. Preference to Course 4 and 4-B majors and Design and Architecture minors.

T. Nagakura
4.507 Introduction to Building Information Modeling in Architecture
Subject meets with 4.567
Prereq: None
U (Spring)
3-2-7 units
Addresses fundamental methods, theories, and practices that engage contemporary modeling tools in the context of architectural design. Introduces selected academic and professional topics through lectures, demonstrations, and assignments. Topics include parametric modeling, component types and assembly, prototyping, scripting, and simulations. Initiates intellectual explorations in the use of building information modeling in research projects and design practices. Additional work required of students taking graduate version.
T. Nagakura

4.511 Advanced Design Projects in Digital Fabrication
Subject meets with 4.501
Prereq: 4.105 or permission of instructor
G (Spring)
Units arranged
Integrates iterative design on paper with physical prototyping across many scales, thereby addressing digital fabrication and online presentation as a single design process. Begins with machine learning and moves on to stepped design and production process using 3-D printing, laser cutting, and CNC machining. Students complete a final project in which they individually design and fabricate a functional piece of furniture. Additional work required of students taking graduate version. Preference given to M.Arch and Department of Architecture majors and minors.
L. Sass

4.520 Visual Computing
Subject meets with 4.521
Prereq: None
U (Spring)
3-0-9 units
Introduces a visual-perceptual, rule-based approach to design using shape grammars. Covers grammar fundamentals through lectures and in-class, exercises. Focuses on shape grammar applications, from stylistic analysis to creative design, through presentations of past applications and through short student exercises and projects. Presents computer programs for automating shape grammars. Additional work required of students taking graduate version.
Consult T. Knight

4.521 Visual Computing
Subject meets with 4.520
Prereq: None
G (Spring)
3-0-6 units
Introduces a visual-perceptual, rule-based approach to design using shape grammars. Covers grammar fundamentals through lectures and in-class, exercises. Focuses on shape grammar applications, from stylistic analysis to creative design, through presentations of past applications and through short student exercises and projects. Presents computer programs for automating shape grammars. Additional work required of students taking graduate version.
Consult T. Knight

4.540 Introduction to Shape Grammars I
Prereq: None
G (Fall)
3-0-6 units
An in-depth introduction to shape grammars and their applications in architecture and related areas of design. Shapes in the algebras $U_i$, in the algebras $V_i$ and $W_i$ incorporating labels and weights, and in algebras formed as composites of these. Rules and computations, shape and structure, designs.
G. Stiny

4.541 Introduction to Shape Grammars II
Prereq: 4.540
G (Spring)
3-0-6 units
An in-depth introduction to shape grammars and their applications in architecture and related areas of design. Shapes in the algebras $U_i$, in the algebras $V_i$ and $W_i$ incorporating labels and weights, and in algebras formed as composites of these. Rules and computations. Shape and structure. Designs.
Consult G. Stiny
4.542 Background to Shape Grammars
Prereq: 4.541 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-6 units
Can be repeated for credit.

An advanced examination of the shape grammar formalism and its relationship to some key issues in a variety of other fields, including art and design, philosophy, history and philosophy of science, linguistics and psychology, literature and literary studies, logic and mathematics, and artificial intelligence. Student presentations and discussion of selected readings are encouraged. Topics vary from year to year. Can be repeated with permission of instructor.

Consult G. Stiny

4.550 Computational Design Lab
Subject meets with 4.570
Prereq: Permission of instructor
U (Spring)
Units arranged
Can be repeated for credit.

Provides students with an opportunity to explore projects that engage real world problems concerning spatial design, technology, media, and society. In collaboration with industry partners and public institutions, students identify topical issues and problems, and also explore and propose solutions through the development of new ideas, theories, tools, and prototypes. Industry and academic collaborators act as a source of expertise, and as clients and critics of projects developed during the term. General theme of workshop varies by semester or year. Open to students from diverse backgrounds in architecture and other design-related areas. Additional work required of students taking graduate version.

T. Nagakura

4.552 Workshop in Architectural Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for exploration of a topic in computation through research-focused design projects or exercises. Registration subject to prior arrangement of topic and supervision by staff.

Computation Staff

4.557[J] City Science
Same subject as MAS.552[J]
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 units
Can be repeated for credit.

See description under subject MAS.552[J].
K. Larson, R. Chin

4.562 Advanced Visualization: Architecture in Motion Graphics
Subject meets with 4.502
Prereq: Permission of instructor
G (Fall)
3-2-7 units

Advanced projects in architectural visualization with an emphasis on the use of computer graphics animation, interactive media, and video production tools. Introduces advanced visualization software and teaches exploration of spatial expressions in motion graphics format. Review and discussion of selected literature and video materials on architecture and film. Additional work required of students taking the graduate version. Preference to Course 4 and 4-B majors and Design and Architecture minors.

Consult T. Nagakura

4.566 Advanced Projects in Digital Media
Prereq: 4.562 or permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.

Develop independent projects in the study of digital media as it relates to architectural design. Students propose a project topic such as digital design tool, modeling and visualization, motion graphics, interactive design, design knowledge representation and media interface.

T. Nagakura
**4.567 Introduction to Building Information Modeling in Architecture**  
Subject meets with 4.507  
Prereq: None  
G (Spring)  
Units arranged

Addresses fundamental methods, theories, and practices that engage contemporary modeling tools in the context of architectural design. Introduces selected academic and professional topics through lectures, demonstrations, and assignments. Topics include parametric modeling, component types and assembly, prototyping, scripting, and simulations. Initiates intellectual explorations in the use of building information modeling in research projects and design practices. Additional work required of students taking graduate version.  
*T. Nagakura*

**4.569[J] Designing Interactions**  
Same subject as CMS.834[J]  
Subject meets with CMS.634  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-3-6 units  
Can be repeated for credit.  

See description under subject CMS.834[J]. Limited to 12.  
*F. Casalegno, T. Nagakura*

**4.570 Computational Design Lab**  
Subject meets with 4.550  
Prereq: Permission of instructor  
G (Spring)  
Units arranged  
Can be repeated for credit.  

Provides students with an opportunity to explore projects that engage real world problems concerning spatial design, technology, media, and society. In collaboration with industry partners and public institutions, students identify topical issues and problems, and also explore and propose solutions through the development of new ideas, theories, tools, and prototypes. Industry and academic collaborators act as a source of expertise, and as clients and critics of projects developed during the term. General theme of workshop varies by semester or year. Open to students from diverse backgrounds in architecture and other design-related areas. Additional work required of students taking graduate version.  
*T. Nagakura*

**4.580 Inquiry into Computation and Design**  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  

Explores the varied nature, history and practice of computation in design through lectures, readings, small projects, discussions, and guest visits by Computation group faculty and others. Topics may vary from year to year. Aims to help students develop a critical awareness of different approaches to and assumptions about computation in design beyond the specifics of techniques and tools, and to open avenues for further research.  
*Consult T. Knight*

**4.581 Proseminar in Computation**  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Can be repeated for credit.  

Introduction to traditions of research in design and computation scholarship.  
*G. Stiny*

**4.582 Research Seminar in Computation**  
Prereq: 4.580 or permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  

In-depth presentations of current research in design and computation.  
*G. Stiny*

**4.583 Forum in Computation**  
Prereq: Permission of instructor  
G (Fall)  
3-0-0 units  
Can be repeated for credit.  

Group discussions and presentation of ongoing graduate student research in the Computation program.  
*T. Knight*

**4.587 SMArchS Computation Pre-Thesis Preparation**  
Prereq: 4.221 or permission of instructor  
G (Spring)  
3-0-3 units  

Preliminary study in preparation for the thesis for the SMArchS degree in Computation. Topics include literature search, precedents examination, thesis structure and typologies, and short writing exercise.  
*T. Knight, T. Nagakura*
4.589 Preparation for Design and Computation PhD Thesis  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
_Computation Staff_

4.591 Independent Study in Architectural Computation  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.  
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
_Computation Staff_

4.592 Independent Study in Architectural Computation  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
_Computation Staff_

4.593 Independent Study in Architectural Computation  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.  
Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
_Computation Staff_

4.594 Independent Study in Architectural Computation  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.  
_Computation Staff_

4.590 Special Subject: Architectural Computation  
Prereq: None  
U (IAP, Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Seminar or lecture on a topic in computation and design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
_Computation Staff_

4.591 Special Subject: Architectural Computation  
Prereq: None  
U (IAP, Spring)  
Not offered regularly; consult department  
Units arranged [P/D/F]  
Can be repeated for credit.  
Seminar or lecture on a topic in computation and design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
_Computation Staff_

4.592 Special Subject: Architectural Computation  
Prereq: Permission of instructor  
G (Fall)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Seminar or lecture on a topic in computation and design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
T. Knight  
_Computation Staff_

4.593 Special Subject: Architectural Computation  
Prereq: Permission of instructor  
G (Spring)  
Units arranged  
Can be repeated for credit.  
Seminar or lecture on a topic in computation and design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.  
_Computation Staff_
4.54 Special Subject: Architectural Computation
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Seminar or lecture on a topic in computation and design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
Computation Staff

4.55 Special Subject: Digital Fabrication
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic in computation and design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
Consult Computation Staff

4.56 Special Subject: Shape Grammars
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic in computation and design that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
Computation Staff

History, Theory and Criticism of Architecture and Art

4.601 Introduction to Art History
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4-0-8 units. HASS-A
Introduction to the history and interpretation of western art that explores painting, graphic arts and sculpture from the Renaissance to the present. Engages diverse methodological perspectives to examine changing conceptions of art and the artist, and to investigate the plural meaning of artworks within the larger contexts of culture and history. Subject includes trips to local museums.
Consult K. Smentek

4.602 Modern Art and Mass Culture
Subject meets with 4.652
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-A; CI-H
Introduction to theories of modernism and postmodernism and their related forms (roughly 18th century to present) in art and design. Focuses on how artists use the tension between fine art and mass culture to critique both. Examines visual art in a range of genres, from painting to design objects and "relational aesthetics." Works of art are viewed in their interaction with advertising, caricature, comics, graffiti, television, fashion, "primitive" art, propaganda, and networks on the internet. Additional work required of students taking graduate version.
Consult C. Jones

4.603 Understanding Modern Architecture
Subject meets with 4.604
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Examines modern architecture, art, and design in the context of the political, economic, aesthetic, and cultural changes that occurred in the twentieth century. Presents foundational debates about social and technological aspects of modern architecture and the continuation of those debates into contemporary architecture. Incorporates varied techniques of historical and theoretical analysis to interpret exemplary objects, buildings, and cities of modernity. Additional work required of students taking the graduate version.
Preference to Course 4 majors and minors.
T. Hyde
4.604 Understanding Modern Architecture
Subject meets with 4.603
Prereq: Permission of instructor
G (Fall)
Units arranged
Examines modern architecture, art, and design in the context of the political, economic, aesthetic, and cultural changes that occurred in the twentieth century. Presents foundational debates about social and technological aspects of modern architecture and the continuation of those debates into contemporary architecture. Incorporates varied techniques of historical and theoretical analysis to interpret exemplary objects, buildings, and cities of modernity. Additional work required of students taking the graduate version. Preference to Course 4 majors.
T. Hyde

4.605 A Global History of Architecture
Subject meets with 4.650
Prereq: None
U (Spring)
4-0-8 units. HASS-A
Provides an outline of the history of architecture and urbanism from ancient times to the early modern period. Analyzes buildings as the products of culture and in relation to the special problems of architectural design. Stresses the geopolitical context of buildings and in the process familiarizes students with buildings, sites and cities from around the world. Additional work required of graduate students.
Consult M. Jarzombek

4.607 Thinking About Architecture: In History and At Present
Prereq: 4.645 or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Studies the interrelationship of theory, history, and practice. Looks at theory not as specialized discourse relating only to architecture, but as touching on many issues, whether they be cultural, aesthetic, philosophical, or professional. Topics and examples are chosen from a wide range of materials, from classical antiquity to today.
M. Jarzombek

4.608 Seminar in the History of Art and Architecture
Subject meets with 4.609
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged
Examination of historical method in art and/or architecture, focusing on periods and problems determined by the research interest of the faculty member leading the seminar. Emphasizes critical reading and viewing and direct tutorial guidance. Additional work required of students taking the graduate version. Limited to 15.
HTC Staff

4.609 Seminar in the History of Art and Architecture
Subject meets with 4.608
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A
Examination of historical method in art and/or architecture, focusing on periods and problems determined by the research interest of the faculty member leading the seminar. Emphasizes critical reading and viewing and direct tutorial guidance. Additional work required of students taking the graduate version. Limited to 15.
HTC Staff

4.612 Islamic Architecture and the Environment
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Studies how Islamic architecture, landscape architecture, and urban planning reflect and transform environmental processes in various regions and climates of the Islamic world, from Andalusia to Southeast Asia, with an emphasis on South Asia, Central Asia, and the Middle East. Using systematic approaches to environmental data collection and analysis, examines strategies behind the design of selected architectural elements and landscape design types, ranging in scale from the fountain to the garden, courtyard, city, and agrarian region. Critically explores cultural interpretations of Islamic environmental design (e.g., paradise gardens), as they developed over time in ways that enrich, modify, or obscure their historical significance.
J. Wescoat
4.614 Building Islam
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Exames the history of Islamic architecture and culture spanning fifteen centuries on three continents - Asia, Africa, Europe. Students study a number of representative examples, from the 7th century House of the Prophet to the current high-rises of Dubai, in conjunction with their urban, social, political, and intellectual environments at the time of their construction.
N. Rabbat

4.616 Topics on Culture and Architecture
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged
Seminar on how culture interacts with architecture. Analyzes architecture as a conveyor of messages that transcend stylistic, formal, and iconographic concerns to include an assessment of disciplinary, political, ideological, social, and cultural factors. Critically reviews methodologies and theoretical premises of studies on culture and meaning. Focuses on examples from Islamic history and establishes historical and theoretical frameworks for investigation. Limited to 16.
Consult N. Rabbat

4.617 Topics in Islamic Urban History
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
Units arranged
Seminar on selected topics from the history of Islamic urbanism. Examines patterns of settlement, urbanization, development, and architectural production in various places and periods, ranging from the formative period in the 7th century to the new cities emerging today. Discusses the leading factors in shaping and transforming urban forms, design imperatives, cultural and economic structures, and social and civic attitudes. Critically analyzes the body of literature on Islamic urbanism. Research paper required.
N. Rabbat

4.619 Historiography of Islamic Art and Architecture
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Critical review of literature on Islamic art and architecture in the last two centuries. Analyzes the cultural, disciplinary, and theoretical contours of the field and highlights the major figures that have influenced its evolution. Challenges the tacit assumptions and biases of standard studies of Islamic art and architecture and addresses historiographic and critical questions concerning how knowledge of a field is defined, produced, and reproduced.
N. Rabbat

4.621 Orientalism, Colonialism, and Representation
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Seminar on the politics of representation with special focus on Orientalist traditions in architecture, art, literature, and scholarship. Critically analyzes pivotal texts, projects, and artworks that reflected the encounters between the West and the Orient from Antiquity to the present. Discusses how political, ideological, and religious attitudes informed the construction and reproduction of Western knowledge about the Islamic world as well as revisionist Eastern self-representations. Research paper required. Limited to 16.
Consult N. Rabbat

4.622 Islamic Gardens and Geographies
Subject meets with 4.623
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A
Seminar focuses on the historical geography of Islamic gardens, from Andalusia to Southeast Asia, with an emphasis on the Indian subcontinent. Critically engages evidence from archaeological, art historical, and cartographic sources, and explores strategies for generating integrative accounts of historical landscapes. Topics include gardens, cities, cultural landscapes, and political territories, along with their contemporary significance for cultural heritage conservation and design. Additional work required of graduate students. Limited to 15.
J. Wescoat
4.623 Islamic Gardens and Geographies
Subject meets with 4.622
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Seminar focuses on the historical geography of Islamic gardens, from Andalusia to Southeast Asia, with an emphasis on the Indian subcontinent. Critically engages evidence from archaeological, art historical, and cartographic sources, and explores strategies for generating integrative accounts of historical landscapes. Topics include gardens, cities, cultural landscapes, and political territories, along with their contemporary significance for cultural heritage conservation and design. Additional work required of graduate students. Limited to 15.

J. Wescoat

4.625 Water Planning, Policy, and Design
Same subject as 11.378
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged
Can be repeated for credit.

Systematic examination of water law and policy issues from the site to metropolitan, state, river basin, national, international and global scales. Focuses on linkages between water history, planning, and policy design. Limited to 15.

J. Wescoat

4.633 Locating Capitalism: Producing Cities and Objects
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged

Explores what defines the parameters of a profit economy in historic Europe. Discusses major interpretive frameworks that historically have guided scholarship in architectural, art, and economic history. Traces the core themes of commodification, production, and consumption - analyzing the relevance of studies on pre- and early modern globalization - to the culture and time under consideration. Can be taken for 9 or 12 units.

L. Jacobi

4.634 Early Modern Architecture and Art
Subject meets with 4.635
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
Units arranged

Presents a history, from the 14th through the early 17th century, of architectural practice and design, as well as visual culture in Europe with an emphasis on Italy. Topics include the production and reception of buildings and artworks; the significance of a reinvigorated interest in antiquity; and representation of the individual, the state, and other institutions. Examines a variety of interpretive methods. Graduate students are expected to complete additional assignments.

L. Jacobi

4.635 Early Modern Architecture and Art
Subject meets with 4.634
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A

Presents a history, from the 14th through the early 17th century, of architectural practice and design, as well as visual culture in Europe with an emphasis on Italy. Topics include the production and reception of buildings and artworks; the significance of a reinvigorated interest in antiquity; and representation of the individual, the state, and other institutions. Examines a variety of interpretive methods. Graduate students are expected to complete additional assignments.

L. Jacobi

4.636 Topics in European Medieval Architecture and Art
Subject meets with 4.637
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A

Investigates architecture and art in medieval Europe, including significant monuments, art objects, themes, and developments from late antiquity through the rise of European cities in the 13th century. Considers a variety of media, ranging from stone- and metalwork to parchment and glass. Topics include sacred places and spaces; pilgrimage; relics and souvenirs; iconoclasm; questions of materiality, agency, and the power associated with objects; nature and magic; visions; medieval conceptions of temporality; and the construct of feudalism. Students taking graduate version complete additional assignments.

L. Jacobi
4.637 Topics in European Medieval Architecture and Art
Subject meets with 4.636
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
Units arranged
Investigates architecture and art in medieval Europe, including significant monuments, art objects, themes, and developments from late antiquity through the rise of European cities in the 13th century. Considers a variety of media, ranging from stone- and metalwork to parchment and glass. Topics include sacred places and spaces; pilgrimage; relics and souvenirs; iconoclasm; questions of materiality, agency, and the power associated with objects; nature and magic; visions; medieval conceptions of temporality; and the construct of feudalism. Students taking graduate version complete additional assignments.
L. Jacobi

4.640 Advanced Study in Critical Theory of Architecture
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged
Can be repeated for credit.
Seminar on a selected topic in critical theory. Requires original research and presentation of oral and written report.
Consult A. Dutta

4.641 19th-Century Art: Painting in the Age of Steam
Subject meets with 4.644
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A
Investigation of visual culture in the nineteenth century with an emphasis on Western Europe and its global points of contact. Topics include art and industry, artists and urban experience, empire and its image, gender and representation, and artistic responses to new technologies from the telegraph to the steam engine to the great refractor telescope. Strikes a balance between historical and contemporary critical perspectives to assess art’s engagement with the social and political experience of modernity. Additional work required of students taking the graduate version. Limited to 15.
A. Dutta

4.644 19th-Century Art: Painting in the Age of Steam
Subject meets with 4.641
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Investigation of visual culture in the nineteenth century with an emphasis on Western Europe and its global points of contact. Topics include art and industry, artists and urban experience, empire and its image, gender and representation, and artistic responses to new technologies from the telegraph to the steam engine to the great refractor telescope. Strikes a balance between historical and contemporary critical perspectives to assess art’s engagement with the social and political experience of modernity. Additional work required of students taking the graduate version. Limited to 15.
Consult K. Smentek

4.645 Selected Topics in Architecture: 1750 to the Present
Prereq: 4.210 or permission of instructor
G (Spring)
3-0-6 units
General study of modern architecture as a response to important technological, cultural, environmental, aesthetic, and theoretical challenges after the European Enlightenment. Focus on the theoretical, historiographic, and design approaches to architectural problems encountered in the age of industrial and post-industrial expansion across the globe, with specific attention to the dominance of European modernism in setting the agenda for the discourse of a global modernity at large. Explores modern architectural history through thematic exposition rather than as simple chronological succession of ideas.
A. Dutta

4.646 Advanced Study in the History of Modern Architecture and Urbanism
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.
Seminar in a selected topic in the history of modern architecture and urbanism. Oral presentations and research paper required.
T. Hyde
4.647 Technopolitics, Culture, Intervention
Prereq: 4.645 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
Units arranged
Examines the manner in which key theories of technology have influenced architectural and art production in terms of their “humanizing” claims. Students test theories of technology on the grounds of whether technology is good or bad for humans. Limited to 15; preference to MArch students.
A. Dutta

Same subject as 21A.507[J]
Subject meets with 4.649[J], 21A.519[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A
Examines the sonic phenomena and experiences that motivate scientific, humanistic, and artistic practices. Explores the aesthetic and technical aspects of how we hear; measure or describe vibrations; record, compress, and distribute resonating materials; and how we ascertain what we know about the world through sound. Although the focus is on sound as an aesthetic, social, and scientific object, the subject also investigates how resonance is used in the analysis of acoustics, architecture, and music theory. Students make a sonic artifact or research project as a final requirement. Students taking graduate version complete additional assignments.
S. Helmreich, C. Jones

Same subject as 21A.519[J]
Subject meets with 4.648[J], 21A.507[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examines the sonic phenomena and experiences that motivate scientific, humanistic, and artistic practices. Explores the aesthetic and technical aspects of how we hear; measure or describe vibrations; record, compress, and distribute resonating materials; and how we ascertain what we know about the world through sound. Although the focus is on sound as an aesthetic, social, and scientific object, the subject also investigates how resonance is used in the analysis of acoustics, architecture, and music theory. Students make a sonic artifact or research project as a final requirement. Students taking graduate version complete additional assignments.
S. Helmreich, C. Jones

4.650 A Global History of Architecture
Subject meets with 4.605
Prereq: None
G (Spring)
4-0-8 units
Provides an outline of the history of architecture and urbanism from ancient times to the early modern period. Analyzes buildings as the products of culture and in relation to the special problems of architectural design. Stresses the geopolitical context of buildings and in the process familiarizes students with buildings, sites and cities from around the world. Additional work required of graduate students.
M. Jarzombek

4.651 Art Since 1940
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A
Critical examination of major developments in European, Asian, and American art from 1940 to the present. Surveys the mainstream of art production but also examines marginal phenomena (feminism, identity politics, AIDS activism, net art) that come to change the terms of arts engagements with civic culture. Visits to area art museums and writing assignments develop skills for visual analysis and critical writing.
C. Jones

4.652 Modern Art and Mass Culture
Subject meets with 4.602
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged
Introduction to theories of modernism and postmodernism and their related forms (roughly 18th century to present) in art and design. Focuses on how artists use the tension between fine art and mass culture to critique both. Examines visual art in a range of genres, from painting to design objects and “relational aesthetics.” Works of art are viewed in their interaction with advertising, caricature, comics, graffiti, television, fashion, “primitive” art, propaganda, and networks on the internet. Additional work required of students taking the graduate version.
C. Jones
4.657 Design: The History of Making Things  
Prereq: None  
U (Spring)  
5-0-7 units. HASS-A; CI-H  

Examines themes in the history of design, with emphasis on Euro-American theory and practice in their global contexts. Addresses the historical design of communications, objects, and environments as meaningful processes of decision-making, adaptation, and innovation. Critically assesses the dynamic interaction of design with politics, economics, technology, and culture in the past and at present. Limited to 36.  
T. Hyde, K. Smentek

4.661 Theory and Method in the Study of Architecture and Art  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Can be repeated for credit.  

Studies theoretical and historiographical works pertaining to the fields of art and architectural history. Members of seminar pursue work designed to examine their own presuppositions and methods. Open only to PhD candidates and other advanced students.  
Consult HTC Staff

4.674 French Photography  
Same subject as 21G.049[J]  
Prereq: None  
Acad Year 2019-2020: U (Fall)  
Acad Year 2020-2021: Not offered  
3-0-9 units. HASS-A; CI-H  

See description under subject 21G.049[J]. Enrollment limited.  
C. Clark

4.675 Collect, Classify, Consume  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
Units arranged  
Can be repeated for credit.  

Historical study of collecting from the Renaissance to the present. Addresses the practices of collecting and display at the both the individual and institutional level, and analyzes their social, aesthetic, scientific, political and economic dimensions. Specific themes vary from year to year. Offered for 9 or 12 units. May be repeated for credit with permission of instructor.  
Consult K. Smentek

4.677 Advanced Study in the History of Art  
Prereq: Permission of instructor  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
Units arranged  
Can be repeated for credit.  

Seminar in a selected topic in the history of art, with a particular emphasis on developments from the 18th century to the present. Oral presentations and research paper required. Offered for 9 or 12 units.  
Consult K. Smentek

4.683 Preparation for HTC Qualifying Paper  
Prereq: Permission of instructor  
G (Fall, Spring)  
1-0-14 units  

Required of doctoral students in HTC as a prerequisite for work on the doctoral dissertation. The qualifying paper is a scholarly article fit to be published in a peer-reviewed journal that is the result of research in the history, theory and criticism of architecture and art. Topic may not be in the area of the proposed thesis. Work is done in consultation with HTC faculty, in accordance with the HTC PhD Degree Program Guidelines. Restricted to HTC PhD students.  
Information: HTC Staff

4.684 Preparation for HTC Major Exam  
Prereq: Permission of instructor  
G (Fall, Spring)  
1-0-26 units  

Required of doctoral students in HTC as a prerequisite for work on the doctoral dissertation. The Major Exam covers a historically broad area of interest and includes components of history, historiography, and theory. Preparation for the exam will focus on four or five themes agreed upon in advance by the student and the examiner, and are defined by their area of teaching interest. Work is done in consultation with HTC faculty, in accordance with the HTC PhD Degree Program Guidelines. Restricted to HTC PhD students.  
Information: HTC Staff
4.685 Preparation for HTC Minor Exam
Prereq: Permission of instructor
G (Fall, Spring)
1-0-14 units

Required of doctoral students in HTC as a prerequisite for work on the doctoral dissertation. The Minor Exam focuses on a specific area of specialization through which the student might develop their particular zone of expertise. Work is done in consultation with HTC faculty, in accordance with the HTC PhD Degree Program Guidelines. Restricted to HTC PhD students.
Information: HTC Staff

4.686 SMArchS AKPIA Pre-Thesis Preparation
Prereq: 4.221 and (4.619 or 4.621)
G (Spring)
0-1-2 units

Preliminary study in preparation for the thesis for the SMArchS degree in the Aga Khan Program for Islamic Architecture. Topics include literature search, precedents examination, thesis structure and typologies, and short writing exercise.
N. Rabbat, J. Wescoat

4.687 SMArchS HTC Pre-Thesis Preparation
Prereq: 4.221 and 4.661
G (Spring)
0-1-2 units

Preliminary study in preparation for the thesis for the SMArchS degree in History, Theory and Criticism. Topics include literature search, precedents examination, thesis structure and typologies, and short writing exercise.
HTC Staff

4.689 Preparation for History, Theory, and Criticism - Ph.D. Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Required for doctoral students in HTC as a prerequisite for work on the doctoral dissertation. Prior to candidacy, doctoral students are required to write and orally defend a proposal laying out the scope of their thesis, its significance, a survey of existing research and literature, the methods of research to be adopted, a bibliography and plan of work. Work is done in consultation with HTC Faculty, in accordance with the HTC PhD Degree Program guidelines. Restricted to HTC PhD students.
Consult HTC Staff

4.691 Independent Study in the History, Theory, and Criticism of Architecture and Art
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
HTC Staff

4.692 Independent Study in the History, Theory, and Criticism of Architecture and Art
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.
HTC Staff

4.693 Independent Study in the History, Theory, and Criticism of Architecture and Art
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.
HTC Staff

4.694 Independent Study in the History, Theory, and Criticism of Architecture and Art
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.
HTC Staff
4.S60 Special Subject: History, Theory and Criticism of Architecture and Art
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic in the history, theory and criticism of architecture and art that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
*HTC Staff*

4.S61 Special Subject: History, Theory and Criticism of Architecture and Art
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Seminar or lecture on a topic in the history, theory and criticism of architecture and art that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
*HTC Staff*

Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic in the history, theory and criticism of architecture and art that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
*C. Jones*

4.S63 Special Subject: History, Theory and Criticism of Architecture and Art
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic in the history, theory and criticism of architecture and art that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
*HTC Staff*

4.S64 Special Subject: History, Theory and Criticism of Architecture and Art
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Seminar or lecture on a topic in the history, theory and criticism of architecture and art that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.
*HTC Staff*

4.S65 Special Subject: Advanced Study in Islamic Architecture
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic in Islamic or non-western architecture that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports, varying at the discretion of the instructor.
*HTC Staff*
4.S66 Special Subject: History, Theory and Criticism of Art
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in the history, theory and criticism of art that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

HTC Staff

4.S67 Special Subject: Study in Modern Art
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in the history, theory and criticism of modern art that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Staff

4.S68 Special Subject: Study in Modern Architecture
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in the history, theory and criticism of modern architecture that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

Consult HTC Staff

4.S69 Special Subject: Advanced Study in the History of Urban Form
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in the history, theory and criticism of urban form that is not covered in the regular curriculum. Requires original research and presentation of oral and written reports and/or design projects, varying at the discretion of the instructor.

HTC Staff

Thesis and UROP

Graduate Subjects

4.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research and writing of thesis; to be arranged by the student with supervising committee.

Staff

Undergraduate Subjects

4.119 Preparation for Undergraduate Architecture Design Thesis
Prereq: 4.024
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-0-10 units

Selection of thesis topic, defining method of approach, and preparation of thesis proposal for BSA degree in architecture. Weekly class meeting as well as individual conference with faculty.

Consult W. O'Brien

Same subject as 11.THT[J]
Prereq: None
U (Fall)
3-0-9 units
Can be repeated for credit.

See description under subject 11.THT[J].

C. Abbanat

4.THU Undergraduate Thesis
Prereq: 4.119 or 11.THT[J]
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of thesis research leading to the writing of an SB thesis, to be arranged by the student and an appropriate MIT faculty member. Intended for seniors. 12 units recommended.

Architecture Staff
4.UR Undergraduate Research in Design
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Research and project activities, which cover the range represented by the various research interests and projects in the Department.
L. Sass

4.URG Undergraduate Research in Design
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Research and project activities, which cover the range represented by the various research interests and projects in the department. Students who wish a letter grade option for their work must register for 4.URG.
L. Sass
20.001 Introduction to Professional Success and Leadership in Biological Engineering
Prereq: None
U (Fall)
1-0-2 units
Interactive introduction to the discipline of Biological Engineering through presentations by alumni practitioners, with additional panels and discussions on skills for professional development. Presentations emphasize the roles of communication through writing and speaking, building and maintaining professional networks, and interpersonal and leadership skills in building successful careers. Provides practical advice about how to prepare for job searches and graduate or professional school applications from an informed viewpoint. Prepares students for UROPs, internships, and selection of BE electives. Subject can count toward the 9-unit discovery-focused credit limit for first-year students.
L. Griffith

20.005 Ethics for Engineers
Subject meets with 1.082[J], 2.900[J], 6.9041, 6.904[J], 10.01[J], 16.676[J], 22.014[J]
Prereq: None
U (Fall, Spring)
2-0-7 units
Integrates classical readings that provide an overview of ethics with a survey of case studies that focus on ethical problems arising in the practice of engineering. Readings taken from a variety of sources, such as Aristotle, Machiavelli, Bacon, Hobbes, Locke, the Founding Fathers, and the Bible. Case studies include written analyses and films that address engineering disasters, biotechnology, court cases, ethical codes, and the ultimate scope and aims of engineering. Students taking independent inquiry version 6.9041 expand the scope of their term project. Students taking 20.005 focus their term project on a problem in biological engineering in which there are intertwined ethical and technical issues.
D. Doneson, B. L. Trout

20.020 Introduction to Biological Engineering Design Using Synthetic Biology
Subject meets with 20.385
Prereq: None
U (Spring)
3-3-3 units
Project-based introduction to the engineering of synthetic biological systems. Throughout the term, students develop projects that are responsive to real-world problems of their choosing, and whose solutions depend on biological technologies. Lectures, discussions, and studio exercises will introduce components and control of prokaryotic and eukaryotic behavior; DNA synthesis, standards, and abstraction in biological engineering; and issues of human practice, including biological safety, security, ethics, and ownership, sharing, and innovation. Preference to freshmen.
N. Kuldell

20.051 NEET Sophomore Seminar: Living Machines
Prereq: None
U (Fall, Spring)
6-0-6 units
Seminar spanning fall and spring terms for sophomores enrolled in the Living Machines New Engineering Education Transformation (NEET) thread. Focuses on topics around “body-on-a-chip” technology via guest lectures and research discussions.
E. Alm, L. Griffith, M. Salek, T. Kassis

20.052 NEET Junior Seminar: Living Machines
Prereq: None
U (Fall, Spring)
6-0-6 units
Seminar spanning fall and spring terms for juniors enrolled in the Living Machines New Engineering Education Transformation (NEET) thread. Focuses on topics around “body-on-a-chip” technology via guest lectures and research discussions.
E. Alm, L. Griffith, T. Kassis

20.053 NEET Senior Seminar: Living Machines
Prereq: None
U (Fall, Spring)
6-0-6 units
Seminar spanning fall and spring terms for seniors enrolled in the Living Machines New Engineering Education Transformation (NEET) thread. Focuses on topics around “body-on-a-chip” technology via guest lectures and research discussions.
E. Alm, L. Griffith, T. Kassis
20.101 Metakaryotic Biology and Epidemiology
Subject meets with 20.A02
Prereq: None
U (Fall)
2-0-4 units
Introduces non-eukaryotic, “metakaryotic” cells with hollow bell-shaped nuclei that serve as the stem cells of human fetal/juvenile growth and development as well as of tumors and atherosclerotic plaques. Studies the relationship of lifetime growth and mutations of metakaryotic stem cells to age-specific death rates. Considers the biological bases of treatment protocols found to kill metakaryotic cancer stem cells in vitro and in human pancreatic cancers in vivo.
W. G. Thilly

20.102 Metakaryotic Stem Cells in Carcinogenesis: Origins and Cures
Subject meets with 20.215
Prereq: Biology (GIR), Calculus II (GIR), and Chemistry (GIR)
U (Fall)
3-0-9 units
E. V. Gostjeva, W. G. Thilly

20.104[J] Environmental Cancer Risks, Prevention, and Therapy
Same subject as 1.081[J]
Prereq: Biology (GIR), Calculus II (GIR), and Chemistry (GIR)
U (Spring)
3-0-9 units
Analysis of the history of cancer and vascular disease mortality rates in predominantly European- and African-American US cohorts, 1895-2016, to discover specific historical shifts. Explored in terms of contemporaneously changing environmental risk factors: air-, food- and water-borne chemicals; subclinical infections; diet and lifestyles. Special section on occupational risk factors. Considers the hypotheses that genetic and/or environmental factors affect metakaryotic stem cell mutation rates in fetuses and juveniles and/or their growth rates of preneoplastic in adults.
W. Thilly, R. McCunney

20.106[J] Applied Microbiology
Same subject as 1.084[J]
Prereq: Biology (GIR) and Chemistry (GIR)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Introductory microbiology from a systems perspective - considers microbial diversity and the integration of data from a molecular, cellular, organismal, and ecological context to understand the interaction of microbial organisms with their environment. Special emphasis on specific viral, bacterial, and eukaryotic microorganisms and their interaction with animal hosts with focus on contemporary problems in areas such as vaccination, emerging disease, antimicrobial drug resistance, and toxicology.
J. C. Niles, K. Ribbeck

20.109 Laboratory Fundamentals in Biological Engineering
Prereq: Biology (GIR), Chemistry (GIR), 6.0002, 18.03, and 20.110[J]
U (Fall, Spring)
2-8-5 units. Institute LAB
Introduces experimental biochemical and molecular techniques from a quantitative engineering perspective. Experimental design, data analysis, and scientific communication form the underpinnings of this subject. Examples of discovery-based experimental modules include DNA engineering in which students design, construct, and use genetic material; parts engineering, which emphasizes protein design and quantitative assessment of protein performance; systems engineering, in which students consider genome-wide consequences of genetic perturbations; and biomaterials engineering, in which students use biologically-encoded devices to design and build materials. Students complete some laboratory time online in advance of each class. Enrollment limited; priority to Course 20 majors.
A. Belcher, B. Engelward, M. Jonas, N. Lyell, L. McClain, A. Belcher, L. Samson, M. Jonas, N. Lyell, L. McClain

20.110[J] Thermodynamics of Biomolecular Systems
Same subject as 2.772[J]
Prereq: Calculus II (GIR), Chemistry (GIR), and Physics I (GIR)
U (Fall)
5-0-7 units. REST
M. Birnbaum C. Voigt
**20.129[J] Biological Circuit Engineering Laboratory**  
Same subject as 6.129[J]  
Prereq: Biology (GIR) and Calculus II (GIR)  
U (Spring)  
2-8-2 units. Institute LAB  
See description under subject 6.129[J]. Enrollment limited.  
*T. Lu, R. Weiss*

**20.200 Biological Engineering Seminar**  
Prereq: Permission of instructor  
G (Fall, Spring)  
1-0-2 units  
Can be repeated for credit.  
Weekly one-hour seminars covering graduate student research and presentations by invited speakers. Limited to BE graduate students.  
*B. Engelward*

**20.201 Fundamentals of Drug Development**  
Prereq: Permission of instructor  
G (Fall, Spring)  
4-0-8 units  
Team-based exploration of the scientific basis for developing new drugs. First portion of term covers fundamentals of target identification, drug discovery, pharmacokinetics, pharmacodynamics, regulatory policy, and intellectual property. Industry experts and academic entrepreneurs then present case studies of specific drugs, drug classes, and therapeutic targets. In a term-long project, student teams develop novel therapeutics to solve major unmet medical needs, with a trajectory to a “start-up” company. Culminates with team presentations to a panel of industry and scientific leaders.  
*P. C. Dedon, R. Sasisekharan*

**20.203[J] Neurotechnology in Action**  
Same subject as 9.123[J]  
Prereq: Permission of instructor  
G (Spring)  
3-6-3 units  
See description under subject 9.123[J].  
*E. Boyden, M. Jonas*

**20.205[J] Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience**  
Same subject as 9.26[J]  
Prereq: Biology (GIR)  
U (Spring)  
3-0-9 units  
See description under subject 9.26[J].  
*F. Zhang*

**20.213 Genome Stability and Engineering in the Context of Diseases, Drugs, and Public Health**  
Prereq: 5.07[J], 7.05, or permission of instructor  
U (Spring; second half of term)  
4-0-5 units  
Studies how DNA damage leads to diseases, and how DNA repair modulates cancer risk and treatment. Also covers how DNA repair impacts genetic engineering, whether by targeted gene therapy or CRISPR-mediated genetic changes. Students gain a public health perspective by examining how DNA-damaging agents in our environment can lead to downstream cancer. Explores the underlying chemical, molecular and biochemical processes of DNA damage and repair, and their implications for disease susceptibility and treatment.  
*B. P. Engelward*

Prereq: Permission of instructor  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
1-1-4 units  
Selected aspects of anatomy, histology, immuno-cytochemistry, in situ hybridization, physiology, and cell biology of mammalian organisms and their pathogens. Subject material integrated with principles of toxicology, in vivo genetic engineering, and molecular biology. A lab/demonstration period each week involves experiments in anatomy (in vivo), physiology, and microscopy to augment the lectures. Offered first half of spring term.  
*J. G. Fox, B. Marini, M. Whary*
20.215 Macroepidemiology, Population Genetics, and Stem Cell Biology of Human Clonal Diseases
Subject meets with 20.102
Prereq: Calculus II (GIR) and 1.00
G (Fall)
3-0-15 units
Studies the logic and technology needed to discover genetic and environmental risks for common human cancers and vascular diseases. Includes an introduction to metakaryotic stem cell biology. Analyzes large, organized historical public health databases using quantitative cascade computer models that include population stratification of stem cell mutation rates in fetal/juvenile tissues and growth rates in preneoplastic colonies and atherosclerotic plaques. Means to test hypotheses (CAST) that certain genes carry mutations conferring risk for common cancers via genetic analyses in large human cohorts. Involves de novo computer modeling of a lifetime disease experience or test of a student-developed hypothesis.
W. G. Thilly

20.219 Selected Topics in Biological Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.
Staff

20.230[J] Immunology
Same subject as 7.23[J]
Subject meets with 7.63[J], 20.630[J]
Prereq: 7.06
U (Spring)
5-0-7 units
See description under subject 7.23[J].
S. Spranger, M. Birnbaum

20.260 Computational Analysis of Biological Data
Prereq: Permission of instructor
U (IAP)
3-0-3 units
Presents foundational methods for analysis of complex biological datasets. Covers fundamental concepts in probability, statistics, and linear algebra underlying computational tools that enable generation of biological insights. Assignments focus on practical examples spanning basic science and medical applications. Assumes basic knowledge of calculus and programming.
E. Alm, D. Lauffenburger

20.305[J] Principles of Synthetic Biology
Same subject as 6.580[J]
Subject meets with 6.589[J], 20.405[J]
Prereq: None
U (Fall)
3-0-9 units
Introduces the basics of synthetic biology, including quantitative cellular network characterization and modeling. Considers the discovery and genetic factoring of useful cellular activities into reusable functions for design. Emphasizes the principles of biomolecular system design and diagnosis of designed systems. Illustrates cutting-edge applications in synthetic biology and enhances skills in analysis and design of synthetic biological applications. Students taking graduate version complete additional assignments.
R. Weiss

20.309[J] Instrumentation and Measurement for Biological Systems
Same subject as 2.673[J]
Subject meets with 20.409
Prereq: (Biology (GIR), Physics II (GIR), 6.0002, and 18.03) or permission of instructor
U (Fall, Spring)
3-6-3 units
Sensing and measurement aimed at quantitative molecular/cell/tissue analysis in terms of genetic, biochemical, and biophysical properties. Methods include light and fluorescence microscopes, and electro-mechanical probes (atomic force microscopy, optical traps, MEMS devices). Application of statistics, probability, signal and noise analysis, and Fourier techniques to experimental data. Enrollment limited; preference to Course 20 undergraduates.
P. Blainey, S. Manalis, E. Frank, S. Wasserman, J. Bagnall, E. Boyden, P. So

20.310[J] Molecular, Cellular, and Tissue Biomechanics
Same subject as 2.797[J], 3.053[J], 6.024[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units
Develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena over a range of length scales. Topics include structure of tissues and the molecular basis for macroscopic properties; chemical and electrical effects on mechanical behavior; cell mechanics, motility and adhesion; biomembranes; biomolecular mechanics and molecular motors. Experimental methods for probing structures at the tissue, cellular, and molecular levels.
M. Bathe, A. Gradzinsky
20.315 Physical Biology
Subject meets with 8.241, 20.415
Prereq: 5.60, 20.110[J], or permission of instructor
U (Spring)
3-0-9 units
Focuses on current major research topics in quantitative, physical biology. Covers synthetic structural biology, synthetic cell biology, microbial systems biology and evolution, cellular decision making, neuronal circuits, and development and morphogenesis. Emphasizes current motivation and historical background, state-of-the-art measurement methodologies and techniques, and quantitative physical modeling frameworks. Experimental techniques include structural biology, next-generation sequencing, fluorescence imaging and spectroscopy, and quantitative biochemistry. Modeling approaches include stochastic rate equations, statistical thermodynamics, and statistical inference. Students taking graduate version complete additional assignments.
J. Gore, I. Cisse

20.320 Analysis of Biomolecular and Cellular Systems
Prereq: 6.0002, 18.03, and 20.110[J]; Coreq: 5.07[J] or 7.05
U (Fall)
4-0-8 units
Analysis of molecular and cellular processes across a hierarchy of scales, including genetic, molecular, cellular, and cell population levels. Topics include gene sequence analysis, molecular modeling, metabolic and gene regulation networks, signal transduction pathways and cell populations in tissues. Emphasis on experimental methods, quantitative analysis, and computational modeling.
F. White, K. D. Wittrup

Same subject as 2.793[J], 6.023[J]
Prereq: Physics II (GIR) and (2.005, 6.021[J], or permission of instructor); Coreq: 20.309[J]
U (Spring)
4-0-8 units
Introduction to electric fields, fluid flows, transport phenomena and their application to biological systems. Flux and continuity laws, Maxwell’s equations, electro-quasistatics, electro-chemical-mechanical driving forces, conservation of mass and momentum, Navier-Stokes flows, and electrokinetics. Applications include biomolecular transport in tissues, electrophoresis, and microfluidics.
J. Han, S. Manalis

20.334 Biological Systems Modeling
Prereq: 20.330[J] or permission of instructor
U (Fall; first half of term)
1-0-5 units
Practices the use of modern numerical analysis tools (e.g., COMSOL) for biological systems with multi-physics behavior. Covers modeling of diffusion, reaction, convection and other transport mechanisms. Analysis of microfluidic devices as examples. Discusses practical issues and challenges in numerical modeling. No prior knowledge of modeling software required. Includes weekly modeling homework and one final modeling project.
J. Han

20.345[J] Bioinstrumentation Project Lab
Same subject as 6.123[J]
Prereq: 20.309[J], (Biology (GIR) and (2.004 or 6.003)), or permission of instructor
U (Spring)
2-7-3 units
In-depth examination of instrumentation design, principles and techniques for studying biological systems, from single molecules to entire organisms. Lectures cover optics, advanced microscopy techniques, electronics for biological measurement, magnetic resonance imaging, computed tomography, MEMs, microfluidic devices, and limits of detection. Students select two lab exercises during the first half of the semester and complete a final design project in the second half. Lab emphasizes design process and skillful realization of a robust system. Enrollment limited; preference to Course 20 majors and minors.
E. Boyden, M. Jonas, S. F. Nagle, P. So, S. Wasserman, M. F. Yanik

20.352 Principles of Neuroengineering
Subject meets with 9.422[J], 20.452[J], MAS.881[J]
Prereq: Permission of instructor
U (Fall)
3-0-9 units
Covers how to innovate technologies for brain analysis and engineering, for accelerating the basic understanding of the brain, and leading to new therapeutic insight and inventions. Focuses on using physical, chemical and biological principles to understand technology design criteria governing ability to observe and alter brain structure and function. Topics include optogenetics, noninvasive brain imaging and stimulation, nanotechnologies, stem cells and tissue engineering, and advanced molecular and structural imaging technologies. Includes design projects. Students taking graduate version complete additional assignments. Designed for students with engineering maturity who are ready for design.
E. S. Boyden, III
20.361[J] Molecular and Engineering Aspects of Biotechnology
Same subject as 7.37[J], 10.441[J]
Prereq: (7.06 and (2.005, 3.012, 5.60, or 20.110[J])) or permission of instructor
U (Spring)
Not offered regularly; consult department
4-0-8 units
Credit cannot also be received for 7.371
See description under subject 7.37[J].

20.363[J] Biomaterials Science and Engineering
Same subject as 3.963[J], 20.463[J]
Subject meets with 3.034, 20.110[J], or permission of instructor
U (Fall)
3-0-9 units
Covers, at a molecular scale, the analysis and design of materials used in contact with biological systems, and biomimetic strategies aimed at creating new materials based on principles found in biology. Topics include molecular interaction between bio- and synthetic molecules and surfaces; design, synthesis, and processing approaches for materials that control cell functions; and application of materials science to problems in tissue engineering, drug delivery, vaccines, and cell-guiding surfaces. Students taking graduate version complete additional assignments.
D. Irvine, K. Ribbeck

20.365 Engineering the Immune System in Cancer and Beyond
Subject meets with 20.465
Prereq: (5.60 or 20.110[J]) and permission of instructor
U (Spring)
3-0-9 units
Examines strategies in clinical and preclinical development for manipulating the immune system to treat and protect against disease. Begins with brief review of immune system. Discusses interaction of tumors with the immune system, followed by approaches by which the immune system can be modulated to attack cancer. Also covers strategies based in biotechnology, chemistry, materials science, and molecular biology to induce immune responses to treat infection, transplantation, and autoimmunity. Students taking graduate version complete additional assignments.
D. Irvine

20.370[J] Cellular Neurophysiology and Computing
Same subject as 2.791[J], 6.021[J], 9.21[J]
Subject meets with 2.794[J], 6.521[J], 9.021[J], 20.470[J], HST.541[J]
Prereq: Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, 20.110[J], or permission of instructor)
U (Fall)
5-2-5 units
See description under subject 6.021[J]. Preference to juniors and seniors.
J. Han, T. Heldt

20.375 Applied Developmental Biology and Tissue Engineering
Subject meets with 20.475
Prereq: (7.06, 20.320, and (7.003 or 20.109)) or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Addresses the integration of engineering and biology design principles to create human tissues and organs for regenerative medicine to drug development. Provides an overview of embryogenesis, how morphogenic phenomena are governed by biochemical and biophysical cues. Analyzes generation of human brain, gut, and other organoids from stem cells. Studies the roles of biomaterials and microreactors in improving organoid formation and function; organoid use in modeling disease and physiology; and engineering and biological principles of reconstructing tissues and organs from postnatal donor cells using biomaterials scaffolds and bioreactors. Includes select applications, such as liver disease, brain disorders, and others. Students taking graduate version complete additional assignments.
L. Griffith

20.380 Biological Engineering Design
Prereq: 7.06, 20.320, and 20.330[J]; Coreq: 20.309[J]
U (Fall, Spring)
5-0-7 units
Illustrates how knowledge and principles of biology, biochemistry, and engineering are integrated to create new products for societal benefit. Uses case study format to examine recently developed products of pharmaceutical and biotechnology industries: how a product evolves from initial idea, through patents, testing, evaluation, production, and marketing. Emphasizes scientific and engineering principles, as well as the responsibility scientists, engineers, and business executives have for the consequences of their technology. Instruction and practice in written and oral communication provided. Enrollment limited; preference to Course 20 undergraduates.
J. Collins, A. Koehler, J. Essigmann, K. Ribbeck


**20.381 Biological Engineering Design II**
Prereq: 20.380 or permission of instructor
U (Spring)
0-12-0 units

Continuation of 20.380 that focuses on practical implementation of design proposals. Student teams choose a feasible scope of work related to their 20.380 design proposals and execute it in the lab.

*M. Jonas, J. Sutton, S. Wasserman*

**20.385 Understanding Current Research in Synthetic Biology**
Subject meets with 20.020
Prereq: (20.109 and 20.320) or permission of instructor
U (Spring)
Not offered regularly; consult department
3-3-3 units

Provides an in-depth understanding of the state of research in synthetic biology. Critical evaluation of primary research literature covering a range of approaches to the design, modeling and programming of cellular behaviors. Focuses on developing the skills needed to read, present and discuss primary research literature, and to manage and lead small teams. Students mentor a small undergraduate team of 20.020 students. Open to advanced students with appropriate background in biology.

*Staff*

Same subject as 6.802[J]
Subject meets with 6.874[J], 20.490, HST.506[J]
Prereq: (7.05 and (6.0002 or 6.01)) or permission of instructor
U (Spring)
3-0-9 units

Presents innovative approaches to computational problems in the life sciences, focusing on deep learning-based approaches with comparisons to conventional methods. Topics include protein-DNA interaction, chromatin accessibility, regulatory variant interpretation, medical image understanding, medical record understanding, therapeutic design, and experiment design (the choice and interpretation of interventions). Focuses on machine learning model selection, robustness, and interpretation. Teams complete a multidisciplinary final research project using TensorFlow or other framework. Provides a comprehensive introduction to each life sciences problem, but relies upon students understanding probabilistic problem formulations. Students taking graduate version complete additional assignments.

*D. K. Gifford*

**20.405[J] Principles of Synthetic Biology**
Same subject as 6.589[J]
Subject meets with 6.580[J], 20.305[J]
Prereq: None
G (Fall)
3-0-9 units

Introduces the basics of synthetic biology, including quantitative cellular network characterization and modeling. Considers the discovery and genetic factoring of useful cellular activities into reusable functions for design. Emphasizes the principles of biomolecular system design and diagnosis of designed systems. Illustrates cutting-edge applications in synthetic biology and enhances skills in analysis and design of synthetic biological applications. Students taking graduate version complete additional assignments.

*R. Weiss*

**20.409 Biological Engineering II: Instrumentation and Measurement**
Subject meets with 2.673[J], 20.309[J]
Prereq: Permission of instructor
G (Fall, Spring)
2-7-3 units

Sensing and measurement aimed at quantitative molecular/cell/tissue analysis in terms of genetic, biochemical, and biophysical properties. Methods include light and fluorescence microscopies, electronic circuits, and electro-mechanical probes (atomic force microscopy, optical traps, MEMS devices). Application of statistics, probability, signal and noise analysis, and Fourier techniques to experimental data. Limited to 5 graduate students.

*P. Blainey, S. Manalis, S. Wasserman, J. Bagnall, E. Frank, E. Boyden, P. So*

**20.410[J] Molecular, Cellular, and Tissue Biomechanics**
Same subject as 2.798[J], 3.974[J], 6.524[J], 10.537[J]
Prereq: Biology (GIR) and (2.002, 2.006, 6.013, 10.301, or 10.302)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena over a range of length scales. Topics include structure of tissues and the molecular basis for macroscopic properties; chemical and electrical effects on mechanical behavior; cell mechanics, motility and adhesion; biomembranes; biomolecular mechanics and molecular motors. Experimental methods for probing structures at the tissue, cellular, and molecular levels.

*R. D. Kamm, K. J. Van Vliet*
20.415 Physical Biology
Subject meets with 8.241, 20.315
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Focuses on current major research topics in quantitative, physical biology. Topics include synthetic structural biology, synthetic cell biology, microbial systems biology and evolution, cellular decision making, neuronal circuits, and development and morphogenesis. Emphasizes current motivation and historical background, state-of-the-art measurement methodologies and techniques, and quantitative physical modeling frameworks. Experimental techniques include structural biology, next-generation sequencing, fluorescence imaging and spectroscopy, and quantitative biochemistry. Modeling approaches include stochastic rate equations, statistical thermodynamics, and statistical inference. Students taking graduate version complete additional assignments.

J. Gore, I. Cisse

20.416[J] Topics in Biophysics and Physical Biology
Same subject as 7.74[J], 8.590[J]
Prereq: None
G (Fall)
2-0-4 units

Provides broad exposure to research in biophysics and physical biology, with emphasis on the critical evaluation of scientific literature. Weekly meetings include in-depth discussion of scientific literature led by distinct faculty on active research topics. Each session also includes brief discussion of non-research topics including effective presentation skills, writing papers and fellowship proposals, choosing scientific and technical research topics, time management, and scientific ethics.

I. Cisse, N. Fakhri, M. Guo

20.420[J] Principles of Molecular Bioengineering
Same subject as 10.538[J]
Prereq: 7.06 and 18.03
G (Fall)
3-0-9 units

Provides an introduction to the mechanistic analysis and engineering of biomolecules and biomolecular systems. Covers methods for measuring, modeling, and manipulating systems, including biophysical experimental tools, computational modeling approaches, and molecular design. Equips students to take systematic and quantitative approaches to the investigation of a wide variety of biological phenomena.

A. Jasanoﬀ, E. Fraenkel

Same subject as 2.795[J], 6.561[J], 10.539[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Molecular diffusion, diffusion-reaction, conduction, convection in biological systems; ﬁelds in heterogeneous media; electrical double layers; Maxwell stress tensor, electrical forces in physiological systems. Fluid and solid continua: equations of motion useful for porous, hydrated biological tissues. Case studies of membrane transport, electrode interfaces, electrical, mechanical, and chemical transduction in tissues, convective-diffusion/reaction, electrophoretic, electroosmotic ﬂows in tissues/MEMs, and ECG. Electromechanical and physicochemical interactions in cells and biomaterials; musculoskeletal, cardiovascular, and other biological and clinical examples. Prior undergraduate coursework in transport recommended.

M. Bathe, A. J. Grodzinsky

20.440 Analysis of Biological Networks
Prereq: Permission of instructor
G (Spring)
6-0-9 units

Explores computational and experimental approaches to analyzing complex biological networks and systems. Includes genomics, transcriptomics, proteomics, metabolomics and microscopy. Stresses the practical considerations required when designing and performing experiments. Also focuses on selection and implementation of appropriate computational tools for processing, visualizing, and integrating different types of experimental data, including supervised and unsupervised machine learning methods, and multi-omics modelling. Students use statistical methods to test hypotheses and assess the validity of conclusions. In problem sets, students read current literature, develop their skills in Python and R, and interpret quantitative results in a biological manner. In the second half of term, students work in groups to complete a project in which they apply the computational approaches covered.

B. Bryson, P. Blainey

20.445[J] Methods and Problems in Microbiology
Same subject as 1.86[J], 7.492[J]
Prereq: None
G (Fall)
3-0-9 units

See description under subject 7.492[J]. Preference to ﬁrst-year Microbiology and Biology students.

M. Laub
20.446[J] Microbial Genetics and Evolution
Same subject as 1.87[J], 7.493[J], 12.493[J]
Prereq: 7.03, 7.05, or permission of instructor
G (Fall)
4-0-8 units
See description under subject 7.493[J].
A. D. Grossman, O. Cordero

20.450 Applied Microbiology
Prereq: (20.420[J] and 20.440) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
Compares the complex molecular and cellular interactions in health and disease between commensal microbial communities, pathogens and the human or animal host. Special focus is given to current research on microbe/host interactions, infection of significant importance to public health, and chronic infectious disease. Classwork will include lecture, but emphasize critical evaluation and class discussion of recent scientific papers, and the development of new research agendas in the fields presented.
J. C. Niles, K. Ribbeck

20.452[J] Principles of Neuroengineering
Same subject as 9.422[J], MAS.881[J]
Subject meets with 20.352
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject MAS.881[J].
E. S. Boyden, III

20.454[J] Revolutionary Ventures: How to Invent and Deploy Transformative Technologies
Same subject as 9.455[J], 15.128[J], MAS.883[J]
Prereq: Permission of instructor
G (Fall)
2-0-7 units
See description under subject MAS.883[J].
E. Boyden, J. Bonsen, J. Jacobson

20.463[J] Biomaterials Science and Engineering
Same subject as 3.963[J]
Subject meets with 3.055[J], 20.363[J]
Prereq: 3.034, 20.110[J], or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Covers, at a molecular scale, the analysis and design of materials used in contact with biological systems, and biomimetic strategies aimed at creating new materials based on principles found in biology. Topics include molecular interaction between bio- and synthetic molecules and surfaces; design, synthesis, and processing approaches for materials that control cell functions; and application of materials science to problems in tissue engineering, drug delivery, vaccines, and cell-guiding surfaces. Students taking graduate version complete additional assignments.
D. Irvine, K. Ribbeck

20.465 Engineering the Immune System in Cancer and Beyond
Subject meets with 20.365
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Examines strategies in clinical and preclinical development for manipulating the immune system to treat and protect against disease. Begins with brief review of immune system. Discusses interaction of tumors with the immune system, followed by approaches by which the immune system can be modulated to attack cancer. Also covers strategies based in biotechnology, chemistry, materials science, and molecular biology to induce immune responses to treat infection, transplantation, and autoimmunity. Students taking graduate version complete additional assignments.
D. Irvine

20.470[J] Cellular Neurophysiology and Computing
Same subject as 2.794[J], 6.521[J], 9.021[J], HST.541[J]
Subject meets with 2.791[J], 6.021[J], 9.21[J], 20.370[J]
Prereq: (Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, or 20.110[J])) or permission of instructor
G (Fall)
5-2-5 units
See description under subject 6.521[J].
J. Han, T. Heldt
20.475 Applied Developmental Biology and Tissue Engineering
Subject meets with 20.375
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

This subject addresses the integration of engineering and biology design principles to create human tissues and organs for regenerative medicine to drug development. Overview of embryogenesis; how morphogenetic phenomena are governed by biochemical and biophysical cues. Analysis of in vitro generation of human brain, gut, and other organoids from stem cells. Roles of biomaterials and microreactors in improving organoid formation and function. Organoid use in modeling disease and physiology in vitro. Engineering and biological principles of reconstructing tissues and organs from postnatal donor cells using biomaterials scaffolds and bioreactors. Select applications such as liver disease, brain disorders, and others. Graduate students will have additional assignments.

L. Griffith

20.486[J] Case Studies and Strategies in Drug Discovery and Development
Same subject as 7.549[J], 15.137[J], HST.916[J]
Prereq: None
G (Spring)
2-0-4 units

Aims to develop appreciation for the stages of drug discovery and development, from target identification, to the submission of preclinical and clinical data to regulatory authorities for marketing approval. Following introductory lectures on the process of drug development, students working in small teams analyze how one of four new drugs or drug candidates traversed the discovery/development landscape. For each case, an outside expert from the sponsoring drug company or pivotal clinical trial principal investigator provides guidance and critiques the teams’ presentations to the class.

A. W. Wood

20.487[J] Optical Microscopy and Spectroscopy for Biology and Medicine
Same subject as 2.715[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

See description under subject 2.715[J].

P. T. So, C. Sheppard

20.490 Computational Systems Biology: Deep Learning in the Life Sciences
Subject meets with 6.802[J], 6.874[J], 20.390[J], HST.506[J]
Prereq: Biology (GIR) and (6.041 or 18.600)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Presents innovative approaches to computational problems in the life sciences, focusing on deep learning-based approaches with comparisons to conventional methods. Topics include protein-DNA interaction, chromatin accessibility, regulatory variant interpretation, medical image understanding, medical record understanding, therapeutic design, and experiment design (the choice and interpretation of interventions). Focuses on machine learning model selection, robustness, and interpretation. Teams complete a multidisciplinary final research project using TensorFlow or other framework. Provides a comprehensive introduction to each life sciences problem, but relies upon students understanding probabilistic problem formulations. Students taking graduate version complete additional assignments.

D. K. Gifford

20.507[J] Introduction to Biological Chemistry
Same subject as 5.07[J]
Prereq: 5.12
U (Fall)
5-0-7 units. REST
Credit cannot also be received for 7.05

See description under subject 5.07[J].

E. Nolan

20.554[J] Frontiers in Chemical Biology
Same subject as 5.54[J], 7.540[J]
Prereq: 5.07[J], 5.13, 7.06, and permission of instructor
G (Fall)
3-0-9 units

See description under subject 5.54[J].

L. Kiessling, M. Shoulders
20.560 Statistics for Biological Engineering
Prereq: Permission of instructor
G (IAP)
Not offered regularly; consult department
2-0-2 units

Provides basic tools for analyzing experimental data, interpreting statistical reports in the literature, and reasoning under uncertain situations. Topics include probability theory, statistical tests, data exploration, Bayesian statistics, and machine learning. Emphasizes discussion and hands-on learning. Experience with MATLAB, Python, or R recommended.
S. Olesen

Same subject as 7.61[J]
Prereq: Permission of instructor
G (Fall)
4-0-8 units

See description under subject 7.61[J]. Enrollment limited.
R. Hynes, M. Krieger, M. Yaffe

20.586[J] Science and Business of Biotechnology
Same subject as 7.546[J], 15.480[J]
Prereq: None. Coreq: 15.401; permission of instructor
G (Spring)
3-0-6 units

See description under subject 15.480[J].
A. Lo, H. Lodish

20.630[J] Immunology
Same subject as 7.63[J]
Subject meets with 7.23[J], 20.230[J]
Prereq: 7.06 and permission of instructor
G (Spring)
5-0-7 units

See description under subject 7.63[J].
S. Spranger, M. Birnbaum

20.903 Independent Study in Biological Engineering
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for independent study under regular supervision by a faculty member. Projects require prior approval, as well as a substantive paper. Minimum 6-12 units required.
Staff

20.920 Practical Work Experience
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 units

For Course 20 students participating in off-campus professional experiences in biological engineering. Before registering for this subject, students must have an offer from a company or organization and must identify a BE supervisor. Upon completion, student must submit a letter from the company or organization describing the experience, along with a substantive final report from the student approved by the MIT supervisor. Subject to departmental approval.
Consult departmental undergraduate office.
Staff

20.930[J] Research Experience in Biopharma
Same subject as 7.930[J]
Prereq: None
G (Fall)
2-10-0 units

Provides exposure to industrial science and develops skills necessary for success in such an environment. Under the guidance of an industrial mentor, students participate in on-site research at a local biopharmaceutical company where they observe and participate in industrial science. Serves as a real-time case study to internalize the factors that shape R&D in industry, including the purpose and scope of a project, key decision points in the past and future, and strategies for execution. Students utilize company resources and work with a scientific team to contribute to the goals of their assigned project; they then present project results to the company and class, emphasizing the logic that dictated their work and their ideas for future directions. Lecture component focuses on professional development.
S. Clarke
20.950 Research Problems in Biological Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.
Directed research in the fields of bioengineering and environmental health. Limited to BE students.
Staff

20.951 Thesis Proposal
Prereq: Permission of instructor
G (Fall, Spring, Summer)
0-24-0 units
Thesis proposal research and presentation to the thesis committee.
Staff

20.960 Teaching Experience in Biological Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
For qualified graduate students interested in teaching. Tutorial, laboratory, or classroom teaching under the supervision of a faculty member. Enrollment limited by availability of suitable teaching assignments.
Staff

20.BME Undergraduate Research in Biomedical Engineering
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Individual research project with biomedical or clinical focus, arranged with appropriate faculty member or approved supervisor. Forms and instructions for the proposal and final report are available in the BE Undergraduate Office.
Consult

20.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units
See description under subject 2.EPE.
Staff

20.EPW UPOP Engineering Practice Workshop
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: None
U (Fall, IAP)
1-0-0 units
See description under subject 2.EPE. Enrollment limited.
Staff

20.S900 Special Subject in Biological Engineering
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.
L. Griffith, G. McKinley

20.S901 Special Subject in Biological Engineering
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.
S. Clarke

20.S940 Special Subject in Biological Engineering
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit.
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.
Staff

20.S947 Special Subject in Biological Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.
Staff
**20.S948 Special Subject in Biological Engineering**  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged  
Can be repeated for credit.  
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.  
*Staff*

**20.S949 Special Subject in Biological Engineering**  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged  
Can be repeated for credit.  
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.  
*Staff*

**20.S952 Special Subject in Biological Engineering**  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.  
*Staff*

**20.THG Graduate Thesis**  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.  
Program of research leading to the writing of an SM or PhD thesis; to be arranged by the student and the MIT faculty advisor.  
*Staff*

**20.THU Undergraduate BE Thesis**  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.  
Program of research leading to the writing of an SB thesis; to be arranged by the student under approved supervision.  
*Staff*

**20.UR Undergraduate Research Opportunities**  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Laboratory research in the fields of bioengineering or environmental health. May be extended over multiple terms.  
*S. Manalis*

**20.URG Undergraduate Research Opportunities**  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.  
Emphasizes direct and active involvement in laboratory research in bioengineering or environmental health. May be extended over multiple terms.  
*Consult S. Manalis*
Undergraduate Subjects

Introductory Biology
All five subjects cover the same core material, comprising about 50% of the course, while the remaining material is specialized for each version as described below. Core material includes fundamental principles of biochemistry, genetics, molecular biology, and cell biology. These topics address structure and regulation of genes, structure and synthesis of proteins, how these molecules are integrated into cells and how cells communicate with one another.

7.012 Introductory Biology
Prereq: None
U (Fall)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.013, 7.014, 7.015, 7.016, ES.7012, ES.7013

Exploration into areas of current research in molecular and cell biology, immunology, neurobiology, human genetics, biochemistry, and evolution. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.
E. Lander, C. Drennan

7.013 Introductory Biology
Prereq: None
U (Spring)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.014, 7.015, 7.016, ES.7012, ES.7013

Genomic approaches to human biology, including neuroscience, development, immunology, tissue repair and stem cells, tissue engineering, and infectious and inherited diseases, including cancer. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.
A. Amon, S. Bell, H. Sive

7.014 Introductory Biology
U (Spring)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.015, 7.016, ES.7012, ES.7013

Studies the fundamental principles of biology and their application towards understanding the Earth as a dynamical system shaped by life. Focuses on molecular ecology in order to show how processes at the molecular level can illuminate macroscopic properties, including evolution and maintenance of biogeochemical cycles, and ecological interactions in ecosystems ranging from the ocean to the human gut. Includes quantitative analysis of population growth, community structure, competition, mutualism and predation; highlights their role in shaping the biosphere. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.
G. C. Walker, D. DesMarais, M. Polz

7.015 Introductory Biology
Prereq: High school course covering cellular and molecular biology or permission of instructor
U (Fall)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.014, 7.016, ES.7012, ES.7013

Emphasizes the application of fundamental biological principles to modern, trending topics in biology. Specific modules focus on antibiotic resistance, the microbiome, biotechnology (e.g., genetically-modified organisms and CRISPR-based genome editing), personal genetics and genomics, neurodegenerative diseases, and metabolism (the science behind making wine, cheese, and natural product drugs). Includes discussion of the social and ethical issues surrounding modern biology. Limited to 60; admittance may be controlled by lottery.
M. Laub, J. K. Weng
7.016 Introductory Biology
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.014, 7.015, ES.7012, ES.7013
Introduction to fundamental principles of biochemistry, molecular biology, and genetics for understanding the functions of living systems. Covers examples of the use of chemical biology, the use of genetics in biological discovery, principles of cellular organization and communication, and engineering biological systems. In addition, includes 21st-century molecular genetics in understanding human health and therapeutic intervention. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.
B. Imperiali, A. Martin

7.002 Fundamentals of Experimental Molecular Biology
Prereq: None
U (Fall, Spring)
1-4-1 units. Partial Lab
Introduces the experimental concepts and methods of molecular biology. Covers basic principles of experimental design and data analysis, with an emphasis on the acquisition of practical laboratory experience. Satisfies 6 units of Institute Laboratory credit. Enrollment limited.
J. Lees

7.003 Molecular Biology Laboratory (New)
Prereq: 7.002
U (Fall, Spring)
2-7-3 units. Partial Lab
Laboratory-based exploration of modern experimental molecular biology. Specific experimental system studied may vary from term to term, depending on instructor. Emphasizes concepts of experimental design, data analysis and communication in biology. Satisfies 6 units of Institute Laboratory credit. Limited to 50 due to laboratory capacity.
Fall: L. Boyer, E. Calo. Spring: J. K. Weng, O. Yilmaz

7.03 Genetics
Prereq: Biology (GIR)
U (Fall, Spring)
4-0-8 units. REST
The principles of genetics with application to the study of biological function at the level of molecules, cells, and multicellular organisms, including humans. Structure and function of genes, chromosomes, and genomes. Biological variation resulting from recombination, mutation, and selection. Population genetics. Use of genetic methods to analyze protein function, gene regulation, and inherited disease.
P. Reddien, M. Hemann, A. Regev

7.05 General Biochemistry
Prereq: Biology (GIR), 5.12, or permission of instructor
U (Spring)
5-0-7 units. REST
Credit cannot also be received for 5.07[J], 20.507[J]
Contributions of biochemistry toward an understanding of the structure and functioning of organisms, tissues, and cells. Chemistry and functions of constituents of cells and tissues and the chemical and physical-chemical basis for the structures of nucleic acids, proteins, and carbohydrates. Basic enzymology and biochemical reaction mechanisms involved in macromolecular synthesis and degradation, signaling, transport, and movement. General metabolism of carbohydrates, fats, and nitrogen-containing materials such as amino acids, proteins, and related compounds.
M. Vander Heiden, M. Yaffe

7.06 Cell Biology
Prereq: 7.03 and 7.05
U (Fall, Spring)
4-0-8 units
Presents the biology of cells of higher organisms. Studies the structure, function, and biosynthesis of cellular membranes and organelles; cell growth and oncogenic transformation; transport, receptors, and cell signaling; the cytoskeleton, the extracellular matrix, and cell movements; cell division and cell cycle; functions of specialized cell types. Emphasizes the current molecular knowledge of cell biological processes as well as the genetic, biochemical, and other experimental approaches that resulted in these discoveries.
I. Cheeseman, J. T. Littleton, F. Solomon, R. Lamason
7.08[J] Biological Chemistry II  
Same subject as 5.08[J]  
Subject meets with 7.80  
Prereq: 5.12 and (5.07[J] or 7.05)  
U (Spring)  
4-0-8 units  
See description under subject 5.08[J].  
B. Imperiali, L. Kiessling, R. Raines

7.09 Quantitative and Computational Biology  
Prereq: 7.03 and 7.05  
U (Spring)  
3-0-9 units  
Quantitative and computational analysis of biological systems at the molecular and cellular level. Includes models of biological processes across different length and time scales, such as steady-state, kinetics of gene expression, circadian clock, stochasticity, and biomolecular phase separation. Methods include physical, systems, and synthetic biology. Also covers single-molecule methods, second-generation sequencing technologies, and computational approaches to data analysis.  
A. Jain, G. W. Li

7.102 Introduction to Molecular Biology Techniques  
Prereq: None  
U (IAP)  
0-5-1 units. Partial Lab  
Designed primarily for first-year students with little or no lab experience. Introduces basic methods of experimental molecular biology. Specific experiments vary from year-to-year, but will focus on the identification and characterization of bacteria and bacteriophages from the wild using an array of basic methods in molecular biology and microbiology. Biology GIR or Chemistry GIR recommended. Satisfies 6 units of Institute Laboratory credit. Limited to 18; admittance may be controlled by lottery.  
C. Drennan

7.11 Biology Teaching  
Prereq: None  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit.  
For qualified undergraduate students interested in gaining some experience in teaching. Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview.  
Consult Biology Education Office

7.19 Communication in Experimental Biology  
Prereq: (7.06 and (5.362, 7.003, or 20.109)) or permission of instructor  
U (Fall, Spring)  
4-4-4 units  
Students carry out independent literature research. Journal club discussions are used to help students evaluate and write scientific papers. Instruction and practice in written and oral communication is provided.  
J. Chen, J. Davis, C. Kaiser

7.20[J] Human Physiology  
Same subject as HST.540[J]  
Prereq: 7.05  
U (Fall)  
5-0-7 units  
Comprehensive exploration of human physiology, emphasizing the molecular basis and applied aspects of organ function and regulation in health and disease. Includes a review of cell structure and function, as well as the mechanisms by which the endocrine and nervous systems integrate cellular metabolism. Special emphasis on examining the cardiovascular, pulmonary, gastrointestinal, and renal systems, as well as liver function, drug metabolism, and pharmacogenetics.  
M. Krieger, D. Sabatini

7.21 Microbial Physiology  
Subject meets with 7.62  
Prereq: 7.03 and 7.05  
U (Fall)  
4-0-8 units  
Biochemical properties of bacteria and other microorganisms that enable them to grow under a variety of conditions. Interaction between bacteria and bacteriophages. Genetic and metabolic regulation of enzyme action and enzyme formation. Structure and function of components of the bacterial cell envelope. Protein secretion with a special emphasis on its various roles in pathogenesis. Additional topics include bioenergetics, symbiosis, quorum sensing, global responses to DNA damage, and biofilms. Students taking the graduate version are expected to explore the subject in greater depth.  
G. C. Walker, A. J. Sinskey
7.23[J] Immunology
Same subject as 20.230[J]
Subject meets with 7.63[J], 20.630[J]
Prereq: 7.06
U (Spring)
5-0-7 units
Comprehensive survey of molecular, genetic, and cellular aspects of the immune system. Topics include innate and adaptive immunity; cells and organs of the immune system; hematopoiesis; immunoglobulin, T cell receptor, and major histocompatibility complex (MHC) proteins and genes; development and functions of B and T lymphocytes; immune responses to infections and tumors; hypersensitivity, autoimmunity, and immunodeficiencies. Particular attention to the development and function of the immune system as a whole, as studied by modern methods and techniques. Students taking graduate version explore the subject in greater depth, including study of recent primary literature.
S. Spranger, M. Birnbaum

7.26 Molecular Basis of Infectious Disease
Subject meets with 7.66
Prereq: 7.06
U (Spring)
4-0-8 units
Focuses on the principles of host-pathogen interactions with an emphasis on infectious diseases of humans. Presents key concepts of pathogenesis through the study of various human pathogens. Includes critical analysis and discussion of assigned readings. Students taking the graduate version are expected to explore the subject in greater depth.
R. Lamason, S. Lourido

7.27 Principles of Human Disease and Aging
Prereq: 7.06
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units
Covers modern approaches to human diseases and aging, emphasizing the molecular and cellular basis of genetic diseases, infectious diseases, aging, and cancer. Topics include the genetics of simple and complex traits; karyotypic analysis and positional cloning; genetic diagnosis; evolutionary determination of aging, genetic and molecular aspects of aging, HIV/AIDS and other infectious diseases; the roles of oncogenes and tumor suppressors; the interaction between genetics and environment; animal models of human disease, cancer, and aging; and treatment strategies for diseases and aging. Includes a paper describing novel treatment options for a specific disease chosen by each student.
D. Housman, L. Guarente

7.28 Molecular Biology
Subject meets with 7.58
Prereq: 7.03; Coreq: 7.05
U (Spring)
5-0-7 units
Detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. Topics covered in lecture and readings of relevant literature include: gene regulation, DNA replication, genetic recombination, and mRNA translation. Logic of experimental design and data analysis emphasized. Presentations include both lectures and group discussions of representative papers from the literature. Students taking the graduate version are expected to explore the subject in greater depth.
S. Bell, E. Calo

7.29[J] Cellular and Molecular Neurobiology
Same subject as 9.09[J]
Prereq: 7.05 or 9.01
U (Spring)
4-0-8 units
Introduction to the structure and function of the nervous system. Emphasizes the cellular properties of neurons and other excitable cells. Includes the structure and biophysical properties of excitable cells, synaptic transmission, neurochemistry, neurodevelopment, integration of information in simple systems, and detection and information coding during sensory transduction.
M. Heiman, M. Wilson

Same subject as 1.018[J], 12.031[J]
Prereq: None
U (Fall)
4-0-8 units. REST
See description under subject 1.018[J].
M. Follows, D. Des Marais
7.31 Current Topics in Mammalian Biology: Medical Implications
Prereq: 7.06 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4.0-8 units

Covers recent advances in mammalian cell and developmental biology with particular emphasis on approaches that utilize mouse genetics. Combines formal lectures on selected topics with readings of original papers which are discussed in class. Major emphasis on the implications of mechanisms of human genetic diseases. Topics include early mammalian development; genomic imprinting; X inactivation; embryonic stem cells; nuclear reprogramming of somatic cells; cell migration; nervous system development; and central nervous system degenerative diseases such as Alzheimer’s and Huntington’s disease. Limited to 20.
F. Gertler, R. Jaenisch

7.32 Systems Biology
Subject meets with 7.81[J], 8.591[J]
Prereq: (18.03 and 18.05) or permission of instructor
U (Fall)
3.0-9 units

Introduction to cellular and population-level systems biology with an emphasis on synthetic biology, modeling of genetic networks, cell-cell interactions, and evolutionary dynamics. Cellular systems include genetic switches and oscillators, network motifs, genetic network evolution, and cellular decision-making. Population-level systems include models of pattern formation, cell-cell communications, and evolutionary systems biology. Students taking graduate version explore the subject in more depth.
J. Gore

Same subject as 6.049[J]
Prereq: (6.0001 and 7.03) or permission of instructor
U (Spring)
3.0-9 units

Explores and illustrates how evolution explains biology, with an emphasis on computational model building for analyzing evolutionary data. Covers key concepts of biological evolution, including adaptive evolution, neutral evolution, evolution of sex, genomic conflict, speciation, phylogeny and comparative methods, life’s history, coevolution, human evolution, and evolution of disease.
R. Berwick, D. Bartel

7.34-7.344 Advanced Undergraduate Seminar
Prereq: 7.06 or 7.28
U (Fall, Spring)
2.0-4 units
Can be repeated for credit.

Seminars covering topics of current interest in biology with a focus on how to understand experimental methods and design and how to critically read the primary research literature. Small class size facilitates discussions and interactions with an active research scientist. Students visit research laboratories to see firsthand how biological research is conducted. Contact Biology Education Office for topics.
H. R. Horvitz

7.345-7.349 Advanced Undergraduate Seminar
Prereq: 7.06 or 7.28
U (Fall, Spring)
2.0-4 units
Can be repeated for credit.

Seminars covering topics of current interest in biology with a focus on how to understand experimental methods and design and how to critically read the primary research literature. Small class size facilitates discussions and interactions with an active research scientist. Students visit research laboratories to see firsthand how biological research is conducted. Contact Biology Education Office for topics.
H. R. Horvitz

7.37[J] Molecular and Engineering Aspects of Biotechnology
Same subject as 10.441[J], 20.361[J]
Prereq: (7.06 and (2.005, 3.012, 5.60, or 20.110[J])) or permission of instructor
U (Spring)
Not offered regularly; consult department
4.0-8 units
Credit cannot also be received for 7.371

Covers biological and bioengineering principles underlying the development and therapeutic use of recombinant proteins and stem cells; glycoengineering of recombinant proteins; normal and pathological signaling by growth factors and their receptors; receptor trafficking; monoclonal antibodies as therapeutics; protein pharmacology and delivery; stem cell-derived tissues as therapeutics; RNA therapeutics; combinatorial protein engineering; and new antitumor drugs.
Staff
7.371 Biological and Engineering Principles Underlying Novel Biotherapeutics
Prereq: 7.06
U (Fall)
4-0-8 units
Credit cannot also be received for 7.37[J], 10.441[J], 20.361[J]
Covers biological and bioengineering principles underlying the development and therapeutic use of recombinant proteins and immune cells. Special attention to monoclonal antibodies and engineered immune system cells as therapeutics; protein- and glyco-engineering to enhance protein function; protein pharmacology and delivery; nucleic acid-based biotherapeutics; generation of functional cells and tissues from embryonic stem cells and iPS cells; and immune cell-cancer cell interactions in cancer immunotherapy.
J. Chen, H. Lodish

7.45 The Hallmarks of Cancer
Subject meets with 7.85
Prereq: None. Coreq: 7.06
U (Fall)
4-0-8 units
Provides a comprehensive introduction to the fundamentals of cancer biology and cancer treatment. Topics include cancer genetics, genomics, and epigenetics; familial cancer syndromes; signal transduction, cell cycle control, and apoptosis; cancer metabolism; stem cells and cancer; metastasis; cancer immunology and immunotherapy; conventional and molecularly-targeted therapies; and early detection and prevention. Students taking graduate version complete additional assignments.
T. Jacks, M. Vander Heiden

7.46 Building with Cells
Subject meets with 7.86
Prereq: 7.03 and 7.05
U (Fall)
4-0-8 units
Identifies principles of developmental biology by which cells build organs and organisms. Explores the pivotal of stem cells in maintenance or repair, and in treatment of disease. Analyzes how cells can construct useful structures through tissue engineering. Students taking graduate version complete additional assignments.
H. Sive

7.458[J] Advances in Biomanufacturing
Same subject as 10.03[J]
Subject meets with 7.548[J], 10.53[J]
Prereq: None
U (Spring; second half of term)
1-0-2 units
Seminar examines how biopharmaceuticals, an increasingly important class of pharmaceuticals, are manufactured. Topics range from fundamental bioprocesses to new technologies to the economics of biomanufacturing. Also covers the impact of globalization on regulation and quality approaches as well as supply chain integrity. Students taking graduate version complete additional assignments.
J. C. Love, A. Sinskey, S. Springs

7.49[J] Developmental Neurobiology
Same subject as 9.18[J]
Subject meets with 7.69[J], 9.181[J]
Prereq: 7.03, 7.05, 9.01, or permission of instructor
U (Spring)
3-0-9 units
Considers molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Topics include: neural induction and pattern formation, cell lineage and fate determination, neuronal migration, axon guidance, synapse formation and stabilization, activity-dependent development and critical periods, development of behavior. Students taking graduate version complete additional readings that will be addressed in their mid-term and final exams.
E. Nedivi, M. Heiman

7.390 Practical Internship Experience in Biology
Prereq: None
U (Summer)
0-1-0 units
Can be repeated for credit.
For Course 7, 5-7, and 6-7 students participating in curriculum-related off-campus internship experiences in biology. Before enrolling, students must consult the Biology Education Office for details on procedures and restrictions, and have approval from their faculty advisor. Subject to department approval. Upon completion, the student must submit a write-up of the experience, approved by their faculty advisor.
Staff
7.391 Independent Study in Biology
Prereq: None
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.392 Independent Study in Biology
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.393 Independent Study in Genetics
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.394 Independent Study in Biochemistry
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.395 Independent Study in Cell and Molecular Biology
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.396 Independent Study in Experimental Biology
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.396 Independent Study in Experimental Biology
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Program of study or research to be arranged with a department faculty member.
Staff

7.391 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.392 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.399 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.UR Undergraduate Research
Prereq: Permission of department
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Undergraduate research opportunities in the Department of Biology.
For further information, consult departmental coordinator, Gene Brown.
Staff
7.URG Undergraduate Research
Prereq: Permission of department
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Undergraduate research opportunities in the Department of Biology.
For further information, consult departmental coordinator, Gene Brown.
Staff

Graduate Subjects

MIT-WHOI Joint Program in Oceanography

7.410 Applied Statistics
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.

Provides an introduction to modern applied statistics. Topics include likelihood-based methods for estimation, confidence intervals, and hypothesis-testing; bootstrapping; time series modeling; linear models; nonparametric regression; and model selection. Organized around examples drawn from the recent literature.
A. Solow

7.411 Seminars in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Selected topics in biological oceanography.
WHOI Staff

7.421 Problems in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Advanced problems in biological oceanography with assigned reading and consultation.
Information: M. Neubert (WHOI)

7.430 Topics in Quantitative Marine Science
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Lectures and discussions on quantitative marine ecology. Topics vary from year to year.
WHOI Staff

7.431 Topics in Marine Ecology
Prereq: Permission of instructor
G (Spring)
2-0-4 units
Can be repeated for credit.

Lectures and discussions on ecological principles and processes in marine populations, communities, and ecosystems. Topics vary from year to year.
WHOI Staff

7.432 Topics in Marine Physiology and Biochemistry
Prereq: Permission of instructor
G (Spring)
2-0-4 units
Can be repeated for credit.

Lectures and discussions on physiological and biochemical processes in marine organisms. Topics vary from year to year.
WHOI Staff

7.433 Topics in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Lectures and discussions on biological oceanography. Topics vary from year to year.
WHOI Staff

7.434 Topics in Zooplankton Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Lectures and discussions on the biology of marine zooplankton. Topics vary from year to year.
WHOI Staff
7.435 Topics in Benthic Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.
Lectures and discussions on the biology of marine benthos. Topics vary from year to year.

WHOI Staff

7.436 Topics in Phytoplankton Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.
Lectures and discussion on the biology of marine phytoplankton. Topics vary from year to year.

WHOI Staff

7.437 Topics in Molecular Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.
Lectures and discussion on molecular biological oceanography. Topics vary from year to year.

WHOI Staff

7.438 Topics in the Behavior of Marine Animals
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.
Lectures and discussion on the behavioral biology of marine animals. Topics vary from year to year.

WHOI Staff

7.439 Topics in Marine Microbiology
Prereq: Permission of instructor
G (Spring)
2-0-4 units
Can be repeated for credit.
Lectures and discussion on the biology of marine prokaryotes. Topics vary from year to year.

WHOI Staff

7.440 An Introduction to Mathematical Ecology
Prereq: Calculus I (GIR), 1.018[J], or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Covers the basic models of population growth, demography, population interaction (competition, predation, mutualism), food webs, harvesting, and infectious disease, and the mathematical tools required for their analysis. Because these tools are also basic to the analysis of models in biochemistry, physiology, and behavior, subject also broadly relevant to students whose interests are not limited to ecological problems.

M. Neubert (WHOI)

7.470 Biological Oceanography
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Intended for students with advanced training in biology. Intensive overview of biological oceanography. Major paradigms discussed, and dependence of biological processes in the ocean on physical and chemical aspects of the environment examined. Surveys the diversity of marine habitats, major groups of taxa inhabiting those habitats, and the general biology of the various taxa: the production and consumption of organic material in the ocean, as well as factors controlling those processes. Species diversity, structure of marine food webs, and the flow of energy within different marine habitats are detailed and contrasted.

WHOI Staff

7.491 Research in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Directed research in biological oceanography not leading to graduate thesis and initiated prior to the qualifying exam.

WHOI Staff
Microbiology (MICRO)

7.492[J] Methods and Problems in Microbiology
Same subject as 1.86[J], 20.445[J]
Prereq: None
G (Fall)
3-0-9 units

Students will read and discuss primary literature covering key areas of microbial research with emphasis on methods and approaches used to understand and manipulate microbes. Preference to first-year Microbiology and Biology students.
M. Laub

7.493[J] Microbial Genetics and Evolution
Same subject as 1.87[J], 12.493[J], 20.446[J]
Prereq: 7.03, 7.05, or permission of instructor
G (Fall)
4-0-8 units

Covers aspects of microbial genetic and genomic analyses, central dogma, horizontal gene transfer, and evolution.
A. D. Grossman, O. Cordero

7.494 Research Problems in Microbiology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Directed research in the fields of microbial science and engineering.
Staff

7.498 Teaching Experience in Microbiology
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]
Can be repeated for credit.

For qualified graduate students in the Microbiology graduate program interested in teaching. Classroom or laboratory teaching under the supervision of a faculty member.
Staff

7.499 Research Rotations in Microbiology
Prereq: None. Coreq: 7.492[J] or 7.493[J]; permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Introduces students to faculty participating in the interdepartmental Microbiology graduate program through a series of three lab rotations, which provide broad exposure to microbiology research at MIT. Students select a lab for thesis research by the end of their first year. Given the interdisciplinary nature of the program and the many research programs available, students may be able to work jointly with more than one research supervisor. Limited to students in the Microbiology graduate program.
Staff

7.MTG Microbiology Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a PhD thesis. To be arranged by the student and the appropriate MIT faculty member.
Staff

Biology

7.50 Method and Logic in Molecular Biology
Prereq: None. Coreq: 7.51 and 7.52; or permission of instructor
G (Fall)
4-0-8 units

Logic, experimental design and methods in biology, using discussions of the primary literature to discern the principles of biological investigation in making discoveries and testing hypotheses. In collaboration with faculty, students also apply those principles to generate a potential research project, presented in both written and oral form. Limited to Course 7 graduate students.
I. Cheeseman, M. Gehring, M. Hemann, J. Lees, D. Sabatini, F. Solomon
7.51 Principles of Biochemical Analysis  
Prereq: Permission of instructor  
G (Fall)  
6-0-6 units  
Principles of biochemistry, emphasizing structure, equilibrium studies, kinetics, informatics, single-molecule studies, and experimental design. Topics include macromolecular binding and specificity, protein folding and unfolding, allosteric systems, transcription factors, kinases, membrane channels and transporters, and molecular machines.  
A. Keating, R. T. Sauer

7.52 Genetics for Graduate Students  
Prereq: Permission of instructor  
G (Fall)  
4-0-8 units  
Principles and approaches of genetic analysis, including Mendelian inheritance and prokaryotic genetics, yeast genetics, developmental genetics, neurogenetics, and human genetics.  
H. R. Horvitz, C. Kaiser, E. Lander

7.540[J] Frontiers in Chemical Biology  
Same subject as 5.54[J], 20.554[J]  
Prereq: 5.07[J], 5.13, 7.06, and permission of instructor  
G (Fall)  
3-0-9 units  
See description under subject 5.54[J].  
L. Kiessling, M. Shoulders

7.546[J] Science and Business of Biotechnology  
Same subject as 15.480[J], 20.586[J]  
Prereq: None. Coreq: 15.401; permission of instructor  
G (Spring)  
3-0-6 units  
See description under subject 15.480[J].  
A. Lo, H. Lodish

7.547[J] Principles and Practice of Drug Development  
Same subject as 10.547[J], 15.136[J], HST.920[J], IDS.620[J]  
Prereq: Permission of instructor  
G (Fall)  
3-0-6 units  
See description under subject 15.136[J].  
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

7.548[J] Advances in Biomanufacturing  
Same subject as 10.53[J]  
Subject meets with 7.458[J], 10.03[J]  
Prereq: None  
G (Spring; second half of term)  
1-0-2 units  
Seminar examines how biopharmaceuticals, an increasingly important class of pharmaceuticals, are manufactured. Topics range from fundamental bioprocesses to new technologies to the economics of biomanufacturing. Also covers the impact of globalization on regulation and quality approaches as well as supply chain integrity. Students taking graduate version complete additional assignments.  
J. C. Love, A. Sinskey, S. Springs

7.549[J] Case Studies and Strategies in Drug Discovery and Development  
Same subject as 15.137[J], 20.486[J], HST.916[J]  
Prereq: None  
G (Spring)  
2-0-4 units  
See description under subject 20.486[J].  
A. W. Wood

7.55 Case Studies in Modern Experimental Design  
Prereq: Permission of instructor  
G (Spring)  
2-0-7 units  
Focuses on enhancing students’ ability to analyze, design and present experiments, emphasizing modern techniques. Class discussions begin with papers that developed or utilized contemporary approaches (e.g., quantitative microscopy, biophysical and molecular genetic methods) to address important problems in biology. Each student prepares one specific aim of a standard research proposal for a project that emphasizes research strategy, experimental design, and writing.  
F. Solomon, S. Spranger
7.57 Quantitative Biology for Graduate Students
Prereq: Permission of instructor
G (Spring)
4-0-8 units
Introduces the fundamental concepts and tools of quantitative approaches to molecular and cellular biology. Covers a wide range of mathematical, computational, and statistical methods, although no previous expertise in these areas is required. Focuses on understanding quantitative approaches through the analysis of particular problems and examples drawn from classical genetics, molecular biology, cell biology, genomics, and systems biology.
J. Davis, G. W. Li

7.58 Molecular Biology
Subject meets with 7.28
Prereq: 7.03, 7.05, and permission of instructor
G (Spring)
5-0-7 units
Detailed analysis of the biochemical mechanisms that control the maintenance, expression, and evolution of prokaryotic and eukaryotic genomes. Topics covered in lecture and readings of relevant literature include: gene regulation, DNA replication, genetic recombination, and mRNA translation. Logic of experimental design and data analysis emphasized. Presentations include both lectures and group discussions of representative papers from the literature. Students taking the graduate version are expected to explore the subject in greater depth.
S. Bell, E. Calo

7.59[J] Teaching College-Level Science and Engineering
Same subject as 1.95[J], 5.95[J], 8.395[J], 18.094[J]
Subject meets with 2.978
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-0-2 units
See description under subject 5.95[J].
J. Rankin

7.60 Cell Biology: Structure and Functions of the Nucleus
Prereq: 7.06 or permission of instructor
G (Spring)
3-0-9 units
Eukaryotic genome structure, function, and expression, processing of RNA, and regulation of the cell cycle. Emphasis on the techniques and logic used to address important problems in nuclear cell biology. Lectures on broad topic areas in nuclear cell biology and discussions on representative recent papers.
L. Boyer, R. Young

7.61[J] Eukaryotic Cell Biology: Principles and Practice
Same subject as 20.561[J]
Prereq: Permission of instructor
G (Fall)
4-0-8 units
Emphasizes methods and logic used to analyze structure and function of eukaryotic cells in diverse systems (e.g., yeast, fly, worm, mouse, human; development, stem cells, neurons). Combines lectures and in-depth roundtable discussions of literature readings with the active participation of faculty experts. Focuses on membranes (structure, function, traffic), organelles, the cell surface, signal transduction, cytoskeleton, cell motility and extracellular matrix. Ranges from basic studies to applications to human disease, while stressing critical analysis of experimental approaches. Enrollment limited.
R. Hynes, M. Krieger, M. Yaffe

7.62 Microbial Physiology
Subject meets with 7.21
Prereq: 7.03, 7.05, and permission of instructor
G (Fall)
4-0-8 units
Biochemical properties of bacteria and other microorganisms that enable them to grow under a variety of conditions. Interaction between bacteria and bacteriophages. Genetic and metabolic regulation of enzyme action and enzyme formation. Structure and function of components of the bacterial cell envelope. Protein secretion with a special emphasis on its various roles in pathogenesis. Additional topics include bioenergetics, symbiosis, quorum sensing, global responses to DNA damage, and biofilms. Students taking the graduate version are expected to explore the subject in greater depth.
G. C. Walker, A. J. Sinskey
7.63[J] Immunology
Same subject as 20.630[J]
Subject meets with 7.23[J], 20.230[J]
Prereq: 7.06 and permission of instructor
G (Spring)
5-0-7 units

Comprehensive survey of molecular, genetic, and cellular aspects of the immune system. Topics include innate and adaptive immunity; cells and organs of the immune system; hematopoiesis; immunoglobulin, T cell receptor, and major histocompatibility complex (MHC) proteins and genes; development and functions of B and T lymphocytes; immune responses to infections and tumors; hypersensitivity, autoimmunity, and immunodeficiencies. Particular attention to the development and function of the immune system as a whole, as studied by modern methods and techniques. Students taking graduate version explore the subject in greater depth, including study of recent primary literature.
S. Spranger, M. Birnbaum

7.64 Molecular Mechanisms, Pathology and Therapy of Human Neuromuscular Disorders
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Investigates the molecular and clinical basis of central nervous system and neuromuscular disorders with particular emphasis on strategies for therapeutic intervention. Considers the in-depth analysis of clinical features, pathological mechanisms, and responses to current therapeutic interventions. Covers neurodegenerative diseases, such as Huntington's disease, Parkinson's disease, Alzheimer's disease, Amyotrophic Lateral Sclerosis, Frontal Temporal Dementia, and neuromuscular disorders, such as Myotonic Dystrophy, Facio Scapular Humoral Dystrophy, and Duchenne Muscular Dystrophy.
D. Housman

7.65[J] Molecular and Cellular Neuroscience Core I
Same subject as 9.015[J]
Prereq: None
G (Fall)
3-0-9 units

See description under subject 9.015[J].
J. T. Littleton, H. Sive

7.66 Molecular Basis of Infectious Disease
Subject meets with 7.26
Prereq: 7.06 and permission of instructor
G (Spring)
4-0-8 units

Focuses on the principles of host-pathogen interactions with an emphasis on infectious diseases of humans. Presents key concepts of pathogenesis through the study of various human pathogens. Includes critical analysis and discussion of assigned readings. Students taking the graduate version are expected to explore the subject in greater depth.
R. Lamason, S. Lourido

7.68[J] Molecular and Cellular Neuroscience Core II
Same subject as 9.013[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

See description under subject 9.013[J].
G. Feng, L.-H. Tsai

7.69[J] Developmental Neurobiology
Same subject as 9.181[J]
Subject meets with 7.49[J], 9.18[J]
Prereq: 9.011 or permission of instructor
G (Spring)
3-0-9 units

See description under subject 9.181[J].
E. Nedivi, M. Heiman

7.70 Regulation of Gene Expression
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
4-0-8 units

Seminar examines basic principles of biological regulation of gene expression. Focuses on examples that underpin these principles, as well as those that challenge certain long-held views. Topics covered may include the role of transcription factors, enhancers, DNA modifications, non-coding RNAs, and chromatin structure in the regulation of gene expression and mechanisms for epigenetic inheritance of transcriptional states. Limited to 40.
Staff
7.71 Structural and Biophysical Analysis of Biological Macromolecules

Subject meets with 5.78
Prereq: 5.13, 5.60, (5.07[J] or 7.05), and permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
5-0-7 units

Studies theory and practice of 3-D analysis of macromolecules, using X-ray crystallography and EM analysis. Covers biophysical methods to characterize molecular properties and interactions. Includes discussion of current literature and, importantly, practical exercises in crystallization, model building, and the use of shared instrumentation available at MIT. Meets with 5.78 when offered concurrently.

T. Schwartz

7.72 Stem Cells, Regeneration, and Development

Prereq: Permission of instructor
G (Spring)
4-0-8 units

Topics include diverse stem cells, such as muscle, intestine, skin, hair and hematopoietic stem cells, as well as pluripotent stem cells. Topics address cell polarity and cell fate; positional information and patterning of development and regeneration; limb, heart and whole body regeneration; stem cell renewal; progenitor cells in development; responses to wounding; and applications of stem cells in development of therapies. Discussions of papers supplement lectures.

R. Hynes, R. Jaenisch, P. Reddien

7.73 Principles of Chemical Biology

Prereq: 7.05 and permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Spanning the fields of biology, chemistry and engineering, class addresses the principles of chemical biology and its application of chemical and physical methods and reagents to the study and manipulation of biological systems. Topics include bioorthogonal reactions and activity-based protein profiling, small molecule inhibitors and chemical genetics, fluorescent probes for biological studies, and unnatural amino acid mutagenesis. Also covers chemical biology approaches for studying dynamic post-translational modification reactions, natural product biosynthesis and mutasynthesis, and high-throughput drug screening. Students taking the graduate version are expected to explore the subject in greater depth.

B. Imperiali, J. K. Weng

7.74[J] Topics in Biophysics and Physical Biology

Same subject as 8.590[J], 20.416[J]
Prereq: None
G (Fall)
2-0-4 units

See description under subject 20.416[J].

I. Cisse, N. Fakhri, M. Guo

7.76 Topics in Macromolecular Structure and Function

Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-6 units

In-depth analysis and discussion of classic and current literature, with an emphasis on the structure, function, and mechanisms of proteins and other biological macromolecules.

T. Baker, R. T. Sauer

7.77 Nucleic Acids, Structure, Function, Evolution and Their Interactions with Proteins

Prereq: 7.05, 7.51, or permission of instructor
G (Spring)
3-0-9 units

Surveys primary literature, focusing on biochemical, biophysical, genetic, and combinatorial approaches for understanding nucleic acids. Topics include the general properties, functions, and structural motifs of DNA and RNA; RNAs as catalysts and as regulators of gene expression; RNA editing and surveillance, and the interaction of nucleic acids with proteins, such as zinc-finger proteins, modification enzymes, aminoacyl-tRNA synthetases and other proteins of the translational machinery. Includes some lectures but is mostly analysis and discussion of current literature in the context of student presentations.

D. Bartel, U. RajBhandary

7.80 Biological Chemistry II

Subject meets with 5.08[J], 7.08[J]
Prereq: 5.12 and (5.07[J] or 7.05)
G (Spring)
4-0-8 units

More advanced treatment of biochemical mechanisms that underlie biological processes. Topics include macromolecular machines such as the ribosome, the proteosome, fatty acid synthases as a paradigm for polyketide syntheses and non-ribosomal polypeptide syntheses, and polymerases. Emphasis is on experimental methods used to unravel these processes and how these processes fit into the cellular context and coordinate regulation. Students taking the graduate version are expected to explore the subject in greater depth.

E. Nolan, R. Raines
7.81[J] Systems Biology  
Same subject as 8.591[J]  
Subject meets with 7.32  
Prereq: (18.03 and 18.05) or permission of instructor  
G (Fall)  
3-0-9 units  
See description under subject 8.591[J].  
J. Gore

7.82 Topics of Mammalian Development and Genetics  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  
Seminar covering embryologic, molecular, and genetic approaches to development in mice and humans. Topics include preimplantation development; gastrulation; embryonic stem cells, gene targeting and nuclear reprogramming of somatic cells; genomic imprinting; X-inactivation; sex determination; and germ cells.  
R. Jaenisch, R. Young

7.85 The Hallmarks of Cancer  
Subject meets with 7.45  
Prereq: None. Coreq: 7.06; permission of instructor  
G (Fall)  
4-0-8 units  
Provides a comprehensive introduction to the fundamentals of cancer biology and cancer treatment. Topics include cancer genetics, genomics, and epigenetics; familial cancer syndromes; signal transduction, cell cycle control, and apoptosis; cancer metabolism; stem cells and cancer; metastasis; cancer immunology and immunotherapy; conventional and molecularly-targeted therapies; and early detection and prevention. Students taking graduate version complete additional assignments.  
T. Jacks, M. Vander Heiden

7.86 Building with Cells  
Subject meets with 7.46  
Prereq: 7.03 and 7.05  
G (Fall)  
4-0-8 units  
Identifies principles of developmental biology by which cells build organs and organisms. Explores the pivotal of stem cells in maintenance or repair, and in treatment of disease. Analyzes how cells can construct useful structures through tissue engineering. Students taking graduate version complete additional assignments.  
H. Sive

7.89[J] Topics in Computational and Systems Biology  
Same subject as CSB.100[J]  
Prereq: Permission of instructor  
G (Fall)  
2-0-10 units  
See description under subject CSB.100[J]. Preference to first-year CSB PhD students.  
C. Burge

7.930[J] Research Experience in Biopharma  
Same subject as 20.930[J]  
Prereq: None  
G (Fall)  
2-10-0 units  
See description under subject 20.930[J].  
S. Clarke

7.931 Independent Study in Biology  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Program of study or research to be arranged with a department faculty member.  
Staff

7.932 Independent Study in Biology  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged  
Can be repeated for credit.  
Program of study or research to be arranged with a department faculty member.  
Staff

7.933 Research Rotations in Biology  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Introduces students to faculty participating in the Biology graduate program through a series of lab rotations, which provide broad exposure to biology research at MIT. Students select a lab for thesis research by the end of their first year. Limited to students in the Biology graduate program.  
Staff
7.934 Teaching Experience in Biology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]

For qualified graduate students in the Biology graduate program interested in teaching. Classroom or laboratory teaching under the supervision of a faculty member.

Staff

7.935 Responsible Conduct in Biology
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]

Sessions focus on the responsible conduct of science. Considers recordkeeping and reporting; roles of mentor and mentee; authorship, review, and confidentiality; resolving conflicts; misfeasance and malfeasance; collaborations, competing interests, and intellectual property; and proper practices in the use of animal and human subjects. Limited to second-year graduate students in Biology.

Staff

7.941 Research Problems
Prereq: Permission of instructor
G (Fall, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Directed research in a field of biological science, but not contributory to graduate thesis.

Consult Biology Education Office

7.942 Research Problems
Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Directed research in a field of biological science, but not contributory to graduate thesis.

Consult Biology Education Office

7.95 Cancer Biology
Prereq: 7.85 and permission of instructor
G (Spring)
3-0-9 units

Advanced seminar involving intensive analysis of historical and current developments in cancer biology. Topics address principles of apoptosis, principles of cancer biology, cancer genetics, cancer cell metabolism, tumor immunology, and therapy. Detailed analysis of research literature, including important reports published in recent years. Enrollment limited.

R. Weinberg, O. Yilmaz

7.98[J] Neural Plasticity in Learning and Memory
Same subject as 9.301[J]
Prereq: Permission of instructor
G (Spring)
3-0-6 units

See description under subject 9.301[J]. Juniors and seniors require instructor’s permission.

S. Tonegawa

7.9930 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.

Staff

7.9931 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.

Staff

7.9932 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.

Staff
7.939 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Covers material in various fields of biology not offered by the regular subjects of instruction.
Staff

7.THG Graduate Biology Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a Ph.D. thesis; to be arranged by the student and an appropriate MIT faculty member.
Staff
BRAIN AND COGNITIVE SCIENCES (COURSE 9)

9.00 Introduction to Psychological Science
Prereq: None
U (Spring)
4-0-8 units. HASS-S

A survey of the scientific study of human nature, including how the mind works, and how the brain supports the mind. Topics include the mental and neural bases of perception, emotion, learning, memory, cognition, child development, personality, psychopathology, and social interaction. Consideration of how such knowledge relates to debates about nature and nurture, free will, consciousness, human differences, self, and society.

J. D. Gabrieli

9.01 Introduction to Neuroscience
Prereq: None
U (Fall)
4-0-8 units. REST

Introduction to the mammalian nervous system, with emphasis on the structure and function of the human brain. Topics include the function of nerve cells, sensory systems, control of movement, learning and memory, and diseases of the brain.

M. Bear

9.011 Systems Neuroscience Core I
Prereq: Permission of instructor
G (Fall)
6-0-12 units

Survey of brain and behavioral studies. Examines principles underlying the structure and function of the nervous system, with a focus on systems approaches. Topics include development of the nervous system and its connections, sensory systems of the brain, the motor system, higher cortical functions, and behavioral and cellular analyses of learning and memory. Preference to first-year graduate students in BCS.

R. Desimone, E. K. Miller

9.012 Cognitive Science
Prereq: Permission of instructor
G (Spring)
6-0-12 units

Intensive survey of cognitive science. Topics include visual perception, language, memory, cognitive architecture, learning, reasoning, decision-making, and cognitive development. Topics covered from behavioral, computational, and neural perspectives.

E. Gibson, P. Sinha, J. Tenenbaum

9.013[J] Molecular and Cellular Neuroscience Core II
Same subject as 7.68[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Survey and primary literature review of major areas in molecular and cellular neurobiology. Covers genetic neurotrophin signaling, adult neurogenesis, G-protein coupled receptor signaling, glia function, epigenetics, neuronal and homeostatic plasticity, neuromodulators of circuit function, and neurological/psychiatric disease mechanisms. Includes lectures and exams, and involves presentation and discussion of primary literature. 9.015[J] recommended, though the core subjects can be taken in any sequence.

G. Feng, L.-H. Tsai

9.014 Quantitative Methods and Computational Models in Neurosciences
Prereq: None
G (Fall)
3-1-8 units

Provides theoretical background and practical skills needed to analyze and model neurobiological observations at the molecular, systems and cognitive levels. Develops an intuitive understanding of mathematical tools and computational techniques which students apply to analyze, visualize and model research data using MATLAB programming. Topics include linear systems and operations, dimensionality reduction (e.g., PCA), Bayesian approaches, descriptive and generative models, classification and clustering, and dynamical systems. Limited to 18; priority to current BCS Graduate students.

M. Jazayeri, D. Zysman

9.015[J] Molecular and Cellular Neuroscience Core I
Same subject as 7.65[J]
Prereq: None
G (Fall)
3-0-9 units

Survey and primary literature review of major topic areas in molecular and cellular neurobiology. Covers neurogenomics, nervous system formation, axonal pathfinding, cytoskeletal regulation, synapse formation, neurotransmitter release, and cellular neurophysiology. Includes lectures and weekly paper write-ups, together with student presentations and discussion of primary literature. A final two-page research write-up is also due at the end of the term.

J. T. Littleton, H. Sive
Same subject as HST.714[J]
Prereq: (6.003 and 8.03) or permission of instructor
G (Fall)
4-0-8 units
See description under subject HST.714[J].
S. S. Ghosh, H. H. Nakajima

9.017 Systems Neuroscience Core II
Prereq: 18.06 or (9.011 and 9.014)
G (Spring)
2-2-8 units
Focuses on forebrain systems that are most closely associated
with cognition (cortex, thalamus, and basal ganglia) as well
as on describing neural circuits as parametric objects that are
hierarchical in nature, and whose operations can have biophysical
interpretations. Uses parametric behavior to discover circuit
parameters and define circuit form in a cognitive context. Divided
into five modules in the following order: sensory systems, motor
systems, associative systems (memory and decision making),
basal ganglia loops, and single neuron computations (dendritic
integration, plasticity rules). Discusses biophysical mechanisms in
the first half of the term and problem sets/student-led discussions in
the second half.
M. Halassa

9.021[J] Cellular Neurophysiology and Computing
Same subject as 2.794[J], 6.521[J], 20.470[J], HST.541[J]
Subject meets with 2.791[J], 6.021[J], 9.21[J], 20.370[J]
Prereq: (Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, or
20.110[J])) or permission of instructor
G (Fall)
5-2-5 units
See description under subject 6.521[J].
J. Han, T. Heldt

9.04 Sensory Systems
Prereq: 9.01 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-8 units
Examines the neural bases of sensory perception. Focuses on
physiological and anatomical studies of the mammalian nervous
system as well as behavioral studies of animals and humans.
Topics include visual pattern, color and depth perception, auditory
responses and sound localization, olfactory and somatosensory
perception.
G. Choi

9.07 Statistics for Brain and Cognitive Science
Prereq: 6.0002
U (Fall)
4-0-8 units
Provides students with the basic tools for analyzing experimental
data, properly interpreting statistical reports in the literature,
and reasoning under uncertain situations. Topics organized
around three key theories: probability, statistical, and the linear
model. Probability theory covers axioms of probability, discrete
and continuous probability models, law of large numbers, and
the Central Limit Theorem. Statistical theory covers estimation,
likelihood theory, Bayesian methods, bootstrap and other Monte
Carlo methods, as well as hypothesis testing, confidence intervals,
elementary design of experiments principles and goodness-of-fit.
The linear model theory covers the simple regression model and
the analysis of variance. Places equal emphasis on theory, data
analyses, and simulation studies.
E. N. Brown

Same subject as HST.460[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
A survey of statistical methods for neuroscience research. Core
topics include introductions to the theory of point processes, the
generalized linear model, Monte Carlo methods, Bayesian methods,
multivariate methods, time-series analysis, spectral analysis and
state-space modeling. Emphasis on developing a firm conceptual
understanding of the statistical paradigm and statistical methods
primarily through analyses of actual experimental data.
E. N. Brown

9.09[J] Cellular and Molecular Neurobiology
Same subject as 7.29[J]
Prereq: 7.05 or 9.01
U (Spring)
4-0-8 units
See description under subject 7.29[J].
M. Heiman, M. Wilson

9.110[J] Nonlinear Control
Same subject as 2.152[J]
Prereq: 2.151, 6.241[J], 16.31, or permission of instructor
G (Spring)
3-0-9 units
See description under subject 2.152[J].
J.-J. E. Slotine
9.12 Experimental Molecular Neurobiology
Prereq: Biology (GIR) and 9.01
U (Spring)
2-4-6 units. Institute LAB

Experimental techniques in cellular and molecular neurobiology. Designed for students without previous experience in techniques of cellular and molecular biology. Experimental approaches include DNA manipulation, molecular cloning, protein biochemistry, dissection and culture of brain cells, synaptic protein analysis, immunocytochemistry, and fluorescent microscopy. One lab session plus one paper review session per week. Instruction and practice in written communication provided. Limited to 22 due to lab capacity.

G. Choi

9.123[J] Neurotechnology in Action
Same subject as 20.203[J]
Prereq: Permission of instructor
G (Spring)
3-6-3 units

Offers a fast-paced introduction to numerous laboratory methods at the forefront of modern neurobiology. Comprises a sequence of modules focusing on neurotechnologies that are developed and used by MIT research groups. Each module consists of a background lecture and 1-2 days of firsthand laboratory experience. Topics typically include optical imaging, optogenetics, high throughput neurobiology, MRI/fMRI, advanced electrophysiology, viral and genetic tools, and connectomics.

E. Boyden, M. Jonas

9.13 The Human Brain
Prereq: 9.00, 9.01, or permission of instructor
U (Spring)
3-0-9 units

Surveys the core perceptual and cognitive abilities of the human mind and asks how these are implemented in the brain. Key themes include the functional organization of the cortex, as well as the representations and computations, developmental origins, and degree of functional specificity of particular cortical regions. Emphasizes the methods available in human cognitive neuroscience, and what inferences can and cannot be drawn from each.

N. Kanwisher

9.17 Systems Neuroscience Laboratory
Prereq: 9.01 or permission of instructor
U (Fall)
2-4-6 units. Institute LAB

Consists of a series of laboratories designed to give students experience with basic techniques for conducting systems neuroscience research. Includes sessions on anatomical, neurophysiological, and data acquisition and analysis techniques, and how these techniques are used to study nervous system function. Involves the use of experimental animals. Assignments include weekly preparation for lab sessions, two major lab reports and a series of basic computer programming tutorials (MATLAB). Instruction and practice in written communication provided. Enrollment limited.

M. Harnett, S. Flavell

9.175[J] Robotics
Same subject as 2.165[J]
Prereq: 2.151 or permission of instructor
G (Spring)
3-0-9 units

See description under subject 2.165[J].

J.-J. E. Slotine, H. Asada

9.18[J] Developmental Neurobiology
Same subject as 7.49[J]
Subject meets with 7.69[J], 9.181[J]
Prereq: 7.03, 7.05, 9.01, or permission of instructor
U (Spring)
3-0-9 units

Considers molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Topics include: neural induction and pattern formation, cell lineage and fate determination, neuronal migration, axon guidance, synapse formation and stabilization, activity-dependent development and critical periods, development of behavior. Students taking graduate version complete additional readings that will be addressed in their mid-term and final exams.

E. Nedivi, M. Heiman
**9.181[J] Developmental Neurobiology**
Same subject as 7.69[J]
Subject meets with 7.49[J], 9.18[J]
Prereq: 9.011 or permission of instructor
G (Spring)
3-0-9 units

Considers molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Topics include: neural induction and pattern formation, cell lineage and fate determination, neuronal migration, axon guidance, synapse formation and stabilization, activity-dependent development and critical periods, development of behavior. In addition to final exam, analysis and presentation of research papers required for final grade. Students taking graduate version complete additional readings that will be addressed in their mid-term and final exams.

E. Nedivi, M. Heiman

**9.19 Computational Psycholinguistics**
Subject meets with 9.190
Prereq: (6.0002 and (6.041, 9.40, or 24.900)) or permission of instructor
U (Spring)
3-0-9 units

Introduces computational approaches to natural language processing and acquisition by humans and machines, combining symbolic and probabilistic modeling techniques. Covers models such as n-grams, finite state automata, and context-free and mildly context-sensitive grammars, for analyzing phonology, morphology, syntax, semantics, pragmatics, and larger document structure. Applications range from accurate document classification and sentence parsing by machine to modeling human language acquisition and real-time understanding. Covers both theory and contemporary computational tools and datasets. Students taking graduate version complete additional assignments.

R. P. Levy

**9.21[J] Cellular Neurophysiology and Computing**
Same subject as 2.791[J], 6.021[J], 20.370[J]
Subject meets with 2.794[J], 6.521[J], 9.021[J], 20.470[J], HST.541[J]
Prereq: Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, 20.110[J], or permission of instructor)
U (Fall)
5-2-5 units

See description under subject 6.021[J]. Preference to juniors and seniors.

J. Han, T. Heldt

**9.24 Disorders and Diseases of the Nervous System**
Prereq: (7.29[J] and 9.01) or permission of instructor
U (Spring)
3-0-9 units

Topics examined include regional functional anatomy of the CNS; brain systems and circuits; neurodevelopmental disorders including autism; neuropsychiatric disorders such as schizophrenia; neurodegenerative diseases such as Parkinson’s and Alzheimer’s; autoimmune disorders such as multiple sclerosis; gliomas. Emphasis on diseases for which a molecular mechanism is understood. Diagnostic criteria, clinical and pathological findings, genetics, model systems, pathophysiology, and treatment are discussed for individual disorders and diseases. Limited to 18.

M. Sur
9.26J Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience
Same subject as 20.205J
Prereq: Biology (GIR)
U (Spring)
3-0-9 units
Covers principles underlying current and future genetic engineering approaches, ranging from single cellular organisms to whole animals. Focuses on development and invention of technologies for engineering biological systems at the genomic level, and applications of engineered biological systems for medical and biotechnological needs, with particular emphasis on genetic manipulation of the nervous system. Design projects by students.
F. Zhang

9.271J Pioneering Technologies for Interrogating Complex Biological Systems (New)
Same subject as 10.562J, HST.562J
Prereq: None
G (Spring)
3-1-8 units
See description under subject HST.562J. Limited to 15.
K. Chung

9.272J Topics in Neural Signal Processing
Same subject as HST.576J
Prereq: Permission of instructor
Acad Year 2019–2020: G (Spring)
Acad Year 2020–2021: Not offered
3-0-9 units
Presents signal processing and statistical methods used to study neural systems and analyze neurophysiological data. Topics include state-space modeling formulated using the Bayesian Chapman-Kolmogorov system, theory of point processes, EM algorithm, Bayesian and sequential Monte Carlo methods. Applications include dynamic analyses of neural encoding, neural spike train decoding, studies of neural receptive field plasticity, algorithms for neural prosthetic control, EEG and MEG source localization. Students should know introductory probability theory and statistics.
E. N. Brown

9.28 Current Topics in Developmental Neurobiology
Prereq: None. Coreq: 9.18J
U (Spring)
3-0-6 units
Considers recent advances in the field of developmental neurobiology based on primary research articles that address molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Also considers new techniques and methodologies as applied to the field. Students critically analyze articles and prepare concise and informative presentations based on their content. Instruction and practice in written and oral communication provided. Requires class participation, practice sessions, and presentations.
E. Nedivi

Same subject as HST.723J
Prereq: Permission of instructor
G (Spring)
6-0-6 units
See description under subject HST.723J.
J. McDermott, D. Polley, B. Delgutte, M. C. Brown

9.301J Neural Plasticity in Learning and Memory
Same subject as 7.98J
Prereq: Permission of instructor
G (Spring)
3-0-6 units
Examination of the role of neural plasticity during learning and memory of invertebrates and mammals. Detailed critical analysis of the current literature of molecular, cellular, genetic, electrophysiological, and behavioral studies. Student-directed presentations and discussions of original papers supplemented by introductory lectures. Juniors and seniors require instructor's permission.
S. Tonegawa
9.32 Genes, Circuits, and Behavior  
Prereq: 7.29[J], 9.16, 9.18[J], or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units  
Focuses on understanding molecular and cellular mechanisms of circuitry development, function and plasticity, and their relevance to normal and abnormal behaviors/psychiatric disorders. Highlights cutting-edge technologies for neuroscience research. Students build professional skills through presentations and critical evaluation of original research papers.  
G. Feng

9.34[J] Biomechanics and Neural Control of Movement  
Same subject as 2.183[J]  
Subject meets with 2.184  
Prereq: 2.004 or permission of instructor  
G (Spring)  
3-0-9 units  
See description under subject 2.183[J].  
N. Hogan

9.35 Perception  
Prereq: 9.01 or permission of instructor  
U (Spring)  
4-0-8 units  
Studies how the senses work and how physical stimuli are transformed into signals in the nervous system. Examines how the brain uses those signals to make inferences about the world, and uses illusions and demonstrations to gain insight into those inferences. Emphasizes audition and vision, with some discussion of touch, taste, and smell. Provides experience with psychophysical methods.  
J. McDermott

9.357 Current Topics in Perception  
Prereq: Permission of instructor  
G (Spring)  
2-0-7 units  
Can be repeated for credit.  
Advanced seminar on issues of current interest in human and machine vision. Topics vary from year to year. Participants discuss current literature as well as their ongoing research.  
E. H. Adelson

9.40 Introduction to Neural Computation  
Prereq: (Physics II (GIR), 6.0002, and 9.01) or permission of instructor  
U (Spring)  
4-0-8 units  
Introduces quantitative approaches to understanding brain and cognitive functions. Topics include mathematical description of neurons, the response of neurons to sensory stimuli, simple neuronal networks, statistical inference and decision making. Also covers foundational quantitative tools of data analysis in neuroscience: correlation, convolution, spectral analysis, principal components analysis. Mathematical concepts include simple differential equations and linear algebra.  
M. Fee

9.41 Research and Communication in Neuroscience and Cognitive Science  
Prereq: 9.URG and permission of instructor  
U (Fall)  
2-12-4 units  
Emphasizes research and scientific communication. Instruction and practice in written and oral communication provided. Based on results of his/her UROP research, each student creates a full-length paper and a poster as part of an oral presentation at the end of the term. Other assignments include peer editing and reading/critiquing published research papers. Prior to starting class, students must have collected enough data from their UROP research projects to write a paper. Limited to juniors and seniors.  
L. Schulz

9.42 The Brain and Its Interface with the Body  
Prereq: 7.28, 7.29[J], or permission of instructor  
U (Spring)  
3-0-9 units  
Covers a range of topics, such as brain-immune system interaction, the gut-brain axis, and bioengineering approaches for studying the brain and its interactions with different organs. Explores how these interactions may be involved in nervous system disease processes.  
F. Zhang

9.422[J] Principles of Neuroengineering  
Same subject as 20.452[J], MAS.881[J]  
Subject meets with 20.352  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
See description under subject MAS.881[J].  
E. S. Boyden, III
9.455[J] Revolutionary Ventures: How to Invent and Deploy Transformative Technologies
Same subject as 15.128[J], 20.454[J], MAS.883[J]
Prereq: Permission of instructor
G (Fall)
2-0-7 units

See description under subject MAS.883[J].
E. Boyden, J. Bonsen, J. Jacobson

9.46 Neuroscience of Morality
Prereq: 9.00, 9.01, and (9.13 or 9.85)
U (Fall)
5-0-7 units. HASS-S

Advanced seminar that covers both classic and cutting-edge primary literature from psychology and the neuroscience of morality. Addresses questions about how the human brain decides which actions are morally right or wrong (including neural mechanisms of empathy and self-control), how such brain systems develop over childhood and differ across individuals and cultures, and how they are affected by brain diseases (such as psychopathy, autism, tumors, or addiction). Instruction and practice in written and oral communication provided. Limited to 24.
R. Saxe

9.48[J] Philosophical Issues in Brain Science
Same subject as 24.08[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H

See description under subject 24.08[J].
E. J. Green

9.49 Neural Circuits for Cognition (New)
Subject meets with 9.490
Prereq: 9.40, 18.06, or permission of instructor
U (Fall)
3-0-9 units

Takes a computational approach to examine circuits in the brain that perform elemental cognitive tasks: tasks that are neither directly sensory nor directly motor in function, but are essential to bridging from perception to action. Covers circuits and circuit motifs in the brain that underlie computations like integration, decision-making, spatial navigation, inference, and other cognitive elements. Students study empirical results, build dynamical models of neural circuits, and examine the mathematical theory of representations and computation in such circuits. Considers noise, stability, plasticity, and learning rules for these systems. Students taking graduate version complete additional assignments.
I. Fiete

9.490 Neural Circuits for Cognition (New)
Subject meets with 9.49
Prereq: 9.40, 18.06, or permission of instructor
G (Fall)
3-0-9 units

Takes a computational approach to examine circuits in the brain that perform elemental cognitive tasks: tasks that are neither directly sensory nor directly motor in function, but are essential to bridging from perception to action. Covers circuits and circuit motifs in the brain that underlie computations like integration, decision-making, spatial navigation, inference, and other cognitive elements. Students study empirical results, build dynamical models of neural circuits, and examine the mathematical theory of representations and computation in such circuits. Considers noise, stability, plasticity, and learning rules for these systems. Students taking graduate version complete additional assignments.
I. Fiete

9.50 Research in Brain and Cognitive Sciences
Prereq: 9.00 and permission of instructor
U (Fall, Spring)
0-12-0 units

Can be repeated for credit.

Laboratory research in brain and cognitive science, using physiological, anatomical, pharmacological, developmental, behavioral, and computational methods. Each student carries out an experimental study under the direction of a member of the faculty. Project must be approved in advance by the faculty supervisor and the undergraduate faculty officer. Written presentation of results is required.
Consult L. Schulz
9.520[J] Statistical Learning Theory and Applications
Same subject as 6.860[J]
Prereq: 6.041, 6.867, 18.06, or permission of instructor
G (Fall)
3-0-9 units
Provides students with the knowledge needed to use and develop advanced machine learning solutions to challenging problems. Covers foundations and recent advances of machine learning in the framework of statistical learning theory. Focuses on regularization techniques key to high-dimensional supervised learning. Starting from classical methods such as regularization networks and support vector machines, addresses state-of-the-art techniques based on principles such as geometry or sparsity, and discusses a variety of algorithms for supervised learning, feature selection, structured prediction, and multitask learning. Also focuses on unsupervised learning of data representations, with an emphasis on hierarchical (deep) architectures.
T. Poggio, L. Rosasco

Same subject as IDS.160[J]
Prereq: (6.436[J], 18.06, and 18.6501) or permission of instructor
G (Spring)
4-0-8 units
Introduces students to modern non-asymptotic statistical analysis. Topics include high-dimensional models, nonparametric regression, covariance estimation, principal component analysis, oracle inequalities, prediction and margin analysis for classification. Develops a rigorous probabilistic toolkit, including tail bounds and a basic theory of empirical processes
S. Rakhlin

Same subject as 6.861[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Integrates neuroscience, cognitive and computer science to explore the nature of intelligence, how it is produced by the brain, and how it can be replicated in machines. Discusses an array of current research connected through an overarching theme of how it contributes to a computational account of how humans analyze dynamic visual imagery to understand objects and actions in the world.
T. Poggio, S. Ullman

9.53 Emergent Computations Within Distributed Neural Circuits
Subject meets with 9.530
Prereq: 9.40 or permission of instructor
U (Spring)
4-0-8 units
Addresses the fundamental scientific question of how the human brain still outperforms the best computer algorithms in most domains of sensory, motor and cognitive function, as well as the parallel and distributed nature of neural processing (as opposed to the serial organization of computer architectures/ algorithms) required to answer it. Explores the biologically plausible computational mechanisms and principles that underlie neural computing, such as competitive and unsupervised learning rules, attractor networks, self-organizing feature maps, content-addressable memory, expansion recoding, the stability-plasticity dilemma, the role of lateral and top-down feedback in neural systems, the role of noise in neural computing. Students taking graduate version complete additional assignments.
R. Ajemian

9.530 Emergent Computations Within Distributed Neural Circuits
Subject meets with 9.53
Prereq: 9.40 or permission of instructor
G (Spring)
4-0-8 units
Addresses the fundamental scientific question of how the human brain still outperforms the best computer algorithms in most domains of sensory, motor and cognitive function, as well as the parallel and distributed nature of neural processing (as opposed to the serial organization of computer architectures/ algorithms) required to answer it. Explores the biologically plausible computational mechanisms and principles that underlie neural computing, such as competitive and unsupervised learning rules, attractor networks, self-organizing feature maps, content-addressable memory, expansion recoding, the stability-plasticity dilemma, the role of lateral and top-down feedback in neural systems, the role of noise in neural computing. Students taking graduate version complete additional assignments.
R. Ajemian
9.58 Projects in the Science of Intelligence (New)  
Prereq: (6.036 and (9.40 or 18.06)) or permission of instructor  
U (Fall)  
3-0-9 units  
Provides instruction on the mechanistic basis of intelligence - how the brain produces intelligent behavior and how we may be able to replicate intelligence in machines. Examines how human intelligence emerges from computations in neural circuits to reproduce similar intelligent behavior in machines. Working in teams, students complete computational projects and exercises that reinforce the theme of collaboration between (computer science + math) and (neuroscience + cognitive science). Culminates with student presentations of their projects. Instruction and practice in oral and written communication provided. Limited to 30.  
T. Poggio, S. Ullman

9.583[J] Functional Magnetic Resonance Imaging: Data Acquisition and Analysis  
Same subject as HST.583[J]  
Prereq: 18.05 and (18.06 or permission of instructor)  
Acad Year 2019-2020: G (Fall)  
Acad Year 2020-2021: Not offered  
2-3-7 units  
See description under subject HST.583[J].  
J. Polimeni, A. Yendiki

9.59[J] Laboratory in Psycholinguistics  
Same subject as 24.905[J]  
Prereq: None  
U (Spring)  
3-3-6 units. Institute LAB  
Hands-on experience designing, conducting, analyzing, and presenting experiments on the structure and processing of human language. Focuses on constructing, conducting, analyzing, and presenting an original and independent experimental project of publishable quality. Develops skills in reading and writing scientific research reports in cognitive science, including evaluating the methods section of a published paper, reading and understanding graphical displays and statistical claims about data, and evaluating theoretical claims based on experimental data. Instruction and practice in oral and written communication provided.  
E. Gibson

9.60 Machine-Motivated Human Vision  
Prereq: None  
U (Spring)  
2-1-9 units. Institute LAB  
Explores how studies of human vision can be motivated by, and enhance the capabilities of, machine-based systems. Considers the twin questions of how the performance of state-of-the-art machine vision systems compares with that of humans, and what kinds of strategies the human visual system uses in tasks where human performance exceeds that of machines. Includes presentations by engineers from companies with significant engineering efforts in vision. Based on these presentations, students define and conduct studies to address the two aforementioned questions and present their results to the public at the end of the term. Directed towards students interested in exploring vision from computational, experimental and practical perspectives. Provides instruction and practice in written and oral communication.  
P. Sinha

9.601[J] Language Acquisition I  
Same subject as 24.949[J]  
Prereq: Permission of instructor  
G (Fall)  
3-0-6 units  
Lectures, reading, and discussion of current theory and data concerning the psychology and biology of language acquisition. Emphasizes learning of syntax, semantics, and morphology, together with some discussion of phonology, and especially research relating grammatical theory and learnability theory to empirical studies of children.  
A. Aravind, M. Hackl

9.611[J] Natural Language and the Computer Representation of Knowledge  
Same subject as 6.863[J]  
Prereq: 6.034  
G (Spring)  
3-3-6 units  
See description under subject 6.863[J].  
R. C. Berwick
Same subject as 6.804[J]
Subject meets with 9.660
Prereq: 6.008, 6.036, 6.041, 9.40, 18.05, or permission of instructor
U (Fall)
3-0-9 units

Introduction to computational theories of human cognition. Focus on principles of inductive learning and inference, and the representation of knowledge. Computational frameworks covered include Bayesian and hierarchical Bayesian models; probabilistic graphical models; nonparametric statistical models and the Bayesian Occam's razor; sampling algorithms for approximate learning and inference; and probabilistic models defined over structured representations such as first-order logic, grammars, or relational schemas. Applications to understanding core aspects of cognition, such as concept learning and categorization, causal reasoning, theory formation, language acquisition, and social inference. Graduate students complete a final project.

J. Tenenbaum

9.660 Computational Cognitive Science
Subject meets with 6.804[J], 9.66[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Introduction to computational theories of human cognition. Focus on principles of inductive learning and inference, and the representation of knowledge. Computational frameworks include Bayesian and hierarchical Bayesian models, probabilistic graphical models, nonparametric statistical models and the Bayesian Occam's razor, sampling algorithms for approximate learning and inference, and probabilistic models defined over structured representations such as first-order logic, grammars, or relational schemas. Applications to understanding core aspects of cognition, such as concept learning and categorization, causal reasoning, theory formation, language acquisition, and social inference. Graduate students complete a final project.

J. Tenenbaum

9.72 Vision in Art and Neuroscience (New)
Subject meets with 9.720
Prereq: None
U (Fall)
2-2-8 units

Introduces and provides practical engagement with core concepts in vision neuroscience. Combination of seminar and studio work fosters interdisciplinary dialogue between visual art and vision neuroscience, culminating in a gallery exhibition of students' individual, semester-long projects. Treats the processes of visual perception and the creation of visual art in parallel, making use of the fact that both are constructive. Through lectures and readings in experimental and computational vision research, explores the hierarchy of visual processing, from the moment that light strikes the retina to the internal experience of a rich visual world. In the studio, students examine how each stage of this process manifests in the experience of art, wherein the perceptual system observes itself. Students taking graduate version complete additional assignments.

P. Sinha, S. Riskin

9.720 Vision in Art and Neuroscience (New)
Subject meets with 9.72
Prereq: None
G (Fall)
2-2-8 units

Introduces and provides practical engagement with core concepts in vision neuroscience. Combination of seminar and studio work fosters interdisciplinary dialogue between visual art and vision neuroscience, culminating in a gallery exhibition of students’ individual, semester-long projects. Treats the processes of visual perception and the creation of visual art in parallel, making use of the fact that both are constructive. Through lectures and readings in experimental and computational vision research, explores the hierarchy of visual processing, from the moment that light strikes the retina to the internal experience of a rich visual world. In the studio, students examine how each stage of this process manifests in the experience of art, wherein the perceptual system observes itself. Students taking graduate version complete additional assignments.

P. Sinha, S. Riskin

9.822[J] Psychology and Economics
Same subject as 14.137[J]
Prereq: None
G (Spring)
4-0-8 units

See description under subject 14.137[J].

D. Prelec
9.85 Infant and Early Childhood Cognition
Prereq: 9.00
U (Fall)
3-0-9 units. HASS-S

Introduction to cognitive development focusing on children's understanding of objects, agents, and causality. Develops a critical understanding of experimental design. Discusses how developmental research might address philosophical questions about the origins of knowledge, appearance and reality, and the problem of other minds. Provides instruction and practice in written communication as necessary to research in cognitive science (including critical reviews of journal papers, a literature review and an original research proposal), as well as instruction and practice in oral communication in the form of a poster presentation of a journal paper.

L. Schulz

9.89 Off-Campus Undergraduate Research in Brain and Cognitive Sciences
Prereq: None
U (Fall, IAP, Spring)
Units arranged

For Brain and Cognitive Sciences undergraduates participating in curriculum-related research off-campus. Before enrolling, students must consult the BCS Academic Office for details on procedures and restrictions, and have approval from their faculty advisor. Subject to departmental approval. Upon completion, the off-campus supervisor will provide an evaluation of the student’s work. The student must also submit a write-up of the experience, approved by the MIT supervisor.

Staff

9.90 Practical Experience in Brain and Cognitive Sciences
Prereq: Permission of instructor
U (Summer)
0-1-0 units

For Brain and Cognitive Sciences undergraduates participating in curriculum-related off-campus professional experiences. Before enrolling, students must consult the BCS Academic Office for details on procedures and restrictions, and have approval from their faculty advisor. Subject to departmental approval. Upon completion, the student must submit a write-up of the experience, approved by the MIT supervisor.

Staff

9.900 Clinical Connection Module
Prereq: None. Coreq: 9.011, 9.012, 9.013[J], 9.014, or 9.015[J]; permission of instructor
G (Fall, IAP, Spring)
0-1-0 units
Can be repeated for credit.

Provides students the opportunity to connect their core neuroscience training to clinical experience (pathogenesis, diagnosis, management and therapeutic clinical trials of nervous system diseases). Students attend, along with Harvard faculty, fellows, residents and medical students at Massachusetts General Hospital, clinical seminars at MGH conducted by clinical and basic science faculty of Harvard Medical School. Each clinical experience is one week in length; students have the option to attend up to four seminars in their individual week chosen from: neuroradiology, neuropathology, neurodegenerative diseases, epilepsy, movement disorders, psychiatry, neuropsychiatric diseases and behavioral neurology, and functional neurosurgery. Seminars are followed by one-on-one discussion with instructor to connect the clinical experience with parallel course material on the neurobiology of disease.

T. Byrne

9.901 Responsible Conduct in Science
Prereq: None
G (IAP)
1-0-1 units

Provides instruction and dialogue on practical ethical issues relating to the responsible conduct of human and animal research in the brain and cognitive sciences. Specific emphasis on topics relevant to young researchers including data handling, animal and human subjects, misconduct, mentoring, intellectual property, and publication. Preliminary assigned readings and initial faculty lecture followed by discussion groups of four to five students each. A short written summary of the discussions submitted at the end of each class. See IAP Guide for registration information.

M. Wilson

9.91 Independent Study in Brain and Cognitive Sciences
Prereq: 9.00, two additional subjects in Brain and Cognitive Sciences, and permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Individual study of a topic under the direction of a member of the faculty.

Consult Staff
9.919 Teaching Brain and Cognitive Sciences  
Prereq: None  
G (Fall, Spring)  
Units arranged  
Can be repeated for credit.  

For teaching assistants in Brain and Cognitive Sciences, in cases where teaching assignment is approved for academic credit by the department.  
Staff

9.921 Research in Brain and Cognitive Sciences  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged  
Can be repeated for credit.  

Guided research under the sponsorship of individual members of the faculty. Ordinarily restricted to candidates for the doctoral degree in Course 9.  
Staff

9.941 Graduate Thesis Proposal  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  

Students submit written proposals for thesis according to stated deadlines.  
Staff

9.97 Introduction to Neuroanatomy  
Prereq: None  
U (IAP)  
1-0-0 units  

Intensive introduction to neuroanatomy that consists of lectures, demonstrations, and interactive laboratories, including a brain dissection. No prior knowledge of neuroanatomy required, although general knowledge of brain structures is helpful. Pre-register on WebSIS; must attend first class. Limited to 24.  
R. Ellis-Behnke

9.51 Special Subject in Brain and Cognitive Sciences  
Prereq: 9.00 and any other two subjects in Brain and Cognitive Sciences  
U (Fall)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  

Undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.  
I. Pepperberg

9.52 Special Subject in Brain and Cognitive Sciences  
Prereq: 9.00 and any other two subjects in Brain and Cognitive Sciences  
U (Fall)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  

Undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.  
P. Sinha

9.511 Special Subject in Brain and Cognitive Sciences  
Prereq: Permission of instructor  
G (Fall; partial term)  
Units arranged [P/D/F]  
Can be repeated for credit.  

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum. 9.511 is graded P/D/F.  
N. G. Kanwisher

9.512 Special Subject in Brain and Cognitive Sciences  
Prereq: Permission of instructor  
G (Spring)  
Units arranged  
Can be repeated for credit.  

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.  
L. Schulz

9.513 Special Subject in Brain and Cognitive Sciences  
Prereq: Permission of instructor  
G (Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  

Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.  
R. P. Levy, N. Feldman, R. Katzir
9.S914 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.
Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Staff

9.S915 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Staff

9.S916 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
P. Sinha

9.917 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
J. DiCarlo

9.S918 Special Subject in Brain and Cognitive Sciences
Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum. 9.S918 is graded P/D/F.
J. DiCarlo

9.S92 Special Subject in Brain and Cognitive Sciences
Prereq: 9.00
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Consult Staff

Prereq: None
U (Spring)
Units arranged [P/D/F]
For undergraduate study in brain and cognitive sciences during Independent Activities Period; covers material not offered in regular curriculum. See IAP Guide for details.
Staff

9.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of a Ph.D. thesis; to be arranged by the student and an appropriate MIT faculty member.
Staff

9.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Individual participation in an ongoing research project.
Staff

9.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual participation in an ongoing research project.
Consult Staff
CHEMICAL ENGINEERING (COURSE 10)

10.00 Molecule Builders
Prereq: Chemistry (GIR) and Physics I (GIR)
U (Spring)
1-3-2 units
Project-based introduction to the applications of engineering design at the molecular level. Working in teams, students complete an open-ended design project that focuses on a topic such as reactor or biomolecular engineering, chemical process design, materials and polymers, or energy. Provides students practical exposure to the field of chemical engineering as well as potential opportunities to continue their project designs in national/international competitions. Limited to 36; preference to first year students.
B. D. Olsen

10.000 Engineering Molecular Marvels: Careers and ChemE at MIT
Prereq: None
U (Fall, Spring)
2-0-0 units
Exposes students to the ways in which chemical technologies have profoundly altered the course of history. Discusses the next century’s great challenges, such as curing cancer and supplying the planet’s surging demand for clean water, food and energy, sustainably. Provides an overview of how ChemE students apply fundamental engineering principles and leverage technology, from molecules to systems, in the pursuit of practical solutions for these problems and more. Subject can count toward the 9-unit discovery-focused credit limit for first year students.
T. A. Kinney, B. S. Johnston

10.01 Ethics for Engineers
Engineering School-Wide Elective Subject.
Offered under: 1.082, 2.900, 6.904, 10.01, 16.676, 22.0014
Prereq: None
U (Fall, Spring)
2-0-4 units
Integrates classical readings that provide an overview of ethics with a survey of case studies that focus on ethical problems arising in the practice of engineering. Readings taken from a variety of sources, such as Aristotle, Machiavelli, Bacon, Hobbes, Locke, the Founding Fathers, and the Bible. Case studies include written analyses and films that address engineering disasters, biotechnology, court cases, ethical codes, and the ultimate scope and aims of engineering.
Students taking independent inquiry version 6.9041 expand the scope of their term project. Students taking 20.005 focus their term project on a problem in biological engineering in which there are intertwined ethical and technical issues.
D. Doneson, B. L. Trout

10.02 Foundations of Entrepreneurship for Engineers
Prereq: None
U (Spring)
3-0-9 units
Studies economic and leadership foundations of entrepreneurship as they relate to engineering. Case studies illustrate major impacts of engineering on the world and examine the leaders responsible for such impacts. Authors include Franklin, Keynes, Leonardo, Lincoln, Locke, Machiavelli, Marx, Schmidt, Schumpeter, Smith, Thiel, and Tocqueville. Discusses topics such as the difference between an entrepreneur and a manager, the entrepreneur as founder, and characteristics of principled entrepreneurship.
D. Doneson, B. L. Trout

10.03[J] Advances in Biomanufacturing
Same subject as 7.458[J]
Subject meets with 7.548[J], 10.53[J]
Prereq: None
U (Spring; second half of term)
1-0-2 units
Seminar examines how biopharmaceuticals, an increasingly important class of pharmaceuticals, are manufactured. Topics range from fundamental bioprocesses to new technologies to the economics of biomanufacturing. Also covers the impact of globalization on regulation and quality approaches as well as supply chain integrity. Students taking graduate version complete additional assignments.
J. C. Love, A. Sinskey, S. Springs
10.04 A Philosophical History of Energy
Prereq: None
U (Spring)
3-0-9 units
Philosophic and historical approach to conceptions of energy through the 19th century. Relation of long standing scientific and philosophic problems in the field of energy to 21st-century debates. Topics include the development of thermodynamics and kinetic theories, the foundation of the scientific project, the classical view of energy, and the harnessing of nature. Authors include Bacon, Boltzmann, Carnot, Compte, Descartes, Gibbs, Plato, Aristotle, Leibniz, Kant, Hegel, Mill, Peirce, Whitehead, and Maxwell. Key texts and controversies form topics of weekly writing assignments and term papers.
B. L. Trout, A. Schulman

10.05 Foundational Analyses of Problems in Energy and the Environment
Prereq: None
U (Spring)
3-0-9 units
Investigates key texts and papers on the foundational thought of current issues in energy and environmental science. Builds an understanding of key debates (scientific, ethical, and political). Aims to inform solutions to key problems related to procurement of energy and environmental degradation. Topics address alternative energy technologies and fossil fuel utilization and emissions, especially carbon dioxide, carbon dioxide sequestration, and geoengineering. Foundational readings from Homer and Greek playwrights, Aristotle, Genesis, Bacon, Locke, Rousseau, Coleridge, Carnot, Clausius, Marx, Heidegger, Carson, Gore, Singer, and Brundtland. Assignments include weekly analyses of readings, videos and related engineering calculations in addition to a final project. Limited to 18.
B. L. Trout

10.06 Advanced Topics in Ethics for Engineers
Prereq: 10.01, 10.05, or permission of instructor
U (Fall, Spring)
2-0-4 units
Can be repeated for credit.
In-depth study of varying advanced topics in ethics for engineers. Focuses on foundational works and their significance for the choices that engineers make, both as students and as practicing engineers. Each semester, different works and topics, based on current and perennial issues in ethics and engineering, will be chosen in order to explore facets of the extremely complex and varied subject of the place of engineering for the individual and society. Examples of topics include genetic engineering and what it means to be human, artificial intelligence and thought, the scope and limits of engineering, and engineering and freedom. May be repeated for credit with permission of instructor. Limited to 20.
B. L. Trout, D. Doneson

10.07 Debating About Society and Engineering
Prereq: None
U (Fall, Spring)
3-0-6 units
Explores the various interconnections between society and engineering as expressed in a variety of media: speech, visualization, art and music, and writing. Analysis of foundational texts and art together with case studies form the basis for students’ weekly assignments. Topics include the connection between engineering and society, the significance of artificial intelligence, evolution, social bias, and relativism of thought and culture. Includes oral and written presentations. Limited to 18.
E. Schiappa, B. L. Trout
### 10.08 Cultural Studies for Chemical Engineering Graduate Students

**Prereq:** None  
**G (Fall)**  
**2-0-4 units**

Seminar explores some of the key cultural developments of human beings and their related engineering aspects together with insights into the evolution of chemical engineering. Begins with discussion of Warren K. Lewis on culture and civilization, in addition to other chemical engineering luminaries, Rutherford Aris and John Prausnitz, and Sam Florman. Following their leads, seminar addresses key developments in Greek culture, followed by Renaissance culture, and culminating with contemporary culture. Discusses the influence of chemical engineering throughout the term, but focuses on broader cultural understanding as advocated by Lewis and Aris. Weekly meetings and study question responses are complemented with direct experience of culture and its connection to engineering. Includes guests with various expertise in culture and chemical engineering.

*B. L. Trout*

### 10.10 Introduction to Chemical Engineering

**Prereq:** Chemistry (GIR) and Physics I (GIR); **Coreq:** 18.03  
**U (Fall, Spring)**  
**4-0-8 units**

Explores the diverse applications of chemical engineering through example problems designed to build computer skills and familiarity with the elements of engineering design. Solutions require application of fundamental concepts of mass and energy conservation to batch and continuous systems involving chemical and biological processes. Problem-solving exercises distributed among lectures and recitation.

*B. S. Johnston, K. L. J. Prather*

### 10.213 Chemical and Biological Engineering Thermodynamics

**Prereq:** 5.601 and 10.10  
**U (Spring)**  
**4-0-8 units**

Thermodynamics of multicomponent, multiphase chemical and biological systems. Applications of first, second, and third laws of thermodynamics to open and closed systems. Properties of mixtures, including colligative properties, chemical reaction equilibrium, and phase equilibrium; non-ideal solutions; power cycles; refrigeration; separation systems.

*K. K. Gleason, H. D. Sikes*

### 10.22 Molecular Engineering

**Prereq:** 5.60 and 10.213  
**U (Spring)**  
**3-0-9 units**

Introduces molecular concepts in relation to engineering thermodynamics. Includes topics in statistical mechanics, molecular description of gases and liquids, property estimation, description of equilibrium and dynamic properties of fluids from molecular principles, and kinetics of activated processes. Also covers some basic aspects of molecular simulation and applications in systems of engineering interest.

*G. C. Rutledge, P. S. Doyle*

### 10.25 Industrial Chemistry and Chemical Process Pathways

**Prereq:** Chemistry (GIR), 10.213, and 10.37  
**G (Fall)**  
Not offered regularly; consult department  
**3-0-6 units**

Chemical and engineering principles involved in creation and operation of viable industrial processes. Topics: analysis of process chemistry by p-pathways (i.e., radical, ionic, and pericyclic reactions of organic syntheses) and d-pathways (i.e., catalysis by transition-metal complexes). Use of reaction mechanisms for inference of co-product formation, kinetics, and equilibria: process synthesis logic related to reaction selectivity, recycle, separations. Illustrations drawn from current and contemplated commercial practice.

*P. S. Virk*

### 10.26 Chemical Engineering Projects Laboratory

Subject meets with 10.27, 10.29  
**Prereq:** (10.302 and (2.671, 3.014, 5.310, 7.003, 12.335, 20.109, (1.106 and 1.107), or (5.351, 5.352, and 5.353))) or permission of instructor  
**U (Spring)**  
**3-8-4 units**

Projects in applied chemical engineering research. Students work in teams on one project for the term. Projects often suggested by local industry. Includes training in project planning and project management, execution of experimental work, data analysis, oral presentation, individual and collaborative report writing.

*C. K. Colton, B. S. Johnston, B. D. Burrell, G. C. Rutledge*
10.27 Energy Engineering Projects Laboratory
Subject meets with 10.26, 10.29
Prereq: (10.302 and (2.671, 3.014, 5.310, 7.003, 12.335, 20.109, (1.106 and 1.107), or (5.351, 5.352, and 5.353))) or permission of instructor
U (Spring)
3-8-4 units

Projects in applied energy engineering research. Students work in teams on one project for the term. Projects often suggested by local industry. Includes training in project planning and project management, execution of experimental work, data analysis, oral presentation, individual and collaborative report writing. Preference to Energy Studies minors.

G. C. Rutledge

10.28 Chemical-Biological Engineering Laboratory
Prereq: ((5.07[J] or 7.05) and (5.310 or 7.003)) or permission of instructor
U (Fall)
2-8-5 units
Credit cannot also be received for 10.28B

Introduces the complete design of the bioprocess: from vector selection to production, separation, and characterization of recombinant products. Utilize concepts from many fields, such as, chemical and electrical engineering, and biology. Student teams work through parallel modules spanning microbial fermentation and animal cell culture. With the bioreactor at the core of the experiments, students study cell metabolism and biological pathways, kinetics of cell growth and product formation, oxygen mass transport, scale-up and techniques for the design of process control loops. Introduces novel bioreactors and powerful analytical instrumentation. Downstream processing and recombinant product purification also included. Credit cannot also be received for 10.28A. Enrollment limited.

J.-F. Hamel

10.28A Chemical-Biological Engineering Laboratory I: Introduction to Lab Experiments
Prereq: ((5.07[J] or 7.05) and (5.310 or 7.003)) or permission of instructor
U (IAP, Spring)
1-3-0 units

First in a two-subject sequence that spans IAP and spring term, and covers the same content as 10.28; see 10.28 for description. Course utilizes online learning technologies and simulations in addition to traditional lab experiments. 10.28A comprises the major lab portion of the subject. Credit cannot also be received for 10.28. Enrollment limited.

J.-F. Hamel

10.28B Chemical-Biological Engineering Laboratory II: Long-term, Online and Simulated Experiments
Prereq: 10.28A
U (Spring)
1-2-8 units
Credit cannot also be received for 10.28

Second in a two-subject sequence that spans IAP and spring term, and covers the same content as 10.28; see 10.28 for description. Course utilizes online learning technologies and simulations in addition to traditional lab experiments. 10.28B comprises the simulation portion of the subject, and most of the communication component. Enrollment limited.

J.-F. Hamel

10.29 Biological Engineering Projects Laboratory
Subject meets with 10.26, 10.27
Prereq: (10.302 and (2.671, 3.014, 5.310, 7.003, 12.335, 20.109, (1.106 and 1.107), or (5.351, 5.352, and 5.353))) or permission of instructor
U (Spring)
3-8-4 units

Projects in applied biological engineering research. Students work in teams on one project for the term. Projects often suggested by local industry. Includes training in project planning and project management, execution of experimental work, data analysis, oral presentation, individual and collaborative report writing.

G. C. Rutledge

10.291[J] Introduction to Sustainable Energy
Same subject as 2.650[J], 22.081[J]
Subject meets with 1.818[J], 2.65[J], 10.391[J], 11.371[J], 22.811[J]
Prereq: Permission of instructor
U (Fall)
3-1-8 units

See description under subject 22.081[J]. Limited to juniors and seniors.

M. W. Golay
10.301 Fluid Mechanics
Prereq: 10.10 and 18.03
U (Spring)
4-0-8 units. REST


P. S. Doyle, F. R. Brushett

10.302 Transport Processes
Prereq: (5.601, 10.213, and 10.301) or permission of instructor
U (Fall)
4-0-8 units

Principles of heat and mass transfer. Steady and transient conduction and diffusion. Radiative heat transfer. Convective transport of heat and mass in both laminar and turbulent flows. Emphasis on the development of a physical understanding of the underlying phenomena and upon the ability to solve real heat and mass transfer problems of engineering significance.

K. Manthiram, K. Chung

10.31 Nanoscale Energy Transport Processes
Subject meets with 10.51
Prereq: ((2.51 or 10.302) and (3.024 or 5.61)) or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 units

Explores the impact of nanoscale phenomena on macroscale transport of energy-carrying molecules, phonons, electrons, and excitons. Studies the effect of structural and energetic disorder, wave-like vs. particle-like transport, quantum and classical size effects, and quantum coherence. Emphasizes quantitative analysis, including the Boltzmann transport equation, Einstein relation, Wiedemann-Franz law, and Marcus electron transfer theory. Also addresses percolation theory and the connection to energy conversion technologies, such as solar cells, thermoelectrics, and LEDs. Students taking graduate version complete additional assignments.

W. A. Tisdale

10.32 Separation Processes
Prereq: 10.213 and 10.302
U (Spring)
2-0-4 units

General principles of separation by equilibrium and rate processes. Staged cascades. Applications to distillation, absorption, adsorption, and membrane processes. Use of material balances, phase equilibria, and diffusion to understand and design separation processes.

T. A. Hatton

10.333 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject.
Offered under: 1.021, 3.021, 10.333, 22.00
Prereq: 3.016B, 18.03, or permission of instructor
U (Spring)
4-0-8 units. REST

See description under subject 3.021.
M. Buehler, R. Gomez-Bombarelli

10.34 Numerical Methods Applied to Chemical Engineering
Prereq: Permission of instructor
G (Fall)
3-0-6 units

Numerical methods for solving problems arising in heat and mass transfer, fluid mechanics, chemical reaction engineering, and molecular simulation. Topics: numerical linear algebra, solution of nonlinear algebraic equations and ordinary differential equations, solution of partial differential equations (e.g., Navier-Stokes), numerical methods in molecular simulation (dynamics, geometry optimization). All methods are presented within the context of chemical engineering problems. Familiarity with structured programming is assumed.

W. H. Green, J. W. Swan
10.345 Fundamentals of Metabolic and Biochemical Engineering: Applications to Biomanufacturing
Subject meets with 10.545
Prereq: 5.07[J], 7.05, or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units
Examines the fundamentals of cell and metabolic engineering for biocatalyst design and optimization, as well as biochemical engineering principles for bioreactor design and operation, and downstream processing. Presents applications of microbial processes for production of commodity and specialty chemicals and biofuels in addition to mammalian cell cultures for production of biopharmaceuticals. Students taking graduate version complete additional assignments.
Gr. Stephanopoulos

10.352 Modern Control Design (New)
Subject meets with 10.552
Prereq: 18.03 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-6 units
Covers modern methods for dynamical systems analysis, state estimation, controller design, and related topics. Uses example applications to demonstrate Lyapunov and linear matrix inequality-based methods that explicitly address actuator constraints, nonlinearities, and model uncertainties. Students taking graduate version complete additional assignments. Limited to 30.
R. D. Braatz

10.353 Model Predictive Control (New)
Subject meets with 10.553
Prereq: 18.03 or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-6 units
Provides an introduction to the multivariable control of dynamical systems with constraints on manipulated, state, and output variables. Covers multiple mathematical formulations that are popular in academia and industry, including dynamic matrix control and state-space model predictive control of uncertain, nonlinear, and large-scale systems. Uses numerous real industrial processes as examples. Students taking graduate version complete additional assignments.
R. D. Braatz

10.354[J] Process Data Analytics (New)
Same subject as 2.874[J]
Subject meets with 2.884[J], 10.554[J]
Prereq: 18.03 or permission of instructor
U (Fall)
3-0-6 units
Provides an introduction to data analytics for manufacturing processes. Topics include chemometrics, discriminant analysis, hyperspectral imaging, machine learning, big data, Bayesian methods, experimental design, feature spaces, and pattern recognition as relevant to manufacturing process applications (e.g., output estimation, process control, and fault detection, identification and diagnosis). Students taking graduate version complete additional assignments.
R. D. Braatz, B. Anthony

10.37 Chemical Kinetics and Reactor Design
Prereq: 5.601 and 10.301
U (Spring)
3-0-9 units
Applies the concepts of reaction rate, stoichiometry and equilibrium to the analysis of chemical and biological reacting systems. Derivation of rate expressions from reaction mechanisms and equilibrium or steady state assumptions. Design of chemical and biochemical reactors via synthesis of chemical kinetics, transport phenomena, and mass and energy balances. Topics: chemical/biochemical pathways; enzymatic, pathway and cell growth kinetics; batch, plug flow and well-stirred reactors for chemical reactions and cultivations of microorganisms and mammalian cells; heterogeneous and enzymatic catalysis; heat and mass transport in reactors, including diffusion to and within catalyst particles and cells or immobilized enzymes.
Gr. Stephanopoulos, Y. Roman

Same subject as 2.60[J]
Subject meets with 2.62[J], 10.392[J], 22.40[J]
Prereq: 2.006, (2.051 and 2.06), or permission of instructor
U (Spring)
4-0-8 units
See description under subject 2.60[J].
A. F. Ghoniem, W. Green
10.391[J] Sustainable Energy
Same subject as 1.818[J], 2.65[J], 11.371[J], 22.811[J]
Subject meets with 2.650[J], 10.291[J], 22.081[J]
Prereq: Permission of instructor
G (Fall)
3-1-8 units
See description under subject 22.811[J].
M. W. Golay

Same subject as 2.62[J], 22.40[J]
Subject meets with 2.60[J], 10.390[J]
Prereq: 2.006, (2.051 and 2.06), or permission of instructor
G (Spring)
4-0-8 units
See description under subject 2.62[J].
A. F. Ghoniem, W. Green

10.40 Chemical Engineering Thermodynamics
Prereq: 10.213
G (Fall)
4-0-8 units
Basic postulates of classical thermodynamics. Application to transient open and closed systems. Criteria of stability and equilibria. Constitutive property models of pure materials and mixtures emphasizing molecular-level effects using the formalism of statistical mechanics. Phase and chemical equilibria of multicomponent systems. Applications emphasized through extensive problem work relating to practical cases.
D. Blankschtein

Same subject as 2.916[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units
Introduction to the substance and process of funding technology startups. Topics include a comparative analysis of various sources of capital; templates to identify the optimal investor; legal frameworks, US and offshore, of the investment process and its related jargon; an introduction to understanding venture capital as a business; and market practice and standards for term sheet negotiation. Emphasizes strategy as well as tactics necessary to negotiate and build effective, long-term relationships with investors, particularly venture capital firms (VCs).
S. Loessberg, D. P. Hart

10.424 Pharmaceutical Engineering
Subject meets with 10.524
Prereq: 10.213
U (Fall)
3-0-6 units
Presents engineering principles and unit operations involved in the manufacture of small molecules pharmaceuticals, from the isolation of purified active pharmaceutical ingredients (API) to the final production of drug product. Regulatory issues include quality by design and process analytical technologies of unit operations, such as crystallization, filtration, drying, milling, blending, granulation, tableting and coating. Also covers principles of formulation for solid dosage forms and parenteral drugs. Students taking graduate version complete additional assignments. Limited to 50.
A. S. Myerson

10.426 Electrochemical Energy Systems
Subject meets with 10.626
Prereq: 10.302 or permission of instructor
U (Spring)
3-0-9 units
Introduces electrochemical energy systems from the perspective of thermodynamics, kinetics, and transport. Surveys analysis and design of electrochemical reactions and processes by integrating chemical engineering fundamentals with knowledge from diverse fields, including chemistry, electrical engineering, and materials science. Includes applications to fuel cells, electrolyzers, and batteries. Students taking graduate version complete additional assignments.
K. Manthiram

10.43 Introduction to Interfacial Phenomena
Prereq: 10.213 or introductory subject in thermodynamics or physical chemistry
G (Spring)
Not offered regularly; consult department
3-0-6 units
D. Blankschtein
10.437[J] Computational Chemistry
Same subject as 5.697[J]
Subject meets with 5.698[J], 10.637[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Addresses both the theory and application of first-principles computer simulations methods (i.e., quantum, chemical, or electronic structure), including Hartree-Fock theory, density functional theory, and correlated wavefunction methods. Covers enhanced sampling, ab initio molecular dynamics, and transition-path-finding approaches as well as errors and accuracy in total and free energies. Discusses applications such as the study and prediction of properties of chemical systems, including heterogeneous, molecular, and biological catalysts (enzymes), and physical properties of materials. Students taking graduate version complete additional assignments.

H. J. Kulik

10.441[J] Molecular and Engineering Aspects of Biotechnology
Same subject as 7.37[J], 20.361[J]
Prereq: (7.06 and (2.005, 3.012, 5.60, or 20.110[J])) or permission of instructor
U (Spring)
Not offered regularly; consult department
4-0-8 units
Credit cannot also be received for 7.371
See description under subject 7.37[J].

Staff

10.443 Future Medicine: Drug Delivery, Therapeutics, and Diagnostics
Subject meets with 10.643[J], HST.526[J]
Prereq: 5.12 or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-6 units
Aims to describe the direction and future of medical technology. Introduces pharmaceutics, pharmacology, and conventional medical devices, then transitions to drug delivery systems, mechanical/electric-based and biological/cell-based therapies, and sensors. Covers nano- and micro drug delivery systems, including polymer-drug conjugates, protein therapeutics, liposomes and polymer nanoparticles, viral and non-viral genetic therapy, and tissue engineering. Previous coursework in cell biology and organic chemistry recommended. Students taking graduate version complete additional assignments. Limited to 40.

D. G. Anderson

10.450 Process Dynamics, Operations, and Control
Prereq: 10.302 and 18.03
U (Spring)
3-0-6 units
Introduction to dynamic processes and the engineering tasks of process operations and control. Subject covers modeling the static and dynamic behavior of processes; control strategies; design of feedback, feedforward, and other control structures; model-based control; applications to process equipment.

B. S. Johnston

10.466 Structure of Soft Matter
Subject meets with 10.566
Prereq: 5.60
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-6 units
Provides an introduction to the basic thermodynamic language used for describing the structure of materials, followed by a survey of the scattering, microscopy and spectroscopic techniques for structure and morphology characterization. Applies these concepts to a series of case studies illustrating the diverse structures formed in soft materials and the common length, time and energy scales that unify this field. For students interested in studying polymer science, colloid science, nanotechnology, biomaterials, and liquid crystals. Students taking graduate version complete additional assignments.

B. D. Olsen

10.467 Polymer Science Laboratory
Prereq: 5.12 and 5.310
U (Fall)
2-7-6 units
Experiments broadly aimed at acquainting students with the range of properties of polymers, methods of synthesis, and physical chemistry. Examples: solution polymerization of acrylamide, bead polymerization of divinylbenzene, interfacial polymerization of nylon 6,10. Evaluation of networks by tensile and swelling experiments. Rheology of polymer solutions and suspensions. Physical properties of natural and silicone rubber. Preference to Course 10 seniors and juniors.

Z. Smith
**10.489 Concepts in Modern Heterogeneous Catalysis**
Subject meets with 10.689
Prereq: 10.302 and 10.37
U (Spring)
Not offered regularly; consult department
3-0-6 units
Explores topics in the design and implementation of heterogeneous catalysts for chemical transformations. Emphasizes use of catalysis for environmentally benign and sustainable chemical processes. Lectures address concepts in catalyst preparation, catalyst characterization, quantum chemical calculations, and microkinetic analysis of catalytic processes. Shows how experimental and theoretical approaches can illustrate important reactive intermediates and transition states involved in chemical reaction pathways, and uses that information to help identify possible new catalysts that may facilitate reactions of interest. Draws examples from current relevant topics in catalysis. Includes a group project in which students investigate a specific topic in greater depth. Students taking graduate version complete additional assignments.
Y. Roman

**10.490 Integrated Chemical Engineering**
Prereq: 10.37
U (Fall, Spring)
3-0-6 units
Can be repeated for credit.

Presents and solves chemical engineering problems in an industrial context. Emphasis on the integration of fundamental concepts with approaches in process design, and on problems that demand synthesis, economic analysis, and process design; consideration of safety analysis, process dynamics and the use of process simulators and related tools to approach such problems. The specific application of these fundamental concepts will vary each term, and may include chemical, electrochemical, pharmaceutical, biopharmaceutical (biologic) or related processes, operated in batch, semi-batch, continuous or hybrid mode. May be repeated once for credit with permission of instructor.
B. S. Johnston, Y. Roman

**10.492A Integrated Chemical Engineering Topics I**
Prereq: 10.301 and permission of instructor
U (Fall; first half of term)
2-0-4 units
Credit cannot also be received for 10.492B
Chemical engineering problems presented and analyzed in an industrial context. Emphasizes the integration of fundamentals with material property estimation, process control, product development, and computer simulation. Integration of societal issues, such as engineering ethics, environmental and safety considerations, and impact of technology on society are addressed in the context of case studies. 10.37 and 10.302 required for certain topic modules. See departmental website for individual ICE-T module descriptions.
K. F. Jensen, Geo. Stephanopoulos

**10.492B Integrated Chemical Engineering Topics I**
Prereq: 10.301 and permission of instructor
U (Fall; second half of term)
2-0-4 units
Credit cannot also be received for 10.492A
Chemical engineering problems presented and analyzed in an industrial context. Emphasizes the integration of fundamentals with material property estimation, process control, product development, and computer simulation. Integration of societal issues, such as engineering ethics, environmental and safety considerations, and impact of technology on society are addressed in the context of case studies. 10.37 and 10.302 required for certain topic modules. See departmental website for individual ICE-T module descriptions.
K. F. Jensen, Geo. Stephanopoulos

**10.493 Integrated Chemical Engineering Topics II**
Prereq: 10.301 and permission of instructor
U (IAP; partial term)
2-0-4 units
Chemical engineering problems presented and analyzed in an industrial context. Emphasizes the integration of fundamentals with material property estimation, process control, product development, and computer simulation. Integration of societal issues, such as engineering ethics, environmental and safety considerations, and impact of technology on society are addressed in the context of case studies. 10.37 and 10.302 required for certain topic modules. See departmental website for individual ICE-T module descriptions.
J. Drake
10.494A Integrated Chemical Engineering Topics III
Prereq: 10.301 and permission of instructor
U (Spring)
2-0-4 units
Credit cannot also be received for 10.494B
Chemical engineering problems presented and analyzed in an industrial context. Emphasizes the integration of fundamentals with material property estimation, process control, product development, and computer simulation. Integration of societal issues, such as engineering ethics, environmental and safety considerations, and impact of technology on society are addressed in the context of case studies. 10.37 and 10.302 required for certain topic modules. See departmental website for individual ICE-T module descriptions.
K. F. Jensen, R. C. Armstrong

10.494B Integrated Chemical Engineering Topics III
Prereq: 10.301 and permission of instructor
U (Spring; second half of term)
2-0-4 units
Credit cannot also be received for 10.494A
Chemical engineering problems presented and analyzed in an industrial context. Emphasizes the integration of fundamentals with material property estimation, process control, product development, and computer simulation. Integration of societal issues, such as engineering ethics, environmental and safety considerations, and impact of technology on society are addressed in the context of case studies. 10.37 and 10.302 required for certain topic modules. See departmental website for individual ICE-T module descriptions.
K. F. Jensen, R. C. Armstrong

10.495 Molecular Design and Bioprocess Development of Immunotherapies
Subject meets with 10.595
Prereq: 7.06 or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-6 units
Examines challenges and opportunities for applying chemical engineering principles to address the growing global burden of infectious disease, including drug-resistant strains and neglected pathogens. Topics include a historical overview of vaccines and immunotherapies, the molecular design considerations for new immunotherapies and adjuvants, the economic challenges for process development and manufacturing of immunotherapies, and new technologies for designing and assessing therapies. Case studies to cover topics for specific diseases. Students taking graduate version complete additional assignments.
J. C. Love

10.50 Analysis of Transport Phenomena
Prereq: 10.301 and 10.302
G (Fall)
4-0-8 units
Unified treatment of heat transfer, mass transfer, and fluid mechanics, emphasizing scaling concepts in formulating models and analytical methods for obtaining solutions. Topics include conduction and diffusion, laminar flow regimes, convective heat and mass transfer, and simultaneous heat and mass transfer with chemical reaction or phase change.
W. M. Deen, M. Z. Bazant

10.51 Nanoscale Energy Transport Processes
Subject meets with 10.31
Prereq: ((2.51 or 10.302) and (3.024 or 5.61)) or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units
Explores the impact of nanoscale phenomena on macroscale transport of energy-carrying molecules, phonons, electrons, and excitons. Studies the effect of structural and energetic disorder, wave-like vs. particle-like transport, quantum and classical size effects, and quantum coherence. Emphasizes quantitative analysis, including the Boltzmann transport equation, Einstein relation, Wiedemann-Franz law, and Marcus electron transfer theory. Also addresses percolation theory and the connection to energy conversion technologies, such as solar cells, thermoelectrics, and LEDs. Students taking graduate version complete additional assignments.
W. A. Tisdale

10.52 Mechanics of Fluids
Prereq: 10.50
G (Fall)
Not offered regularly; consult department
3-0-6 units
Advanced subject in fluid and continuum mechanics. Content includes kinematics, macroscopic balances for linear and angular momentum, the stress tensor, creeping flows and the lubrication approximation, the boundary layer approximation, linear stability theory, and some simple turbulent flows.
Staff
10.524 Pharmaceutical Engineering
Subject meets with 10.424
Prereq: None
G (Fall)
3-0-6 units
Presents engineering principles and unit operations involved in the manufacture of small molecules pharmaceuticals, from the isolation of purified active pharmaceutical ingredients (API) to the final production of drug product. Regulatory issues include quality by design and process analytical technologies of unit operations, such as crystallization, filtration, drying, milling, blending, granulation, tableting and coating. Also covers principles of formulation for solid dosage forms and parenteral drugs. Students taking graduate version complete additional assignments. Limited to 50.
A. S. Myerson

10.531[J] Macromolecular Hydrodynamics
Same subject as 2.341[J]
Prereq: 2.25, 10.301, or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-6 units
See description under subject 2.341[J].
R. C. Armstrong, G. H. McKinley

10.536[J] Thermal Hydraulics in Power Technology
Same subject as 2.59[J], 22.313[J]
Prereq: 2.006, 10.302, 22.312, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-2-7 units
See description under subject 22.313[J].
E. Baglietto, M. Bucci

10.537[J] Molecular, Cellular, and Tissue Biomechanics
Same subject as 2.798[J], 3.971[J], 6.524[J], 20.410[J]
Prereq: Biology (GIR) and (2.002, 2.006, 6.013, 10.301, or 10.302)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 20.410[J].
R. D. Kamm, K. J. Van Vliet

10.538[J] Principles of Molecular Bioengineering
Same subject as 20.420[J]
Prereq: 7.06 and 18.03
G (Fall)
3-0-9 units
See description under subject 20.420[J].
A. Jasanoﬀ, E. Fraenkel

Same subject as 2.795[J], 6.561[J], 20.430[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject 20.430[J].
M. Bathe, A. J. Grodzinsky

10.540 Intracellular Dynamics
Prereq: 7.06, 10.302, 18.03, or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Covers current models and descriptions of the internal cell dynamics of macromolecules due to reaction and transport. Two major areas will be explored: the process of gene expression, including protein-DNA interactions, chromatin dynamics, and the stochastic nature of gene expression; and cell signaling systems, especially those that lead to or rely on intracellular protein gradients. This class is intended for graduate students or advanced undergraduates with some background in cell biology, transport, and kinetics. An introductory class in probability is recommended.
N. Maheshri
10.542 Biochemical Engineering
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units

Interaction of chemical engineering, biochemistry, and microbiology. Mathematical representations of microbial systems. Kinetics of growth, death, and metabolism. Continuous fermentation, agitation, mass transfer, and scale-up in fermentation systems, enzyme technology.
K. J. Prather

10.544 Metabolic and Cell Engineering
Prereq: 7.05, 10.302, and 18.03
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units

Presentation of a framework for quantitative understanding of cell functions as integrated molecular systems. Analysis of cell-level processes in terms of underlying molecular mechanisms based on thermodynamics, kinetics, mechanics, and transport principles, emphasizing an engineering, problem-oriented perspective. Objective is to rationalize target selection for genetic engineering and evaluate the physiology of recombinant cells. Topics include cell metabolism and energy production, transport across cell compartment barriers, protein synthesis and secretion, regulation of gene expression, transduction of signals from extracellular environment, cell proliferation, cell adhesion and migration.
Gr. Stephanopoulos

10.545 Fundamentals of Metabolic and Biochemical Engineering: Applications to Biomanufacturing
Subject meets with 10.345
Prereq: 5.07[J], 7.05, or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Examines the fundamentals of cell and metabolic engineering for biocatalyst design and optimization, as well as biochemical engineering principles for bioreactor design and operation, and downstream processing. Presents applications of microbial processes for production of commodity and specialty chemicals and biofuels in addition to mammalian cell cultures for production of biopharmaceuticals. Students taking graduate version complete additional assignments.
Gr. Stephanopoulos

10.546[J] Statistical Thermodynamics
Same subject as 5.70[J]
Prereq: 5.60 or permission of instructor
G (Fall)
3-0-9 units

See description under subject 5.70[J].
J. Cao, B. Zhang

10.547[J] Principles and Practice of Drug Development
Same subject as 7.547[J], 15.136[J], HST.920[J], IDS.620[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units

See description under subject 15.136[J].
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

Same subject as HST.525[J]
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
2-0-4 units

See description under subject HST.525[J].
R. K. Jain

10.55 Colloid and Surfactant Science
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-6 units

Introduces fundamental and applied aspects of colloidal dispersions, where the typical particle size is less than a micrometer. Discusses the characterization and unique behavior of colloidal dispersions, including their large surface-to-volume ratio, tendency to sediment in gravitational and centrifugal fields, diffusion characteristics, and ability to generate osmotic pressure and establish Donnan equilibrium. Covers the fundamentals of attractive van der Waals forces and repulsive electrostatic forces. Presents an in-depth discussion of electrostatic and polymer-induced colloid stabilization, including the DLVO theory of colloid stability. Presents an introductory discussion of surfactant physical chemistry.
D. Blankschtein
10.551 Systems Engineering
Prereq: 10.213, 10.302, and 10.37
G (Spring)
3-0-6 units

Introduction to the elements of systems engineering. Special attention devoted to those tools that help students structure and solve complex problems. Illustrative examples drawn from a broad variety of chemical engineering topics, including product development and design, process development and design, experimental and theoretical analysis of physico-chemical process, analysis of process operations.
R. D. Braatz, P. I. Barton

10.552 Modern Control Design
Subject meets with 10.352
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-6 units

Covers modern methods for dynamical systems analysis, state estimation, controller design, and related topics. Uses example applications to demonstrate Lyapunov and linear matrix inequality-based methods that explicitly address actuator constraints, nonlinearities, and model uncertainties. Students taking graduate version complete additional assignments. Limited to 30.
R. D. Braatz

10.553 Model Predictive Control
Subject meets with 10.353
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-6 units

Provides an introduction to the multivariable control of dynamical systems with constraints on manipulated, state, and output variables. Covers multiple mathematical formulations that are popular in academia and industry, including dynamic matrix control and state-space model predictive control of uncertain, nonlinear, and large-scale systems. Uses numerous real industrial processes as examples. Students taking graduate version complete additional assignments.
R. D. Braatz

10.554[J] Process Data Analytics
Same subject as 2.884[J]
Subject meets with 2.874[J], 10.354[J]
Prereq: None
G (Fall)
3-0-6 units

Provides an introduction to data analytics for manufacturing processes. Topics include chemometrics, discriminant analysis, hyperspectral imaging, machine learning, big data, Bayesian methods, experimental design, feature spaces, and pattern recognition as relevant to manufacturing process applications (e.g., output estimation, process control, and fault detection, identification and diagnosis). Students taking graduate version complete additional assignments.
R. D. Braatz, B. Anthony

10.555[J] Bioinformatics: Principles, Methods and Applications
Same subject as HST.940[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Introduction to bioinformatics, the collection of principles and computational methods used to upgrade the information content of biological data generated by genome sequencing, proteomics, and cell-wide physiological measurements of gene expression and metabolic fluxes. Fundamentals from systems theory presented to define modeling philosophies and simulation methodologies for the integration of genomic and physiological data in the analysis of complex biological processes. Various computational methods address a broad spectrum of problems in functional genomics and cell physiology. Application of bioinformatics to metabolic engineering, drug design, and biotechnology also discussed.
Gr. Stephanopoulos, I. Rigoutsos
10.557 Mixed-integer and Nonconvex Optimization
Prereq: 10.34 or 15.053
G (Spring)
3-0-9 units

Presents the theory and practice of deterministic algorithms for locating the global solution of NP-hard optimization problems. Recurring themes and methods are convex relaxations, branch-and-bound, cutting planes, outer approximation and primal-relaxed dual approaches. Emphasis is placed on the connections between methods. These methods will be applied and illustrated in the development of algorithms for mixed-integer linear programs, mixed-integer convex programs, nonconvex programs, mixed-integer nonconvex programs, and programs with ordinary differential equations embedded. The broad range of engineering applications for these optimization formulations will also be emphasized. Students will be assessed on homework and a term project for which examples from own research are encouraged.

P. I. Barton

10.56 Advanced Topics in Surfactant Science
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units

Introduces fundamental advances and practical aspects of surfactant self-assembly in aqueous media. In-depth discussion of surfactant micellization, including statistical-thermodynamics of micellar solutions, models of micellar growth, molecular models for the free energy of micellization, and geometric packing theories. Presents an introductory examination of mixed micelle and vesicle formation, polymer-surfactant complexation, biomolecule-surfactant interactions, and micellar-assisted solubilization. Discusses molecular dynamics simulations of self-assembling systems. Covers recent advances in surfactant-induced dispersion and stabilization of colloidal particles (e.g., carbon nanotubes and graphene) in aqueous media. Examines surfactant applications in consumer products, environmental and biological separations, enhanced oil recovery using surfactant flooding, mitigation of skin irritation induced by surfactant-containing cosmetic products, and enhanced transdermal drug delivery using ultrasound and surfactants.

D. Blankschtein

10.560 Structure and Properties of Polymers
Prereq: 10.213 or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units

Review of polymer molecular structure and bulk morphology; survey of molecular and morphological influence on bulk physical properties including non-Newtonian flow, macromolecular diffusion, gas transport in polymers, electrical and optical properties, solid-state deformation, and toughness. Case studies for product design.

R. E. Cohen

10.562[J] Pioneering Technologies for Interrogating Complex Biological Systems
Same subject as 9.271[J], HST.562[J]
Prereq: None
G (Spring)
3-1-8 units

See description under subject HST.562[J]. Limited to 15.

K. Chung

10.566 Structure of Soft Matter
Subject meets with 10.466
Prereq: 5.60
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units

Provides an introduction to the basic thermodynamic language used for describing the structure of materials, followed by a survey of the scattering, microscopy and spectroscopic techniques for structure and morphology characterization. Applies these concepts to a series of case studies illustrating the diverse structures formed in soft materials and the common length, time and energy scales that unify this field. For students interested in studying polymer science, colloid science, nanotechnology, biomaterials, and liquid crystals. Students taking graduate version complete additional assignments.

B. D. Olsen
10.568 Physical Chemistry of Polymers
Prereq: 5.60, 10.213, or 10.40
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall, Spring)
3-0-6 units

Introduction to polymer science from a molecular perspective. Covers topics in macromolecular confirmation and spatial extent, polymer solution thermodynamics and the theta state, linear viscoelasticity, rubber elasticity, and the thermodynamics and kinetics of formation of glasses and semicrystalline solids. Also provides a basic introduction to dynamics of macromolecules in solutions and melts, with entanglements. Presents methods for characterizing the molecular structure of polymers.
G. C. Rutledge, A. Alexander-Katz

10.569 Synthesis of Polymers
Prereq: 5.12
G (Spring)
3-0-6 units

Studies synthesis of polymeric materials, emphasizing interrelationships of chemical pathways, process conditions, and microarchitecture of molecules produced. Chemical pathways include traditional approaches such as anionic, radical condensation, and ring-opening polymerizations. New techniques, including stable free radicals and atom transfer free radicals, new catalytic approaches to well-defined architectures, and polymer functionalization in bulk and at surfaces. Process conditions include bulk, solution, emulsion, suspension, gas phase, and batch vs continuous fluidized bed. Microarchitecture includes tacticity, molecular-weight distribution, sequence distributions in copolymers, errors in chains such as branches, head-to-head addition, and peroxide incorporation.
P. T. Hammond, B. D. Olsen

10.571[J] Atmospheric Physics and Chemistry
Same subject as 12.806[J]
Subject meets with 12.306
Prereq: (18.075 and (5.60 or 5.61)) or permission of instructor
G (Spring)
3-0-9 units

See description under subject 12.806[J].
R. G. Prinn

10.579[J] Energy Technology and Policy: From Principles to Practice
Same subject as 5.00[J], 6.929[J], 22.813[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-6 units

Develops analytical skills to lead a successful technology implementation with an integrated approach that combines technical, economical and social perspectives. Considers corporate and government viewpoints as well as international aspects, such as nuclear weapons proliferation and global climate issues. Discusses technologies such as oil and gas, nuclear, solar, and energy efficiency. Limited to 100.
J. Deutch

10.580 Solid-State Surface Science
Prereq: 10.213
G (Fall)
Not offered regularly; consult department
3-0-6 units

Structural, chemical, and electronic properties of solids and solid surfaces. Analytical tools used to characterize surfaces including Auger and photoelectron spectroscopies and electron diffraction techniques. Surface thermodynamics and kinetics including adsorption-desorption, catalytic properties, and sputtering processes. Applications to microelectronics, optical materials, and catalysis.
K. K. Gleason

10.585 Engineering Nanotechnology
Prereq: 10.213, 10.302, or permission of instructor
G (Fall)
3-0-9 units

Review of fundamental concepts of energy, mass and electron transport in materials confined or geometrically patterned at the nanoscale, where departures from classical laws are dominant. Specific applications to contemporary engineering challenges are discussed including problems in energy, biology, medicine, electronics, and material design.
M. Strano
10.586 Crystallization Science and Technology
Prereq: 10.213
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units
Studies the nucleation and growth of crystals from a melt or a liquid solution and their important role in a wide range of applications, including pharmaceuticals, proteins, and semiconductor materials. Provides background information and covers topics needed to understand, perform experiments, construct and simulate mechanistic models, and design, monitor, and control crystallization processes. Limited to 30.
A. S. Myerson

10.591 Case Studies in Bioengineering
Prereq: Biology (GIR) or permission of instructor
G (Fall)
3-0-6 units
Analysis and discussion of recent research in areas of bioengineering, including drug delivery, protein and tissue engineering, physiological transport, stem cell technology, and quantitative immunology by senior investigators in the Boston area. Students will read and critique papers, then have discussions with authors about their work.
C. K. Colton

10.595 Molecular Design and Bioprocess Development of Immunotherapies
Subject meets with 10.495
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
Examines challenges and opportunities for applying chemical engineering principles to address the growing global burden of infectious disease, including drug-resistant strains and neglected pathogens. Topics include a historical overview of vaccines and immunotherapies, the molecular design considerations for new immunotherapies and adjuvants, the economic challenges for process development and manufacturing of immunotherapies, and new technologies for designing and assessing therapies. Case studies to cover topics for specific diseases. Students taking graduate version complete additional assignments.
J. C. Love

10.606 Picturing Science and Engineering
Prereq: None
G (Spring; second half of term)
1-2-2 units
Provides instruction in best practices for creating more effective graphics and photographs to support and communicate research in science and engineering. Discusses in depth specific examples from a range of scientific contexts, such as journal articles, presentations, grant submissions, and cover art. Topics include graphics for figures depicting form and structure, process, and change over time. Prepares students to create effective graphics for submissions to existing journals and calls attention to the future of published graphics with the advent of interactivity. Limited to 10.
F. Frankel

Same subject as 2.625[J]
Prereq: 2.005, 3.046, 3.53, 10.40, (2.051 and 2.06), or permission of instructor
G (Fall)
4-0-8 units
See description under subject 2.625[J].
Y. Shao-Horn

10.626 Electrochemical Energy Systems
Subject meets with 10.426
Prereq: 10.50 or permission of instructor
G (Spring)
3-0-9 units
Introduces electrochemical energy systems from the perspective of thermodynamics, kinetics, and transport. Surveys analysis and design of electrochemical reactions and processes by integrating chemical engineering fundamentals with knowledge from diverse fields, including chemistry, electrical engineering, and materials science. Includes applications to fuel cells, electrolyzers, and batteries. Students taking graduate version complete additional assignments.
K. Manthiram
**10.631 Structural Theories of Polymer Fluid Mechanics**
Prereq: 10.301  
G (Spring)  
Not offered regularly; consult department  
3-0-6 units

*R. C. Armstrong*

**10.637[J] Quantum Chemical Simulation**
Same subject as 5.698[J]  
Subject meets with 5.697[J], 10.437[J]  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units

Addresses both the theory and application of first-principles computer simulations methods (i.e., quantum, chemical, or electronic structure), including Hartree-Fock theory, density functional theory, and correlated wavefunction methods. Covers enhanced sampling, ab initio molecular dynamics, and transition-path-finding approaches as well as errors and accuracy in total and free energies. Discusses applications such as the study and prediction of properties of chemical systems, including heterogeneous, molecular, and biological catalysts (enzymes), and physical properties of materials. Students taking graduate version complete additional assignments.  
*H. J. Kulik*

**10.643[J] Future Medicine: Drug Delivery, Therapeutics, and Diagnostics**
Same subject as HST.526[J]  
Subject meets with 10.443  
Prereq: 5.12 or permission of instructor  
G (Spring)  
Not offered regularly; consult department  
3-0-6 units

Aims to describe the direction and future of medical technology. Introduces pharmacetics, pharmacology, and conventional medical devices, then transitions to drug delivery systems, mechanical/electric-based and biological/cell-based therapies, and sensors. Covers nano- and micro drug delivery systems, including polymer-drug conjugates, protein therapeutics, liposomes and polymer nanoparticles, viral and non-viral genetic therapy, and tissue engineering. Previous coursework in cell biology and organic chemistry recommended. Students taking graduate version complete additional assignments. Limited to 40.  
*D. G. Anderson*

Same subject as HST.914[J]  
Prereq: 7.05 or permission of instructor  
G (Fall)  
Not offered regularly; consult department  
3-0-6 units

Provides an introduction to pharmaceutics and conventional oral, injected, transdermal and inhaled drug delivery systems. Includes studies of drug delivery devices and systems, e.g., stents, pumps, depo systems, responsive drug delivery systems, and biological/cell based therapies. Covers nano- and micro drug delivery systems, including polymer-drug conjugates, modified proteins, liposomes and polymer nanoparticles, viral and non-viral genetic therapy, and microencapsulated vaccines. Discusses reviews and current technology. Students taking graduate version complete additional assignments. Limited to 40.  
*D. G. Anderson*
10.65 Chemical Reactor Engineering
Prereq: 10.37 or permission of instructor
G (Spring)
4-0-8 units
Fundamentals of chemically reacting systems with emphasis on synthesis of chemical kinetics and transport phenomena. Topics include kinetics of gas, liquid, and surface reactions; quantum chemistry; transition state theory; surface adsorption, diffusion, and desorption processes; mechanism and kinetics of biological processes; mechanism formulation and sensitivity analysis. Reactor topics include nonideal flow reactors, residence time distribution and dispersion models; multiphase reaction systems; nonlinear reactor phenomena. Examples are drawn from different applications, including heterogeneous catalysis, polymerization, combustion, biochemical systems, and materials processing.
M. Strano, G. Stephanopoulos

Same subject as 5.68[J]
Prereq: 5.62, 10.37, or 10.65
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units
See description under subject 5.68[J].
W. H. Green

10.668[J] Statistical Mechanics of Polymers
Same subject as 3.941[J]
Prereq: 10.568 or permission of instructor
G (Fall)
3-0-9 units
Concepts of statistical mechanics and thermodynamics applied to macromolecules: polymer conformations in melts, solutions, and gels; Rotational Isomeric State theory, Markov processes and molecular simulation methods applied to polymers; incompatibility and segregation in incompressible and compressible systems; molecular theory of viscoelasticity; relation to scattering and experimental measurements.
G. C. Rutledge, A. Alexander-Katz

10.677 Topics in Applied Microfluidics
Prereq: 10.301 or permission of instructor
G (Fall)
3-0-6 units
Provides an introduction to the field of microfluidics. Reviews fundamental concepts in transport phenomena and dimensional analysis, focusing on new phenomena which arise at small scales. Discusses current applications, with an emphasis on the contributions engineers bring to the field. Local and visiting experts in the field discuss their work. Limited to 30.
P. Doyle

10.689 Concepts in Modern Heterogeneous Catalysis
Subject meets with 10.489
Prereq: 10.302 and 10.37
G (Spring)
Not offered regularly; consult department
3-0-6 units
Explores topics in the design and implementation of heterogeneous catalysts for chemical transformations. Emphasizes use of catalysis for environmentally benign and sustainable chemical processes. Lectures address concepts in catalyst preparation, catalyst characterization, quantum chemical calculations, and microkinetic analysis of catalytic processes. Shows how experimental and theoretical approaches can illustrate important reactive intermediates and transition states involved in chemical reaction pathways, and uses that information to help identify possible new catalysts that may facilitate reactions of interest. Draws examples from current relevant topics in catalysis. Includes a group project in which students investigate a specific topic in greater depth. Students taking graduate version complete additional assignments.
Y. Roman

Same subject as 2.890[J], 15.792[J], 16.985[J]
Prereq: None
G (Fall, Spring)
2-0-0 units
Can be repeated for credit.
See description under subject 15.792[J]. Preference to LGO students.
T. Roemer
Same subject as IDS.436[J]
Subject meets with 1.802[J], 1.812[J], 11.022[J], 11.631[J], IDS.061[J], IDS.541[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
See description under subject IDS.436[J].
N. A. Ashford, C. C. Caldart

10.806 Management in Engineering
Engineering School-Wide Elective Subject.
Offered under: 2.96, 6.930, 10.806, 16.653
Prereq: None
U (Fall)
3-1-8 units
See description under subject 2.96. Restricted to juniors and seniors.
H. S. Marcus, J.-H. Chun

10.807[J] Innovation Teams
Same subject as 15.371[J]
Prereq: None
G (Fall)
4-4-4 units
Introduces skills and capabilities for real-world problem solving to take technology from lab to societal impact: technical and functional exploration, opportunity discovery, market understanding, value economics, scale-up, intellectual property, and communicating/working for impact across disciplines. Students work in multidisciplinary teams formed around MIT research breakthroughs, with extensive in-class coaching and guidance from faculty, lab members, and select mentors. Follows a structured approach to innovating in which everything is a variable and the product, technology, and opportunities for new ventures can be seen as an act of synthesis. Teams gather evidence that permits a fact-based iteration across multiple application domains, markets, functionalities, technologies, and products, leading to a recommendation that maps a space of opportunity and includes actionable next steps to evolve the market and technology.
L. Perez-Breva, D. Hart

10.817[J] Atmospheric Chemistry
Same subject as 1.84[J], 12.807[J]
Prereq: 5.60
G (Fall)
3-0-9 units
See description under subject 1.84[J].
J. H. Kroll

School of Chemical Engineering Practice
10.80 (10.82, 10.84, 10.86) School of Chemical Engineering Practice -- Technical Accomplishment
Prereq: None
G (Fall, Spring, Summer)
0-6-0 units
Conducted at industrial field stations of the School of Chemical Engineering Practice. Group problem assignments include process development design, simulation and control, technical service, and new-product development. Grading based on technical accomplishment. Credit granted in lieu of master’s thesis. See departmental description on School of Chemical Engineering Practice for details. Enrollment limited and subject to plant availability.
T. A. Hatton

10.81 (10.83, 10.85, 10.87) School of Chemical Engineering Practice -- Communication Skills and Human Relations
Prereq: None
G (Fall, Spring, Summer)
0-6-0 units
Conducted at industrial field stations of the School of Chemical Engineering Practice. Group problem assignments include process development, design, simulation and control, technical service, and new-product development. Grading based on communication skills and human relations in group assignments. Credit granted in lieu of master’s thesis; see departmental description on School of Chemical Engineering Practice for details. Enrollment limited and subject to plant availability.
T. A. Hatton
10.90 Independent Research Problem
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

For special and graduate students who wish to carry out some minor investigation in a particular field. Subject and hours to fit individual requirements.  
*P. S. Doyle*

10.910 Independent Research Problem
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

For undergraduate students who wish to carry out a special investigation in a particular field. Topic and hours arranged.  
*B. S. Johnston*

10.911 Independent Research Problem
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For undergraduate students who wish to carry out a special investigation in a particular field. Topic and hours arranged.  
*B. S. Johnston*

10.912 Practical Internship in Chemical Engineering
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 units

Provides academic credit for professional experiences in chemical engineering at external facilities, such as companies or laboratories. At the end of the internship, students must submit a report that describes the experience, details their accomplishments, and synthesizes the perspectives, knowledge, and skills to be carried forward into the rest of their studies.  
*B. S. Johnston*

10.953 Seminar in Heterogeneous Catalysis
Prereq: None
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Students present their research to other students and staff. Research topics include heterogeneous catalysis, design of catalytic materials, biomass conversion, biofuels, and CO₂ utilization.  
*Y. Roman*

10.954 Seminar in Applied Optical Spectroscopy
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Research seminars given by students, postdocs, and visitors. Topics covered include applied optical spectroscopy and imaging, with particular emphasis on nanomaterials and how they relate to alternative energy technologies.  
*W. A. Tisdale*

10.955 Seminar in Electrochemical Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Designed to allow students to present and discuss their research in the area of electrochemical engineering with a particular emphasis on energy storage and conversion (e.g., batteries, fuel cells, electroreactors). Specific topics include active materials design, electroanalytical platform development, and integration of electrochemical and imaging techniques.  
*F. R. Brushett*

10.956 Seminar in Atomistic Simulation
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Seminar allows students to present their research to other students and staff. The research topics include electronic structure theory, computational chemistry techniques, and density functional theory with a focus on applications to catalysis and materials science.  
*H. J. Kulik*
10.957 Seminar in Bioengineering Technology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Research seminars presented by students and guest speakers on emerging biotechnologies.
K. Chung

Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Covers topics related to low Reynolds number hydrodynamics and the statistical physics of particulate media. Specifics include the kinetics of phase transitions in soft matter and the time-varying deformation of colloidal dispersions, glasses and gels.
J. W. Swan

10.960[J] Seminar in Polymers and Soft Matter
Same subject as 3.903[J]
Prereq: None
G (Fall, Spring)
2-0-0 units
Can be repeated for credit.

A series of seminars covering a broad spectrum of topics in polymer science and engineering, featuring both on- and off-campus speakers.
A. Alexander-Katz, R. E. Cohen, D. Irvine

10.961 Seminar in Advanced Air Pollution Research
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
2-0-4 units
Can be repeated for credit.

Research seminars, presented by students engaged in thesis work in the field of air pollution. Particular emphasis given to atmospheric chemistry, mathematical modeling, and policy analysis.
G. J. McRae

10.962 Seminar in Molecular Cell Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Weekly seminar with discussion of ongoing research and relevant literature by graduate students, postdoctoral fellows, and visiting scientists on issues at the interface of chemical engineering with molecular cell biology. Emphasis is on quantitative aspects of physicochemical mechanisms involved in receptor/ligand interactions, receptor signal transduction processes, receptor-mediated cell behavioral responses, and applications of these in biotechnology and medicine.
D. A. Lauffenburger

10.964 Seminar on Transport Theory
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Research seminars presented by students and guest speakers on mathematical modeling of transport phenomena, focusing on electrochemical systems, electrokinetics, and microfluidics.
M. Z. Bazant

10.965 Seminar in Biosystems Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Advanced topics on the state-of-the-art in design and implementation of analytical processes for biological systems, including single-cell analysis, micro/nanotechnologies, systems biology, biomanufacturing, and process engineering. Seminars and discussions guided by the research interests of participating graduate students, postdoctoral associates, faculty, and visiting lecturers.
J. C. Love
**10.966 Seminar in Drug Delivery, Biomaterials, and Tissue Engineering**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Focuses on presentations by students and staff on current research in the area of drug delivery, biomaterials, and tissue engineering. Includes topics such as nanotherapeutics, intracellular delivery, and therapeutics for diabetes.  
*D. G. Anderson*

**10.967 Seminar in Protein-Polymer Materials Engineering**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Research seminar covers topics on protein-based polymeric materials. Specific topics include bioelectronic materials, protein-polymer hybrids, and nanostructured proteins and polymers.  
*B. D. Olsen*

**10.968 Seminar in Biomolecular Engineering**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Covers research progress in the area of design, testing and mechanistic investigation of novel molecular systems for biotechnological applications.  
*H. D. Sikes*

**10.969 Molecular Engineering Seminar**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Seminar allows students to present their research to other students and staff. Research topics include molecular simulations techniques and applications, and molecular engineering of pharmaceutical and biopharmaceutical processes and formulations.  
*B. L. Trout*

**10.970 Seminar in Molecular Computation**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Seminar allows students to present their research to other students and staff. The research topics include computational chemistry techniques, kinetics, and catalysis. Focus is on molecular-level understanding of chemical change.  
*W. H. Green*

**10.971 Seminar in Fluid Mechanics and Transport Phenomena**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Seminar series on current research on Newtonian and non-Newtonian fluid mechanics and transport phenomena, and applications to materials processing. Seminars given by guest speakers and research students.  
*P. S. Doyle, G. H. McKinley, J. W. Swan*

**10.972 Biochemical Engineering Research Seminar**  
Prereq: Permission of instructor  
G (Fall, Spring)  
Not offered regularly; consult department  
2-0-4 units  
Can be repeated for credit.  
Seminar allows students to present their research programs to other students and staff. The research topics include fermentation and enzyme technology, mammalian and animal cell cultivation, and biological product separation.  
*D. I. C. Wang, C. L. Cooney*

**10.973 Bioengineering**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Seminar covering topics related to current research in the application of chemical engineering principles to biomedical science and biotechnology.  
*C. K. Colton*
10.974 Seminar in Chemical Engineering Nanotechnology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Seminar covering topics related to current research in the application of chemical engineering principles to nanotechnology. Limited to 30.

M. S. Strano

10.975 Seminar in Polymer Science and Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Research seminars, presented by students engaged in thesis work in the field of polymers and by visiting lecturers from industry and academia.

R. E. Cohen, P. T. Hammond, G. C. Rutledge

10.976 Process Design, Operations, and Control
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Seminars on the state of the art in design, operations, and control of processing systems, with emphasis on computer-based tools. Discussions guided by the research interests of participating students. Topics include mathematical and numerical techniques, representational methodologies, and software development.

P. I. Barton

10.977 Seminar in Electro catalysis
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Seminar held every week, with presentations by graduate students and postdoctoral researchers on topics related to the molecular engineering of electrocatalysts. Emphasis on correlating atomic-level understanding of surfaces, their interactions with adsorbates, and the resulting impact on catalytic mechanisms.

K. Manthiram

10.978 Seminar in Advanced Materials for Energy Applications
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Students, postdocs, and visitors to present their work on synthesis, design, and characterization of polymeric and inorganic materials for applications related to membrane and adsorption-based separations.

Z. P. Smith

10.981 Seminar in Colloid and Interface Science
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Review of current topics in colloid and interface science. Topics include statistical mechanics and thermodynamics of micellar solutions, self-assembling systems, and microemulsions; solubilization of simple ions, amino acids, and proteins in reversed micelles; enzymatic reactions in reversed micelles; phase equilibria in colloidal systems; interfacial phenomena in colloidal systems; biomedical aspects of colloidal systems.

D. Blankschtein

10.982 Seminar in Experimental Colloid and Surface Chemistry
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

In-depth discussion of fundamental physical relationships underlying techniques commonly used in the study of colloids and surfaces with a focus on recent advances and experimental applications. Topics have included the application of steady-state and time-resolved fluorescence spectroscopies, infrared spectroscopy, and scanning probe microscopies.

T. A. Hatton
10.983 Reactive Processing and Microfabricated Chemical Systems
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Advanced topics in synthesis of materials through processes involving transport phenomena and chemical reactions. Chemical vapor deposition, modeling, and experimental approaches to kinetics of gas phase and surface reactions, transport phenomena in complex systems, materials synthesis, and materials characterization. Design fabrication and applications of microfabricated chemical systems. Seminars by graduate students, postdoctoral associates, participating faculty, and visiting lecturers.

K. F. Jensen

10.984 Biomedical Applications of Chemical Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Weekly seminar with lectures on current research by graduate students, postdoctoral fellows, and visiting scientists on topics related to biomedical applications of chemical engineering. Specific topics include polymeric controlled release technology, extracorporal reactor design, biomedical polymers, bioengineering aspects of pharmaceuticals, and biomaterials/tissue and cell interactions.

R. S. Langer

10.985 Advanced Manufacturing Seminar
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Focuses on the state of the art in the systems engineering of materials products and materials manufacturing processes. Addresses topics such as pharmaceuticals manufacturing, polymeric drug delivery systems, and nano- and microstructured materials. Discussions guided by the research interests of participating students. Includes techniques from applied mathematics and numerical methods, multiscale systems analysis, and control theory.

R. D. Braatz

10.987 Solid Thin Films and Interfaces
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Current research topics and fundamental issues relating to the deposition and properties of solid thin films and interfaces. Emphasis on applying analytical techniques, such as solid-state NMR, to explore the thermodynamics and kinetics of growth, defect formation, and structural modification incurred during film growth and post processing.

K. K. Gleason

10.989 Seminar in Biotechnology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Research seminars, presented by graduate students and visitors from industry and academia, covering a broad range of topics of current interest in biotechnology. Discussion focuses on generic questions with potential biotechnological applications and the quest for solutions through a coordinated interdisciplinary approach.

Gr. Stephanopoulos

10.990 Introduction to Chemical Engineering Research
Prereq: None
G (Fall)
2-4-0 units

Introduction to research in chemical engineering by faculty of chemical engineering department. Focus is on recent developments and research projects available to new graduate students.

P. T. Hammond

10.991 Seminar in Chemical Engineering
Prereq: Permission of instructor
G (Fall)
2-0-4 units
Can be repeated for credit.

For students working on doctoral theses.

P. T. Hammond

10.992 Seminar in Chemical Engineering
Prereq: Permission of instructor
G (Spring)
2-0-4 units
Can be repeated for credit.

For students working on doctoral theses.

K. F. Jensen
10.994 Molecular Bioengineering  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Presentations and discussions by graduate students, postdoctoral fellows, and visiting scientists of current literature and research on the engineering of protein biopharmaceuticals. Topics include combinatorial library construction and screening strategies, antibody engineering, gene therapy, cytokine engineering, and immunotherapy engineering strategies.  
K. D. Wittrup

10.995 Cellular and Metabolic Engineering  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Graduate students, postdoctoral fellows, visiting scientists, and guest industrial practitioners to present their own research and highlight important advances from the literature in biochemical and bioprocess engineering. Topics of interest include metabolic engineering, novel microbial pathway design and optimization, synthetic biology, and applications of molecular biology to bioprocess development.  
K. J. Prather

10.997 Theoretical and Computational Immunology Seminar  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Presentations and discussions of current literature and research in theoretical and computational immunology. Topics include T-cell biology, cell-cell recognition in immunology, polymers and membranes, and statistical mechanics.  
A. K. Chakraborty

10.998 Seminar in Crystallization Science and Technology  
Prereq: None  
G (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
Focuses on current topics related to crystallization science and technology in the chemical, pharmaceutical and food industries. Discusses fundamental work on nucleation, polymorphism, impurity crystal interactions and nano-crystal formation, along with industrial applications of crystallization.  
A. S. Myerson

10.EPE UPOP Engineering Practice Experience  
Engineering School-Wide Elective Subject.  
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE  
Prereq: 2.EPW or permission of instructor  
U (Fall, Spring)  
0-0-1 units  
See description under subject 2.EPE.  
Staff

10.EPW UPOP Engineering Practice Workshop  
Engineering School-Wide Elective Subject.  
Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW  
Prereq: None  
U (Fall, IAP)  
1-0-0 units  
See description under subject 2.EPW. Enrollment limited.  
Staff

10.S94 Special Problems in Chemical Engineering  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.  
Focuses on problem of current interest not covered in regular curriculum; topic varies from year to year.  
Staff

10.S95 Special Problems in Chemical Engineering  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged  
Can be repeated for credit.  
Focuses on problem of current interest not covered in regular curriculum; topic varies from year to year.  
Staff

10.S96 Special Problems in Chemical Engineering (New)  
Prereq: None  
G (Fall)  
Units arranged  
Can be repeated for credit.  
Focuses on problem of current interest not covered in regular curriculum; topic varies from year to year.  
A. L. Furst
10.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and appropriate MIT faculty member.

D. Blankschtein

10.THU Undergraduate Thesis
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to writing an SB thesis; topic arranged between student and MIT faculty member.

B. S. Johnston

10.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for participation in the work of a research group, or for special investigation in a particular field. Topic and hours to fit individual requirements.

B. S. Johnston

10.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for participation in a research group, or for special investigation in a particular field. Topic and hours to fit individual requirements.

B. S. Johnston
CHEMISTRY (COURSE 5)

5.00[J] Energy Technology and Policy: From Principles to Practice
Same subject as 6.929[J], 10.579[J], 22.813[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-6 units
Develops analytical skills to lead a successful technology implementation with an integrated approach that combines technical, economical and social perspectives. Considers corporate and government viewpoints as well as international aspects, such as nuclear weapons proliferation and global climate issues. Discusses technologies such as oil and gas, nuclear, solar, and energy efficiency. Limited to 100.
J. Deutch

5.001 Frontiers in Molecular and Materials Science
Prereq: None
U (Spring)
Not offered regularly; consult department
2-0-0 units
Provides an interactive forum for students who want to know more about the cutting edge of chemistry. Explores how chemistry unlocks the secrets of life and the world around us, saves lives, changes the environment, and fits into the tech startup ecosystem. Emphasizes modern illustrations of the power and wonder of chemistry. Subject can count toward the 9-unit discovery-focused credit limit for first year students.
J. Johnson

5.03 Principles of Inorganic Chemistry I
Prereq: 5.12
U (Spring)
5-0-7 units
Presents principles of chemical bonding and molecular structure, and their application to the chemistry of representative elements of the periodic system.
D. Suess, Y. Surendranath

5.04 Principles of Inorganic Chemistry II
Prereq: 5.03
U (Fall)
4-0-8 units
Systematic presentation of the chemical applications of group theory. Emphasis on the formal development of the subject and its applications to the physical methods of inorganic chemical compounds. Against the backdrop of electronic structure, the electronic, vibrational, and magnetic properties of transition metal complexes are presented and their investigation by the appropriate spectroscopy described.
A. Radosevich, Y. Surendranath

5.05 Principles of Inorganic Chemistry III
Prereq: 5.03; Coreq: 5.04
G (Fall)
2-0-4 units
Principles of main group (s and p block) element chemistry with an emphasis on synthesis, structure, bonding, and reaction mechanisms.
C. C. Cummins

5.061 Principles of Organometallic Chemistry
Prereq: 5.03
G (Spring; first half of term)
2-0-4 units
A comprehensive treatment of organometallic compounds of the transition metals with emphasis on structure, bonding, synthesis, and mechanism.
C. Cummins

5.062 Principles of Bioinorganic Chemistry
Prereq: 5.03
G (Fall; first half of term)
2-0-4 units
Delineates principles that form the basis for understanding how metal ions function in biology. Examples chosen from recent literature on a range of topics, including the global biogeochemical cycles of the elements; choice, uptake and assembly of metal-containing units; structure, function and biosynthesis of complex metallocofactors; electron-transfer and redox chemistry; atom and group transfer chemistry; protein tuning of metal properties; metalloprotein engineering and design; and applications to diagnosis and treatment of disease.
D. Suess
5.063 Organometallic Compounds in Catalytic Reactions
Prereq: 5.061
G (Spring; first half of term)
Not offered regularly; consult department
2-0-4 units

An exploration of organometallic chemistry from the perspective of catalytic reactions in organic and polymer chemistry.
C. Cummins

5.067 Crystal Structure Refinement
Prereq: 5.068, 5.069, or permission of instructor
G (Fall)
2-3-1 units

Practical aspects of crystal structure determination from data collection strategies to data reduction and basic and advanced refinement problems of organic and inorganic molecules.
P. Mueller

5.068 Physical Inorganic Chemistry
Prereq: 5.03 and 5.04
Acad Year 2019-2020: G (Spring; second half of term)
Acad Year 2020-2021: Not offered
3-0-3 units

Discusses the physical methods used to probe the electronic and geometric structures of inorganic compounds, with additional techniques employed in the characterization of inorganic solids and surfaces. Includes vibrational spectroscopy, solid state and solution magnetochemical methods, Mössbauer spectroscopy, electron paramagnetic resonance spectroscopy, electrochemical methods, and a brief survey of surface techniques. Applications to current research problems in inorganic and solid-state chemistry.
M. Dinca

5.069 Crystal Structure Analysis
Prereq: 5.03 and 5.04
G (Spring; first half of term)
2-0-4 units

Introduction to X-ray crystallography: symmetry in real and reciprocal space, space and Laue groups, geometry of diffraction, structure factors, phase problem, direct and Patterson methods, electron density maps, structure refinement, crystal growth, powder methods, limits of diffraction methods, structure data bases.
P. Mueller

5.07[J] Introduction to Biological Chemistry
Same subject as 20.507[J]
Prereq: 5.12
U (Fall)
5-0-7 units. REST
Credit cannot also be received for 7.05

Chemical and physical properties of the cell and its building blocks. Structures of proteins and principles of catalysis. The chemistry of organic/inorganic cofactors required for chemical transformations within the cell. Basic principles of metabolism and regulation in pathways, including glycolysis, gluconeogenesis, fatty acid synthesis/degradation, pentose phosphate pathway, Krebs cycle and oxidative phosphorylation, DNA replication, and transcription and translation.
E. Nolan

5.08[J] Biological Chemistry II
Same subject as 7.08[J]
Subject meets with 7.80
Prereq: 5.12 and (5.07[J] or 7.05)
U (Spring)
4-0-8 units

More advanced treatment of biochemical mechanisms that underlie biological processes. Topics include macromolecular machines such as the ribosome, the proteosome, fatty acid synthases as a paradigm for polyketide synthases and non-ribosomal polypeptide synthases, and polymerases. Emphasis is on experimental methods used to unravel these processes and how these processes fit into the cellular context and coordinate regulation.
B. Imperiali, L. Kiessling, R. Raines

5.111 Principles of Chemical Science
Prereq: None
U (Fall, Spring)
5-0-7 units. CHEMISTRY
Credit cannot also be received for 3.091, 5.112, CC.5111, ES.5111, ES.5112

Introduction to chemistry, with emphasis on basic principles of atomic and molecular electronic structure, thermodynamics, acid-base and redox equilibria, chemical kinetics, and catalysis. Introduction to the chemistry of biological, inorganic, and organic molecules.
K. Nelson, M. Shoulders M. Bawendi, B. Pentelute
5.112 Principles of Chemical Science
Prereq: None
U (Fall)
5-0-7 units. CHEMISTRY
Credit cannot also be received for 3.091, 5.111, CC.5111, ES.5111, ES.5112
Introduction to chemistry for students who have taken two or more years of high school chemistry or who have earned a score of at least 4 on the ETS Advanced Placement Exam. Emphasis on basic principles of atomic and molecular electronic structure, thermodynamics, acid-base and redox equilibria, chemical kinetics, and catalysis. Applications of basic principles to problems in metal coordination chemistry, organic chemistry, and biological chemistry.
S. Ceyer, M. Dinca

5.12 Organic Chemistry I
Prereq: Chemistry (GIR)
U (Fall, Spring)
5-0-7 units. REST
Credit cannot also be received for CC.512
Introduction to organic chemistry. Development of basic principles to understand the structure and reactivity of organic molecules. Emphasis on substitution and elimination reactions and chemistry of the carbonyl group. Introduction to the chemistry of aromatic compounds.
J. Johnson, R. Danheiser

5.13 Organic Chemistry II
Prereq: 5.12
U (Fall)
5-0-7 units
Focuses on synthesis, structure determination, mechanism, and the relationships between structure and reactivity. Selected topics illustrate the role of organic chemistry in biological systems and in the chemical industry.
M. Movassaghi

5.24[J] Archaeological Science
Same subject as 3.985[J], 12.011[J]
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 units. HASS-S
See description under subject 3.985[J].
H. N. Lechtman

5.301 Chemistry Laboratory Techniques
Prereq: Chemistry (GIR) and permission of instructor
U (IAP, Spring)
1-4-1 units
Practical training in basic chemistry laboratory techniques. Intended to provide students with the skills necessary to undertake original research projects in chemistry. Limited to first-year students in IAP (application required); open to all students in spring (enrollment by lottery).
J. Dolhun

5.302 Introduction to Experimental Chemistry
Prereq: None
U (IAP; partial term)
0-3-0 units
Illustrates fundamental principles of chemical science through practical experience with chemical phenomena. Students explore the theoretical concepts of chemistry through the experiments which informed their discovery, and make chemistry happen with activities that are intellectually stimulating and fun. Preference to first-year students.
J. Dolhun, M. Shoulders

5.310 Laboratory Chemistry
Prereq: None. Coreq: 5.12
U (Fall, Spring)
2-8-2 units. Institute LAB
Introduces experimental chemistry for students who are not majoring in Course 5. Principles and applications of chemical laboratory techniques, including preparation and analysis of chemical materials, measurement of pH, gas and liquid chromatography, visible-ultraviolet spectrophotometry, infrared spectroscopy, kinetics, data analysis, and elementary synthesis. Enrollment limited.
J. Dolhun
5.351 Fundamentals of Spectroscopy
Prereq: Chemistry (GIR)
U (Fall, Spring; partial term)
1-2-1 units. Partial Lab

Students carry out an experiment that introduces fundamental principles of the most common types of spectroscopy, including UV-visible absorption and fluorescence, infrared, and nuclear magnetic resonance. Emphasizes principles of how light interacts with matter, a fundamental and hands-on understanding of how spectrometers work, and what can be learned through spectroscopy about prototype molecules and materials. Students record and analyze spectra of small organic molecules, native and denatured proteins, semiconductor quantum dots, and laser crystals. Satisfies 4 units of Institute Laboratory credit.
K. Nelson

5.352 Synthesis of Coordination Compounds and Kinetics
Prereq: None. Coreq: 5.351
U (Fall, Spring; partial term)
1-2-2 units. Partial Lab

Students carry out an experiment that provides an introduction to the synthesis of simple coordination compounds and chemical kinetics. Illustrates cobalt coordination chemistry and its transformations as detected by visible spectroscopy. Students observe isosbestic points in visible spectra, determine the rate and rate law, measure the rate constant at several temperatures, and derive the activation energy for the aquation reaction. Satisfies 5 units of Institute Laboratory credit.
Y. Surendranath

5.353 Macromolecular Prodrugs
Prereq: None. Coreq: 5.12 and 5.352
U (Fall, Spring; partial term)
1-2-1 units. Partial Lab

Students carry out an experiment that builds skills in how to rationally design macromolecules for drug delivery based on fundamental principles of physical organic chemistry. Begins with conjugation of a drug molecule to a polymerizable group through a cleavable linker to generate a prodrug monomer. Continues with polymerization of monomer to produce macromolecular (i.e., polymer) prodrug; monomer and polymer prodrugs are fully characterized. Rate of drug release is measured and correlated to the size of the macromolecule as well as the structure of the cleavable linker. Satisfies 4 units of Institute Laboratory credit.
J. Johnson, K. Danahy

5.361 Expression and Purification of Enzyme Mutants
Prereq: (5.07[J] or 7.05) and (5.310 or 5.352)
U (Spring; partial term)
1-2-1 units

Students use biochemical techniques for protein expression and DNA manipulation of Bcr-Abl kinase, which is inhibited by the blockbuster drug Gleevec in the treatment of chronic myelogenous leukemia. Uses various standard bioanalytical and biochemical methods in lab to characterize and produce this protein.
B. Pentelute

5.362 Kinetics of Enzyme Inhibition
Prereq: (5.07[J] or 7.05) and (5.310 or 5.352); Coreq: 5.361
U (Spring; partial term)
1-2-2 units

Students study the activity and structure of the domains developed in 5.361 to understand the role of mutations in the development of resistance to Gleevec. Students assay both mutant and wild-type Abl kinase domains for phosphorylation activity to determine enzyme kinetics and the inhibition efficacy of Gleevec. They conduct additional testing on kinase activity of Gleevec-resistant mutants in the presence of other potential inhibitors. Uses structure-viewing programs to enable analysis of the mechanistic basis of Bcr-Abl inhibition and Gleevec-resistance.
B. Pentelute

5.363 Organic Structure Determination
Prereq: 5.12; Coreq: 5.13
U (Fall; partial term)
1-2-1 units. Partial Lab

Introduces modern methods for the elucidation of the structure of organic compounds. Students carry out transition metal-catalyzed coupling reactions, based on chemistry developed in the Buchwald laboratory, using reactants of unknown structure. Students also perform full spectroscopic characterization - by proton and carbon NMR, IR, and mass spectrometry of the reactants - and carry out coupling products in order to identify the structures of each compound. Other techniques include transfer and manipulation of organic and organometallic reagents and compounds, separation by extraction, and purification by column chromatography. Satisfies 4 units of Institute Laboratory credit.
S. Buchwald
5.371 Continuous Flow Chemistry: Sustainable Conversion of Reclaimed Vegetable Oil into Biodiesel
Prereq: 5.13 and 5.363
U (Spring; partial term)
1-2-1 units

Presents the theoretical and practical fundamentals of continuous flow synthesis, wherein pumps, tubes, and connectors are used to conduct chemical reactions instead of flasks, beakers, etc. Focuses on a catalytic reaction that converts natural vegetable oil into biodiesel that can be used in a variety of combustion engines. Provides instruction in several important organic chemistry experimental techniques, including purification by extraction, rotary evaporation, acid-base titration, gas chromatography (GC), and $^1$H NMR.

T. Jamison

5.372 Chemistry of Renewable Energy
Prereq: 5.03 and 5.352
U (Fall; partial term)
1-2-1 units

Introduces the electrochemical processes that underlie renewable energy storage and recovery. Students investigate charge transfer reactions at electrode surfaces that are critical to the operation of advanced batteries, fuel cells, and electrolyzers. Develops basic theory behind inner- and outer-sphere charge transfer reactions at interfaces and applies this theory to construct mechanistic models for important energy conversion reactions including the reduction of $O_2$ to water and the reduction of protons to $H_2$. Students will also synthesize new catalytic materials for these reactions and investigate their relative performance.

Y. Surendranath

5.373 Dinitrogen Cleavage
Prereq: 5.03 and 5.363; Coreq: 5.61
U (Fall; partial term)
1-2-1 units

Introduces the research area of small-molecule activation by transition-element complexes. Covers techniques such as glove-box methods for synthesis for exclusion of oxygen and water; filtration, reaction mixture concentration, and recrystallization under a dinitrogen atmosphere and under static vacuum. Characterization methods include proton NMR spectroscopy of both paramagnetic and diamagnetic systems, Evans method magnetic susceptibility measurement, UV-Vis spectroscopy, and infrared spectroscopy of a metal-nitrogen triple bond system.

C. Cummins

5.381 Quantum Dots
Prereq: 5.353 and 5.61
U (Spring; partial term)
1-2-1 units

Covers synthesis of a discrete size series of quantum dots, followed by synthesis of a single size of core/shell quantum dots utilizing air-free Schlenk manipulation of precursors. Uses characterization by absorption and fluorescence spectroscopies to rationalize the compositional/size dependence of the shell on the electronic structure of the quantum dots. Students acquire time traces of the fluorescence of single core and core/shell quantum dots using single molecule spectroscopic tools. The fluorescence on/off blinking distribution observed will be fit to a standard model. Students use Matlab for computational modeling of the electron and hole wavefunction in core and core/shell quantum dots. Analyzes several commercial applications of quantum dot technologies.

M. Bowendi

5.382 Time- and Frequency-resolved Spectroscopy of Photosynthesis
Prereq: 5.07[J], 5.61, or 7.05; Coreq: 5.361
U (Spring; partial term)
1-2-2 units

Uses time- and frequency-resolved fluorescence measurements to investigate photosynthetic light harvesting and energy transfer.

G. Schlau-Cohen

5.383 Fast-flow Peptide and Protein Synthesis
Prereq: 5.363 and (5.07[J] or 7.05)
U (Spring; partial term)
1-2-1 units

Develops understanding of both the theory and practice of fundamental techniques in biological chemistry, including chemical reactivity (amide-bond formation, solid phase synthesis, disulfide bond formation, and protecting group chemistry); separation science for purification and analysis, such as preparative HPLC and MALDI-TOF MS; and protein structure-function relationships (protein folding and binding). Periodically, guest lecturers from the local biotech research community will describe practical applications in industry.

B. Pentelute
5.39 Research and Communication in Chemistry
Prereq: An approved research experience and permission of instructor
U (Spring)
2-12-6 units

Independent research under the direction of a member of the Chemistry Department faculty. Allows students with a strong interest in independent research to fulfill part of the laboratory requirement for the Chemistry Department Program in the context of a research laboratory at MIT. The research must be conducted on the MIT campus and be a continuation of a previous 12-unit UROP project or full-time work over the summer. Instruction and practice in written and oral communication is provided, culminating in a poster presentation of the work at the annual departmental UROP symposium and a research publication-style writeup of the results. Permission of the faculty research supervisor and the Chemistry Education Office must be obtained in advance.
A. Radosevich

5.43 Advanced Organic Chemistry
Prereq: 5.13
U (Fall)
4-0-8 units
Credit cannot also be received for 5.53

Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates. Photochemistry and organometallic chemistry, with an emphasis on fundamental reactivity, mechanistic studies, and applications in organic chemistry.
T. Swager

5.44 Organometallic Chemistry
Prereq: 5.061, 5.43, 5.47, or permission of instructor
Acad Year 2019-2020: G (Spring; second half of term)
Acad Year 2020-2021: Not offered
2-0-4 units

Examination of the most important transformations of organotransition-metal species. Emphasizes basic mechanisms of their reactions, structure-reactivity relationships, and applications in synthesis.
Staff

5.45 Heterocyclic Chemistry
Prereq: 5.511 and 5.53
G (Spring; first half of term)
2-0-4 units

Provides an introduction to the chemistry of heterocyclic compounds. Surveys synthesis and reactivity of the major classes of heterocyclic organic compounds. Discusses the importance of these molecules in the pharmaceutical and other industries.
S. Buchwald

5.46 NMR Spectroscopy and Organic Structure Determination
Prereq: 5.43
G (Spring; first half of term)
2-0-4 units

Applications of 1-D and 2-D $^1$H and $^{13}$C NMR spectroscopy to organic structure determination.
W. Massefski

5.47 Tutorial in Organic Chemistry
Prereq: 5.43 and permission of instructor
G (Fall; partial term)
2-0-4 units

Systematic review of basic principles concerned with the structure and transformations of organic molecules. Problem-solving workshop format. The program is intended primarily for first-year graduate students with a strong interest in organic chemistry. Meets during the month of September.
R. L. Danheiser

5.511 Synthetic Organic Chemistry I
Prereq: 5.43
G (Fall; second half of term)
2-0-4 units

Introduction to the design of syntheses of complex organic compounds.
M. Movassaghi

5.512 Synthetic Organic Chemistry II
Prereq: 5.511
G (Spring; second half of term)
Not offered regularly; consult department
2-0-4 units

General methods and strategies for the synthesis of complex organic compounds.
Staff
5.52 Tutorial in Chemical Biology
Prereq: Permission of instructor
G (Fall)
2-2-8 units

Provides an overview of the core principles of chemistry that underlie biological systems. Students explore research topics and methods in chemical biology by participating in laboratory rotations, then present on experiments performed during each rotation. Intended for first-year graduate students with a strong interest in chemical biology.

R. Raines

5.53 Molecular Structure and Reactivity
Prereq: 5.13 and 5.60
G (Fall; partial term)
3-0-6 units

Credit cannot also be received for 5.43

Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates.

A. Wendlandt

5.54[J] Frontiers in Chemical Biology
Same subject as 7.540[J], 20.554[J]
Prereq: 5.07[J], 5.13, 7.06, and permission of instructor
G (Fall)
3-0-9 units

Introduction to current research at the interface of chemistry, biology, and bioengineering. Topics include imaging of biological processes, metabolic pathway engineering, protein engineering, mechanisms of DNA damage, RNA structure and function, macromolecular machines, protein misfolding and disease, metabonomics, and methods for analyzing signaling network dynamics. Lectures are interspersed with class discussions and student presentations based on current literature.

L. Kiessling, M. Shoulders

5.56 Molecular Structure and Reactivity II
Prereq: 5.53 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring; second half of term)
2-0-4 units

Application of physical principles and methods to contemporary problems of interest in organic and polymer chemistry.

J. Johnson

5.561 Chemistry in Industry
Prereq: 5.03, 5.13, and (5.07[J] or 7.05)
G (Spring; second half of term)
2-0-4 units

Examination of recent advances in organic, biological, and inorganic and physical chemical research in industry. Taught in seminar format with participation by scientists from industrial research laboratories.

R. L. Danheiser

5.60 Thermodynamics and Kinetics
Prereq: Calculus II (GIR) and Chemistry (GIR)
U (Fall, Spring)
5-0-7 units. REST

Equilibrium properties of macroscopic systems. Basic thermodynamics: state of a system, state variables. Work, heat, first law of thermodynamics, thermochemistry. Second and third law of thermodynamics: entropy and free energy, including the molecular basis for these thermodynamic functions. Phase equilibrium and properties of solutions. Chemical equilibrium of reactions in gas and solution phases. Rates of chemical reactions. Special attention to thermodynamics related to global energy issues. Meets with 5.601 first half of term and 5.602 second half of term. Credit cannot also be received for 5.601 or 5.602.

M. Bawendi, A. Shalek, T. Van Voorhis, B. Zhang

5.601 Thermodynamics I
Prereq: Calculus II (GIR) and Chemistry (GIR)
U (Fall, Spring; first half of term)
2-0-4 units

Basic thermodynamics: state of a system, state variables. Work, heat, first law of thermodynamics, thermochemistry. Second and third law of thermodynamics: entropy and free energy, including the molecular basis for these thermodynamic functions. Equilibrium properties of macroscopic systems. Special attention to thermodynamics related to global energy issues and biological systems. Credit cannot also be received for 5.60. Combination of 5.601 and 5.602 counts as a REST subject.

A. Willard, W. Griffin
5.602 Thermodynamics II and Kinetics
Prereq: 5.601
U (Fall, Spring; second half of term)
2-0-4 units
Free energy and chemical potential. Phase equilibrium and properties of solutions. Chemical equilibrium of reactions. Rates of chemical reactions. Special attention to thermodynamics related to global energy issues and biological systems. Credit cannot also be received for 5.60. Combination of 5.601 and 5.602 counts as a REST subject.
Consult W. Griffin, A. Willard

5.61 Physical Chemistry
Prereq: Calculus II (GIR), Chemistry (GIR), and Physics II (GIR)
U (Fall)
5-0-7 units. REST
Introductory quantum chemistry; particles and waves; wave mechanics; atomic structure and the Periodic Table; valence and molecular orbital theory; molecular structure; and photochemistry. Meets with 5.611 first half of term and 5.612 second half of term. Credit cannot also be received for 5.611 or 5.612.
M. Hong, G. Schlau-Cohen

5.611 Introduction to Spectroscopy
Prereq: Calculus II (GIR), Chemistry (GIR), and Physics II (GIR)
U (Fall; first half of term)
2-0-4 units
Introductory quantum chemistry; particles and waves; wave mechanics; harmonic oscillator; applications to IR, Microwave and NMR spectroscopy. Meets with 5.61 first half of term. Combination of 5.611 and 5.612 counts as a REST subject.
M. Hong, G. Schlau-Cohen

5.612 Electronic Structure of Molecules
Prereq: 5.611
U (Fall; second half of term)
2-0-4 units
Introductory electronic structure; atomic structure and the Periodic Table; valence and molecular orbital theory; molecular structure, and photochemistry. Meets with 5.61 second half of term. Credit cannot also be received for 5.61. Combination of 5.611 and 5.612 counts as a REST subject.
M. Hong, G. Schlau-Cohen

5.62 Physical Chemistry
Prereq: 5.60 and 5.61
U (Spring)
4-0-8 units
Elementary statistical mechanics; transport properties; kinetic theory; solid state; reaction rate theory; and chemical reaction dynamics.
J. Cao, S. Ceyer

5.64[J] Frontiers of Interdisciplinary Science in Human Health and Disease
Same subject as HST.539[J]
Prereq: 5.13, 5.60, and (5.07[J] or 7.05)
G (Spring)
3-0-9 units
Introduces major principles, concepts, and clinical applications of biophysics, biophysical chemistry, and systems biology. Emphasizes biological macromolecular interactions, biochemical reaction dynamics, and genomics. Discusses current technological frontiers and areas of active research at the interface of basic and clinical science. Provides integrated, interdisciplinary training and core experimental and computational methods in molecular biochemistry and genomics.
A. Shalek

5.68[J] Kinetics of Chemical Reactions
Same subject as 10.652[J]
Prereq: 5.62, 10.37, or 10.65
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units
Experimental and theoretical aspects of chemical reaction kinetics, including transition-state theories, molecular beam scattering, classical techniques, quantum and statistical mechanical estimation of rate constants, pressure-dependence and chemical activation, modeling complex reacting mixtures, and uncertainty/sensitivity analyses. Reactions in the gas phase, liquid phase, and on surfaces are discussed with examples drawn from atmospheric, combustion, industrial, catalytic, and biological chemistry.
W. H. Green
5.697[J] Computational Chemistry
Same subject as 10.437[J]
Subject meets with 5.698[J], 10.637[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
See description under subject 10.437[J].
H. J. Kulik

5.698[J] Quantum Chemical Simulation
Same subject as 10.637[J]
Subject meets with 5.697[J], 10.437[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 10.637[J].
H. J. Kulik

5.70[J] Statistical Thermodynamics
Same subject as 10.546[J]
Prereq: 5.60 or permission of instructor
G (Fall)
3-0-9 units
Develops classical equilibrium statistical mechanical concepts for application to chemical physics problems. Basic concepts of ensemble theory formulated on the basis of thermodynamic fluctuations. Examples of applications include Ising models, lattice models of binding, ionic and non-ionic solutions, liquid theory, polymer and protein conformations, phase transition, and pattern formation. Introduces computational techniques with examples of liquid and polymer simulations.
J. Cao, B. Zhang

5.72 Statistical Mechanics
Prereq: 5.70[J] or permission of instructor
Acad Year 2019-2020: G (Spring; second half of term)
Acad Year 2020-2021: Not offered
2-0-4 units
J. Cao

5.73 Introductory Quantum Mechanics I
Prereq: 5.61, 8.03, and 18.03
G (Fall)
3-0-9 units
Presents the fundamental concepts of quantum mechanics: wave properties, uncertainty principles, Schrödinger equation, and operator and matrix methods. Includes applications to one-dimensional potentials (harmonic oscillator), three-dimensional centrosymmetric potentials (hydrogen atom), and angular momentum and spin. Approximation methods include WKB, variational principle, and perturbation theory.
M. Bawendi

5.74 Introductory Quantum Mechanics II
Prereq: 5.73
G (Spring)
3-0-9 units
Time-dependent quantum mechanics and spectroscopy. Topics include perturbation theory, two-level systems, light-matter interactions, relaxation in quantum systems, correlation functions and linear response theory, and nonlinear spectroscopy.
K. Nelson, G. Schlau-Cohen

5.78 Biophysical Chemistry Techniques
Subject meets with 7.71
Prereq: 5.07[J] or 7.05
G (Spring)
2-0-4 units
Presents principles of macromolecular crystallography that are essential for structure determinations. Topics include crystallization, diffraction theory, symmetry and space groups, data collection, phase determination methods, model building, and refinement. Discussion of crystallography theory complemented with exercises such as crystallization, data processing, and model building. Meets with 7.71 when offered concurrently. Enrollment limited.
C. Drennan

5.80 Advanced Topics of Current Special Interest
Prereq: None
G (Fall, Spring)
Units arranged
Advanced topics of current special interest.
Staff
5.83 Advanced NMR Spectroscopy
Prereq: 5.73 or permission of instructor
Acad Year 2019-2020: G (Spring; second half of term)
Acad Year 2020-2021: Not offered
2-0-4 units

Offers a classical and quantum mechanical description of nuclear magnetic resonance (NMR) spectroscopy. The former includes key concepts such as nuclear spin magnetic moment, Larmor precession, Bloch equations, the rotating frame, radio-frequency pulses, vector model of pulsed NMR, Fourier transformation in 1D and nD NMR, orientation dependence of nuclear spin frequencies, and NMR relaxation. The latter covers nuclear spin Hamiltonians, density operator and its time evolution, the interaction representation, Average Hamiltonian Theory for multi-pulse experiments, and analysis of some common pulse sequences in solution and solid-state NMR.

M. Hong

5.891 Independent Study in Chemistry for Undergraduates
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of independent study under direction of Chemistry faculty member. May not substitute for required courses for the Chemistry major or minor.

Staff

5.892 Independent Study in Chemistry for Undergraduates
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Program of independent study under direction of Chemistry faculty member. May not substitute for required courses for the Chemistry major or minor.

Staff

5.90 Problems in Chemistry
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Directed research and study of special chemical problems. For Chemistry graduate students only.

R. W. Field

5.913 Seminar in Organic Chemistry
Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 units
Can be repeated for credit.

Discusses current journal publications in organic chemistry.

R. L. Danheiser

5.921 Seminar in Chemical Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 units
Can be repeated for credit.

Discusses topics of current interest in chemical biology.

M. Shoulders

5.931 Seminar in Physical Chemistry
Prereq: 5.60
G (Fall, Spring)
2-0-1 units
Can be repeated for credit.

Discusses topics of current interest in physical chemistry.

A. Willard

5.941 Seminar in Inorganic Chemistry
Prereq: 5.03
G (Fall, Spring)
2-0-1 units
Can be repeated for credit.

Discusses current research in inorganic chemistry.

M. Dinca

5.95[J] Teaching College-Level Science and Engineering
Same subject as 1.95[J], 7.59[J], 8.395[J], 18.094[J]
Subject meets with 2.978
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-0-2 units

Participatory seminar focuses on the knowledge and skills necessary for teaching science and engineering in higher education. Topics include theories of adult learning; course development; promoting active learning, problem solving, and critical thinking in students; communicating with a diverse student body; using educational technology to further learning; lecturing; creating effective tests and assignments; and assessment and evaluation. Students research and present a relevant topic of particular interest. Appropriate for both novices and those with teaching experience.

J. Rankin
**5.THG Graduate Thesis**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a PhD thesis; to be arranged by the student and an appropriate MIT faculty member.

*R. W. Field*

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**5.THU Undergraduate Thesis**
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of original research under supervision of a chemistry faculty member, culminating with the preparation of a thesis. Ordinarily requires equivalent of two terms of research with chemistry department faculty member.

*Staff*

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**5.UR Undergraduate Research**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Program of research to be arranged by the student and a departmental faculty member. Research can be applied toward undergraduate thesis.

*C. C. Cummins*

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**5.URG Undergraduate Research**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research to be arranged by the student and a departmental faculty member. May be taken for up to 12 units per term, not to exceed a cumulative total of 48 units. A 10-page paper summarizing research is required.

*C. C. Cummins*
CIVIL AND ENVIRONMENTAL ENGINEERING (COURSE 1)

Fundamentals

1.00 Engineering Computation and Data Science
Subject meets with 1.001
Prereq: Calculus I (GIR)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-2-7 units. REST

Presents engineering problems in a computational setting with emphasis on data science and problem abstraction. Introduces modern development tools, patterns, and libraries for distributed-asynchronous computing, including distributed hash tables, Merkle trees, PKI encryption and Zero Knowledge Proofs. Covers data cleaning and filtering, linear regression, and basic machine learning algorithms, such as clustering, classifiers, decision trees. Sharpens problem-solving skills in an active learning lab setting. In-class exercises and weekly assignments lead to a group project. Students taking graduate version complete additional assignments and project work.

1.001 Engineering Computation and Data Science
Subject meets with 1.00
Prereq: Calculus I (GIR)
G (Spring)
3-2-7 units

Presents engineering problems in a computational setting with emphasis on data science and problem abstraction. Introduces modern development tools, patterns, and libraries for distributed-asynchronous computing, including Distributed Hash Tables, Merkle trees, PKI encryption and Zero Knowledge Proofs. Covers data cleaning and filtering, linear regression, and basic machine learning algorithms, such as clustering, classifiers, decision trees. Sharpens problem-solving skills in an active learning lab setting. In-class exercises and weekly assignments lead to a group project. Students taking graduate version complete additional assignments and project work.

J. Williams

1.000 Computer Programming for Engineering Applications
Prereq: None. Coreq: 18.03
U (Fall)
3-2-7 units. REST

Presents the fundamentals of computing and computer programming (procedural and object-oriented programming) in an engineering context. Introduces logical operations, floating-point arithmetic, data structures, induction, iteration, and recursion. Computational methods for interpolation, regression, root finding, sorting, searching, and the solution of linear systems of equations and ordinary differential equations. Control of sensors and visualization of scientific data. Draws examples from engineering and scientific applications. Students use the MATLAB programming environment to complete weekly assignments.

R. Juanes

1.007 Big Engineering: Small Solutions with a Large Impact
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-3 units

Provides a practical introduction to key topics, current research and innovative methods in the diverse field of civil and environmental engineering. Discusses career opportunities, innovation, and entrepreneurship. Under faculty supervision, students work on projects in areas such as renewable energy, sustainable design, food security, climate change, and transportation. Projects focus on design of novel solutions to grand challenges related to infrastructure, systems and the environment, and include elements of the different areas to demonstrate the interconnectedness of the discipline. Preference to first-year students and Course 1 sophomores.

B. Marelli
**1.008 Solving Big Engineering Problems (New)**
Prereq: None
U (Fall)
2-1-0 units

Introduction to big engineering problems that span our built infrastructure and natural environment. Topics promote high-level thinking and basic problem-solving skills for societal problems in domains of civil and environmental engineering. Lectures based on case studies that emphasize key challenges and opportunities in areas of digital cities, cyber-physical infrastructure systems (transportation, logistics, power), engineering of natural resources (land, water, energy), and sustainable and resilient design under the changing environment. Students collaborate to identify basic modeling issues, explore analysis tools, and engage in teamwork to discuss the design and implementation of new technologies, policies, and systems in the real-world. Laboratory and field visits illustrate interesting natural phenomena and new engineering applications. Subject can count toward the 9-unit discovery-focused credit limit for first year students.

S. Amin

**1.009 Climate Change (New)**
Prereq: None
U (Fall)
1-0-2 units

Provides an introduction to global climate change processes, drivers, and impacts. Offers exposure to exciting MIT research on climate change. Students explore why and how the world should solve this global problem and how they can contribute to the solutions. Students produce a mini-project on the topic. Subject can count toward the 9-unit discovery-focused credit limit for first year students.

E. Eltahir

**1.010 Probability and Causal Inference**
Prereq: Calculus II (GIR)
U (Fall)
5-0-7 units

Introduces probability and causal inference with an emphasis on understanding, quantifying, and modeling uncertainty and cause-effect relationships in an engineering context. Topics in the first half include events and their probability, the total probability and Bayes’ theorems, discrete and continuous random variables and vectors, and conditional analysis. Topics in the second half include covariance, correlation, regression analysis, causality analysis, structural causal models, interventions, and hypothesis testing. Concepts illustrated through data and applications.

S. Saavedra

**1.013 Senior Civil and Environmental Engineering Design**
Prereq: Permission of instructor
U (Spring)
2-6-4 units

Students engage with faculty around a topic of mutual interest, building on the knowledge/skills gained throughout their program. Synthesizes prior coursework and experiences through a semester-long design project and related assignments. Students form teams to work on projects of their choosing, focusing in depth on the diverse areas within civil and environmental engineering. Teams demonstrate creativity in applying theories and methodologies while considering their project’s technical, environmental and social feasibility. Includes lectures on a variety of related engineering concepts, as well as scholarship and engineering practice and ethics. Provides instruction and practice in oral and written communication.

C. Harvey

**1.015[J] Design of Electromechanical Robotic Systems**
Same subject as 2.017[J]
Prereq: 2.003[J], 2.016, and 2.678; Coreq: 2.671
U (Spring)
3-3-6 units. Partial Lab

See description under subject 2.017[J]. Enrollment may be limited due to laboratory capacity.

M. Triantafyllou, T. Consi

**1.016[J] Design for Complex Environmental Issues: Building Solutions and Communicating Ideas**
Same subject as 2.00C[J], EC.746[J]
Prereq: None
U (Spring)
3-1-5 units

See description under subject 2.00C[J]. Limited to first-year students.

A. W. Epstein, S. L. Hsu
1.018[J] Fundamentals of Ecology
Same subject as 7.30[J], 12.031[J]
Prereq: None
U (Fall)
4-0-8 units. REST


M. Follows, D. Des Marais

1.020 Engineering Sustainability: Analysis and Design
Prereq: Physics I (GIR), 18.03, and (1.00 or 1.000)
U (Spring)
3-2-7 units

Introduces a systems approach to modeling, analysis, and design of sustainable systems. Covers principles of dynamical systems, network models, optimization, and control, with applications in ecosystems, infrastructure networks, and energy systems. Includes a significant programming component. Students implement and analyze numerical models of systems, and make design decisions to balance physical, environmental, and economic considerations based on real and simulated data.

S. Amin

1.021 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject.
Offered under: 1.021, 3.021, 10.333, 22.00
Prereq: 3.016B, 18.03, or permission of instructor
U (Spring)
4-0-8 units. REST

See description under subject 3.021.

M. Buehler, R. Gomez-Bombarelli

1.022 Introduction to Network Models
Prereq: (1.010, 18.03, and (1.00 or 1.000)) or permission of instructor
U (Fall)
4-0-8 units

Provides an introduction to complex networks, their structure, and function, with examples from engineering, applied mathematics and social sciences. Topics include spectral graph theory, notions of centrality, random graph models, contagion phenomena, cascades and diffusion, and opinion dynamics.

A. Jadbaie

1.032 Advanced Soil Mechanics
Subject meets with 1.361
Prereq: 1.037
U (Fall; first half of term)
3-0-6 units

Covers topics in the characterization and nature of soils as multiphase materials; the principle of effective stress; hydraulic conductivity and groundwater seepage; shear strength and stability analyses; stress-deformation properties, consolidation theory and calculation of settlements for clays and sands. Students taking graduate version complete additional assignments.

A. Whittle

1.035 Mechanics of Materials
Subject meets with 1.535
Prereq: 1.050 or permission of instructor
U (Spring)
3-2-7 units

Introduces the structure and properties of natural and manufactured building materials, including rheology elasticity, fracture mechanics, viscoelasticity and plasticity. Emphasizes effects of molecular and nanoscopic structure and interactions on macroscopic material behavior. Focuses on design of natural and structural materials. Discusses material aspects of sustainable development. Presents principles of experimental characterization techniques. Explores microscopic and macroscopic mechanical approaches to characterize structure and properties of materials. In laboratory and in-field sessions, students design and implement experimental approaches to characterize natural and building materials and study their interaction with the environment. Students taking graduate version complete additional assignments.

F. J. Ulm

1.036 Structural Mechanics and Design
Prereq: 1.035 and 1.050
U (Spring)
3-1-8 units

Familiarizes students with structural systems, loads, and basis for structural design, including analysis of determinate and indeterminate structures (trusses, beams, frames, cables, and arches). Covers mechanical properties of construction materials, including concrete, steel, and composites. Studies concrete and steel structures through application of principles of structural mechanics. Evaluates behavior and design of reinforced concrete structural elements using limit strength design and serviceability principles. Introduces plastic analysis and design, and load factor design of structural steel members and connections. Team project emphasizes material covered through behavior and problem-based learning.

O. Buyukozturk
1.037 Soil Mechanics and Geotechnical Design
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-2-7 units
Provides an introduction to soils as engineering materials, including classification and characterization, pore pressures and seepage, principles of effective stress and consolidation, deformation, and shear strength properties. Surveys analysis methods, with a focus on slope stability, limiting earth pressures and bearing capacity, and settlements of foundations. Examines applications in the design of earth dams, earth retaining systems, foundations, and staged construction processes.
A. Whittle

1.041 Transportation Systems Modeling
Prereq: 1.010 and (1.00 or 1.000)
U (Fall)
3-1-8 units
Introduces basic concepts of transportation systems modeling, data analysis and visualization techniques. Covers fundamental analytical and simulation-based methodologies. Topics include time-space diagrams, cumulative plots, queueing theory, network science, data analysis, and their applications. Provides students with an understanding of the current challenges and opportunities in different areas of transportation.
C. Osorio

1.050 Solid Mechanics
Prereq: Physics I (GIR); Coreq: Calculus II (GIR)
U (Fall)
3-2-7 units. REST
Basic principles of mechanics to describe the behavior of materials, structures and fluids. Dimensional analysis, conservation of momentum, static equilibrium, stress and stress states, hydrostatics, moments and forces. Material and structural strength criteria. Deformation and strain. Conservation of energy in solid mechanics, elasticity and elasticity bounds. Energy dissipation, plasticity and fracture. Open-ended geotechnical and structural engineering studio exercises and experiments with natural and man-made physical systems.
F. J. Ulm

1.053[J] Dynamics and Control I
Same subject as 2.003[J]
Prereq: Physics II (GIR); Coreq: 2.087 or 18.03
U (Fall, Spring)
4-1-7 units. REST
See description under subject 2.003[J].
J. K. Vandiver, N. C. Makris, N. M. Patrikalakis, T. Peacock, D. Gossard, K. Turitsyn

1.054 Mechanics and Design of Concrete Structures
Subject meets with 1.541
Prereq: 1.035
U (Fall)
3-0-9 units
Studies strength and deformation of concrete under various states of stress; failure criteria; concrete plasticity; and fracture mechanics concepts. Topics include fundamental behavior of reinforced concrete structural systems and their members; basis for design and code constraints; high-performance concrete materials and their use in innovative design solutions; and yield line theory for slabs. Uses behavior models and nonlinear analysis. Covers complex systems, including bridge structures, concrete shells, and containment.
O. Buyukozturk

1.056[J] Introduction to Structural Design
Same subject as 4.440[J]
Subject meets with 4.462
Prereq: Calculus II (GIR)
U (Spring)
3-3-6 units. REST
See description under subject 4.440[J].
Consult J. Carstensen

1.057 Heritage Science and Technology
Prereq: Permission of instructor
U (Fall)
2-3-4 units
Interdisciplinary, applied introduction to ancient materials and technology. Students explore materials sustainability and durability from multiple perspectives, using ancient societies, architecture and building materials as time-proven examples of innovation in construction. Involves discussions of peer-reviewed literature and cultural heritage, project formulation, data collection, and data analysis. Culminates in presentation of research project(s), and write-ups of the research in manuscript form.
A. Masic
1.058 Structural Dynamics
Subject meets with 1.581[J], 2.060[J], 16.221[J]
Prereq: 18.03 or permission of instructor
U (Fall)
3-0-9 units

Examines response of structures to dynamic excitation: free vibration, harmonic loads, pulses and earthquakes. Covers systems of single- and multiple-degree-of-freedom, up to the continuum limit, by exact and approximate methods. Includes applications to buildings, ships, aircraft and offshore structures. Students taking graduate version complete additional assignments.

T. Cohen

1.060 Fluid Mechanics
Subject meets with 1.060A
Prereq: None
U (Spring)
4-2-6 units


B. Marelli

1.060A Fluid Mechanics I
Subject meets with 1.060
Prereq: None. Coreq: 18.03; or permission of instructor
U (Spring; first half of term)
2-1-3 units


B. Marelli

1.061 Transport Processes in the Environment
Subject meets with 1.61
Prereq: 1.060
U (Fall)
3-1-8 units
Credit cannot also be received for 1.061A

Introduction to mass transport in environmental flows, with emphasis on river and lake systems. Covers derivation and solutions to the differential form of mass conservation equations, hydraulic models for environmental systems, residence time distribution, molecular and turbulent diffusion for continuous and point sources, boundary layers, dissolution, bed-water exchange, air-water exchange, and particle transport. Meets with 1.061A first half of term. Students taking graduate version complete additional assignments.

H. M. Nepf

1.061A Transport Processes in the Environment I
Prereq: 1.060A
U (Fall; first half of term)
2-1-3 units
Credit cannot also be received for 1.061, 1.61

Introduction to mass transport in environmental flows. Covers derivation and solution to the differential form of mass conservation, hydraulic models for environmental systems, residence time distribution, and molecular and turbulent diffusion for continuous and point sources. Meets with 1.061 first half of term.

H. Nepf

1.062[J] Nonlinear Dynamics: Continuum Systems
Same subject as 12.207[J], 18.354[J]
Subject meets with 18.3541
Prereq: Physics II (GIR) and (18.03 or 18.032)
U (Spring)
3-0-9 units

See description under subject 18.354[J].

J. Dunkel
1.063 Fluids and Diseases
Subject meets with 1.631[J], 2.250[J], HST.537[J]
Prereq: 18.03 or permission of instructor
U (Spring)
3-3-6 units

Designed for students in engineering and the quantitative sciences who want to explore applications of mathematics, physics and fluid dynamics to infectious diseases and health; and for students in epidemiology, environmental health, ecology, medicine, and systems modeling seeking to understand physical and spatial modeling, and the role of fluid dynamics and physical constraints on infectious diseases and pathologies. The first part of the class reviews modeling in epidemiology and data collection, and highlights concepts of spatial modeling and heterogeneity. The remainder highlights multi-scale dynamics, the role of fluids and fluid dynamics in physiology, and pathology in a range of infectious diseases. The laboratory portion entails activities aimed at integrating applied learning with theoretical concepts discussed in lectures and covered in problem sets. Students taking graduate version complete additional assignments.

L. Bourouiba

1.064 Physical Limnology
Subject meets with 1.64
Prereq: 1.061
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Provides an introduction to physical processes occurring in lakes and shallow surface water systems with emphasis on mechanisms affecting fate and transport. Topics include internal waves, differential heating and cooling, boundary mixing, turbulent mixing, and influence of vegetation. Begins with a review of Navier-Stokes equation. Students taking graduate version complete additional assignments.

H. M. Nepf

1.068 Nonlinear Dynamics and Turbulence
Subject meets with 1.686[J], 2.033[J], 18.358[J]
Prereq: 1.060A
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-2-7 units

Reviews theoretical notions of nonlinear dynamics, instabilities, and waves with applications in fluid dynamics. Discusses hydrodynamic instabilities leading to flow destabilization and transition to turbulence. Focuses on physical turbulence and mixing from homogeneous isotropic turbulence. Also covers topics such as rotating and stratified flows as they arise in the environment, wave-turbulence, and point source turbulent flows. Laboratory activities integrate theoretical concepts covered in lectures and problem sets. Students taking graduate version complete additional assignments.

L. Bourouiba

1.070A[J] Introduction to Hydrology and Water Resources
Same subject as 12.320A[J]
Prereq: 1.060A; Coreq: 1.061A and 1.106
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall; first half of term)
2-0-4 units

Water in the environment; Water resource systems; The hydrologic cycle at its role in the climate system; Surface water and energy balance; evaporation and transpiration through vegetation; Precipitation formation, infiltration, storm runoff, and flood processes; Groundwater aquifers, subsurface flow and the hydraulics of wells.

D. Entekhabi

1.070B[J] Introduction to Hydrology Modeling
Same subject as 12.320B[J]
Prereq: 1.070A[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall; second half of term)
2-0-4 units

Develops understanding of numerical modeling of aquifers, groundwater flow and contaminant transport, as well as uncertainty and risk analysis for water resources.

D. Entekhabi
1.071[J] Global Change Science
Same subject as 12.300[J]
Prereq: 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Introduces the basic relevant principles and concepts in atmospheric physics, climate dynamics, biogeochemistry, and water and energy balance at the land-atmosphere boundary, through an examination of two current problems in the global environment: carbon dioxide and global warming; and tropical deforestation and regional climate. An introduction to global environmental problems for students in basic sciences and engineering.
E. A. B. Eltahir

1.072 Groundwater Hydrology
Subject meets with 1.72
Prereq: 1.061
U (Spring)
3-1-8 units
Presents the fundamentals of subsurface flow and transport, emphasizing the role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater. Topics include Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, storage properties, regional circulation, unsaturated flow, recharge, stream-aquifer interaction, well hydraulics, flow through fractured rock, numerical models, groundwater quality, contaminant transport processes, dispersion, decay, and adsorption. Includes laboratory and computer demonstrations. Students taking graduate version complete additional assignments.
C. Harvey

1.073 Introduction to Environmental Data Analysis
Prereq: 1.010
U (Spring; first half of term)
2-0-4 units
Covers theory and practical methods for the analysis of univariate data sets. Topics include basics of statistical inference, analysis of trends and stationarity; Gaussian stochastic processes, covariance and correlation analysis, and introduction to spectral analysis. Students analyze data collected from the civil, environment, and systems domains.
E. Eltahir

1.074 Multivariate Data Analysis
Prereq: 1.010
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring; first half of term)
2-0-4 units
Introduction to statistical multivariate analysis methods and their applications to analyze data and mathematical models. Topics include sampling, experimental design, regression analysis, specification testing, dimension reduction, categorical data analysis, classification and clustering.

1.075 Water Resource Systems
Subject meets with 1.731
Prereq: 1.070B[J] or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Surveys optimization and simulation methods for management of water resources. Case studies illustrate linear, quadratic, nonlinear programming and real-time control. Applications include river basin planning, irrigation and agriculture, reservoir operations, capacity expansion, assimilation of remote sensing data, and sustainable resource development. Students taking graduate version complete additional assignments.
D. McLaughlin

1.078 Soil and Environmental Biogeochemistry
Subject meets with 1.78
Prereq: None
U (Fall)
Not offered regularly; consult department
3-2-7 units
Presents the physical, chemical, biological and genetic properties of soils, their global distribution, and response to management. Introduces Earth’s different soil types and their classification; links characteristics with contemporary and historic issues surrounding natural and managed soil systems. Emphasizes soil chemical processes controlling the cycling and fate of soil nutrients and contaminants, including chemical equilibria in soils and natural waters, reduction-oxidation, mineral surface chemistry and precipitation-dissolution reactions. Introduces coupled physical-chemical-biological soil processes that control the transport of porewater constituents. Topics include soil carbon cycling, water and fertilizer management, and challenges associated with soil salinity-sodicity, erosion, and pollution. Students taking graduate version complete a laboratory-based project.
B. Kocar
1.079 Rock-on-a-Chip: Microfluidic Technology for Visualization of Flow in Porous Media
Subject meets with 1.79
Prereq: (Physics II (GIR), 1.050, 1.060, and (1.00, 1.000, or 6.0002)) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-2-8 units
Introduces an innovative approach that uses 3D printing and microfluidic technology to characterize and visualize flow in porous media like soils and rocks. Covers single-phase flow and transport (laser fluorescence, particle image velocimetry), capillarity and wettability, multiphase flow, fracturing of granular media. In lab, students work in groups to unravel the physics and chemistry of flow in porous media, with applications to energy and environmental processes, such as groundwater resources, energy recovery, and carbon sequestration. Students taking graduate version complete additional assignments. Enrollment limited; preference to Course 1 majors and Energy Studies minors.
R. Juanes

1.080 Environmental Chemistry
Prereq: Chemistry (GIR)
U (Spring)
4-0-8 units
Introduces environmental chemistry with a focus on using thermodynamics to understand processes governing chemical behaviors in natural and engineered systems. Topics include vaporization, gas-solution partitioning, salt and mineral dissolution/precipitation, acid-base chemistry, metal complexation, adsorption via ion exchange, and absorption within natural organic matter and organism tissues. Process formulations are combined in box models to compare with observations. Covers intermediate topics in environmental chemistry requiring kinetics to understand processes governing biogeochemical behaviors in natural and engineered systems. Topics include atmospheric oxidations, radiochemistry, mass transfers, and catalysis. Combines an introduction to geochemical modeling, using transport and transformation process formulations in chemical fate models, to compare with observations of concentrations as a function of space and time.
P. Gschwend

1.081[J] Environmental Cancer Risks, Prevention, and Therapy
Same subject as 20.104[J]
Prereq: Biology (GIR), Calculus II (GIR), and Chemistry (GIR)
U (Spring)
3-0-9 units
See description under subject 20.104[J].
W. Thilly, R. McCunney

1.082 Ethics for Engineers
Engineering School-Wide Elective Subject.
Offered under: 1.082, 2.900, 6.904, 10.01, 16.676, 22.014
Subject meets with 6.9041, 20.005
Prereq: None
U (Fall, Spring)
2-0-4 units
See description under subject 10.01.
D. Doneson, B. L. Trout

1.084[J] Applied Microbiology
Same subject as 20.106[J]
Prereq: Biology (GIR) and Chemistry (GIR)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
See description under subject 20.106[J].
J. C. Niles, K. Ribbeck

1.085[J] Air Pollution and Atmospheric Chemistry
Same subject as 12.336[J]
Prereq: 18.03
U (Fall)
3-0-9 units
Provides a working knowledge of basic air quality issues, with emphasis on a multidisciplinary approach to investigating the sources and effects of pollution. Topics include emission sources; atmospheric chemistry and removal processes; meteorological phenomena and their impact on pollution transport at local to global scales; air pollution control technologies; health effects; and regulatory standards. Discusses regional and global issues, such as acid rain, ozone depletion and air quality connections to climate change.
C. Heald
1.087 Ecological Dynamics and Modeling
Subject meets with 1.873
Prereq: 18.06
U (Spring)
3-0-9 units

Centers on mathematical tools linking external perturbations with the structure and persistence of ecological communities - the ensemble of co-occurring and interacting species. Focuses on unstructured populations ranging from single, to pairs, to multiple species. Covers population dynamics, species interactions, stability, feasibility, species coexistence, and perturbations. Lectures address phenomenological and mechanistic understanding through graphical, analytical and numerical analysis. Students taking graduate version complete additional assignments. 
S. Saavedra

1.089 Earth's Microbiomes
Subject meets with 1.89
Prereq: Biology (GIR)
U (Spring)
3-0-9 units

Provides a general introduction to the diverse roles of microorganisms in natural and artificial environments. Topics include energetics and growth, evolution and gene flow, population and community dynamics, water and soil microbiology, biogeochemical cycling, and microorganisms in biodeterioration and bioremediation. 7.014 recommended as prerequisite; students taking graduate version complete additional assignments. 
M. Polz, O. Cordero

1.091 Traveling Research Environmental eXperience (TREX): Fieldwork
Prereq: Permission of instructor
U (IAP)
1-2-0 units

Introduction to environmental fieldwork and research, with a focus on data collection and analysis. Subject spans three weeks, including two weeks of fieldwork, and involves one or more projects central to environmental science and engineering. Location varies year-to-year, though recent projects have focused on the island of Hawaii. Limited to Course 1 students. 
B. Kocar

1.092 Traveling Research Environmental eXperience (TREX): Fieldwork Analysis and Communication
Prereq: 1.091
U (Spring)
1-3-5 units

Building on fieldwork and research conducted in 1.091 over IAP, students focus on interpretation of results and research in support of the fieldwork, with instruction and practice in oral and written communication. Includes a survey of the relevant peer-reviewed literature; laboratory measurements of field samples and/or instrumental response; data analysis and interpretation; and dissemination of results. Culminates in presentation of research project(s), and write-ups of the research in manuscript form. Sequence of 1.091 and 1.092 must be completed in consecutive terms. Limited to Course 1 majors and minors. 
B. Kocar

1.097 Introduction to Civil and Environmental Engineering Research
Prereq: None
U (IAP)
1-5-0 units

Students work one-on-one with a CEE graduate student or postdoc mentor on a project that aligns with their research interests. Previous project topics include transportation networks, structural mechanics, sediment transport, climate science, and microbial ecology. Includes weekly seminar-style talks. Intended for first-year students. 
Staff

Undergraduate Laboratory Subjects

1.101 Introduction to Civil and Environmental Engineering Design I
Prereq: None
U (Fall)
0-4-2 units. Partial Lab

Introduces the creative design process in the context of civil and environmental engineering. Emphasizes the idea-to-product trajectory: identification of a design question/problem, evaluation of requirements/constraints set by the application and/or client, and implementation into a concrete product deliverable. Fosters active learning through open-ended, student-driven projects in which teams apply the design process to a design/planning problem. In labs, students design and build a working model or an experiment that addresses a specific engineering aspect of their project. In addition to written and oral presentations, students start a web-based portfolio. Satisfies 6 units of Institute Laboratory credit. Enrollment limited; preference to Course 1 majors and minors. 
T. Cohen
1.102 Introduction to Civil and Environmental Engineering Design II
Prereq: 1.101 and (Physics II (GIR) or Coreq: 1.06a)
U (Spring)
1-3-2 units. Partial Lab

Project-oriented subject focused on the principles and practice of engineering design. Emphasis on construction and deployment of designs, plus performance testing used to determine if designs behave as expected. Includes a major team project involving use and application of sensors, as well as environmentally-friendly, and energy-effective or energy-producing designs. Develops practical, teamwork and communication skills. Satisfies 6 units of Institute Laboratory credit. Enrollment limited; preference to Course 1 majors and minors.
A. Masic

1.106 Environmental Fluid Transport Processes and Hydrology Laboratory
Prereq: None. Coreq: 1.061A and 1.070A[J]
U (Fall)
0-4-2 units. Partial Lab

Fundamentals of mass transport and flow measurement in environmental systems. Topics include analysis of measurement uncertainty, diffusion, dispersion, air-water exchange, dissolution, and porous media flow. Develops communication skills through the writing and revision of formal lab reports and short oral presentations. Satisfies 6 units of Institute Laboratory credit. Enrollment limited; preference to 1-ENG majors and minors.
H. Nepf, D. Entekhabi

1.107 Environmental Chemistry Laboratory
Prereq: None. Coreq: 1.080
U (Spring)
0-4-2 units. Partial Lab

Laboratory and field techniques in environmental engineering and its application to the understanding of natural and engineered ecosystems. Exercises involve data collection and analysis covering a range of topics, spanning all major domains of the environment (air, water, soils, and sediments), and using a number of modern environmental analytical techniques. Instruction and practice in written and oral communication provided. Concludes with a student-designed final project, which is written up in the form of a scientific manuscript. Satisfies 6 units of Institute Laboratory credit. Enrollment limited; preference to 1-ENG.
D. Plata

Engineering Information Systems and Computation

1.124[J] Software and Computation for Simulation
Same subject as 2.091[J]
Prereq: 1.00 or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

Modern software development techniques and algorithms for engineering computation. Hands-on investigation of computational and software techniques for simulating engineering systems, such as sensor networks, traffic networks, and discrete simulation of materials using atomistic and particle methods. Covers data structures and algorithms for modeling, analysis, and visualization in the setting of multi-core and distributed computing. Treatment of basic topics, such as queuing, sorting and search algorithms, and more advanced numerical techniques based on state machines and distributed agents. Foundation for in-depth exploration of image processing, optimization, finite element and particle methods, computational materials, discrete element methods, and network methods. Knowledge of an object-oriented language required.
J. R. Williams

1.125 Architecting and Engineering Software Systems
Prereq: None
G (Fall)
3-0-9 units

Software architecting and design of cloud-based software-intensive systems. Targeted at future engineering managers who must understand both the business and technical issues involved in architecting enterprise-scale systems. Student teams confront technically challenging problems. Introduces modern dev-ops concepts and cloud-computing, including cloud orchestration for machine learning. Also discusses cyber-security issues of key management and use of encrypted messaging for distributed ledgers, e.g., blockchain. Students face problem solving in an active learning lab setting, completing in-class exercises and weekly assignments leading to a group project. Some programming experience preferred. Enrollment limited.
J. Williams

1.126[J] Pattern Recognition and Analysis
Same subject as MAS.622[J]
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

See description under subject MAS.622[J]. Limited to 20.
R. W. Picard
1.128[J] Computational Geometry
Same subject as 2.089[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
See description under subject 2.089[J].
N. M. Patrikalakis, D. C. Gossard

Engineering Analysis Methods

1.138[J] Wave Propagation
Same subject as 2.062[J], 18.376[J]
Prereq: 2.003[J] and 18.075
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
See description under subject 2.062[J].
T. R. Akylas, R. R. Rosales

Engineering Systems, Economics, and Optimization

1.142[J] Robust Modeling, Optimization, and Computation
Same subject as 15.094[J]
Prereq: 18.06 or permission of instructor
G (Spring)
4-0-8 units
See description under subject 15.094[J].
D. Bertsimas

1.146 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject.
Offered under: 1.146, 16.861, IDS.332
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Credit cannot also be received for IDS.333
See description under subject IDS.332. Enrollment limited.
R. de Neufville

Transportation

1.200[J] Transportation Systems Analysis: Performance and Optimization
Same subject as 11.544[J]
Prereq: 1.010 and permission of instructor
G (Spring)
3-1-8 units
Problem-motivated introduction to methods, models and tools for the analysis and design of transportation networks including their planning, operations and control. Capacity of critical elements of transportation networks. Traffic flows and deterministic and probabilistic delay models. Formulation of optimization models for planning and scheduling of freight, transit and airline systems, and their solution using software packages. User- and system-optimal traffic assignment. Control of traffic flows on highways, urban grids, and airspace.
C. Osorio

1.201[J] Transportation Systems Analysis: Demand and Economics
Same subject as 11.545[J]
Prereq: Permission of instructor
G (Spring)
3-1-8 units
Covers the key principles governing transportation systems planning and management. Introduces the microeconomic concepts central to transportation systems. Topics include economic theories of the firm, consumer, and market, demand models, discrete choice analysis, cost models and production functions, and pricing theory. Applications to transportation systems - including congestion pricing, technological change, resource allocation, market structure and regulation, revenue forecasting, public and private transportation finance, and project evaluation - cover urban passenger transportation, freight, maritime, aviation, and intelligent transportation systems.
Staff
1.202 Demand Modeling  
Prereq: 1.201[J] or permission of instructor  
G (Spring)  
3-1-8 units  
Theory and application of modeling and statistical methods for analysis and forecasting of demand for facilities, services, and products. Topics include: review of probability and statistics, estimation and testing of linear regression models, theory of individual choice behavior, derivation, estimation, and testing of discrete choice models (including logit, nested logit, GEV, probit, and mixture models), estimation under various sample designs and data collection methods (including revealed and stated preferences), sampling, aggregate forecasting methods, and iterative proportional fitting and related methods. Lectures reinforced with case studies, which require specification, estimation, testing, and analysis of models using data sets from actual applications.  
Staff

Same subject as 15.073[J], IDS.700[J]  
Prereq: 6.041B or 18.600  
G (Fall)  
3-0-9 units  
A vigorous use of probabilistic models to approximate real-life situations in Finance, Operations Management, Economics, and Operations Research. Emphasis on how to develop a suitable probabilistic model in a given setting and, merging probability with statistics, and on how to validate a proposed model against empirical evidence. Extensive treatment of Monte Carlo simulation for modeling random processes when analytic solutions are unattainable.  
A. Barnett

1.205 Advanced Demand Modeling  
Prereq: 1.202 or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  
Advanced theories and applications of models for analysis and forecasting of users' behavior and demand for facilities, services, and products. Topics vary each year and typically include linear and nonlinear latent variable models, including structural equations and latent class models; estimation techniques with multiple data sources; joint discrete and continuous choice models; dynamic models; analysis of panel data; analysis of complex choices; estimation and forecasting with large choice sets; multidimensional probabilistic choice models; advanced choice models, including probit, logit mixtures, treatment of endogeneity, hybrid choice models, hidden Markov models, Monte Carlo simulation, Bayesian methods, survey design, sampling, model transferability, and use of stated preferences data. Term paper required.  
M. Ben-Akiva

1.208 Resilient Infrastructure Networks  
Prereq: 6.431 or 15.093[J]  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  
S. Amin
1.231[J] Planning and Design of Airport Systems
Same subject as 16.781[J], IDS.670[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Focuses on current practice, developing trends, and advanced concepts in airport design and planning. Considers economic, environmental, and other trade-offs related to airport location, as well as the impacts of emphasizing "green" measures. Includes an analysis of the effect of airline operations on airports. Topics include demand prediction, determination of airfield capacity, and estimation of levels of congestion; terminal design; the role of airports in the aviation and transportation system; access problems; optimal configuration of air transport networks and implications for airport development; and economics, financing, and institutional aspects. Special attention to international practice and developments.
R. de Neufville, A. R. Odoni

1.232[J] The Airline Industry
Same subject as 15.054[J], 16.71[J]
Prereq: None
G (Fall)
3-0-9 units
See description under subject 16.71[J].
P. P. Belobaba, H. Balakrishnan, A. I. Barnett, R. J. Hansman, T. A. Kochan

1.233[J] Air Transportation Operations Research
Same subject as 16.763[J]
Prereq: 6.431, 15.093[J], 16.71[J], or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 16.763[J].
H. Balakrishnan, C. Barnhart, P. P. Belobaba

1.234[J] Airline Management
Same subject as 16.75[J]
Prereq: 16.71[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
See description under subject 16.75[J].
P. P. Belobaba

1.251[J] Comparative Land Use and Transportation Planning
Same subject as 11.526[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
See description under subject 11.526[J].
C. Zegras

1.253[J] Transportation Policy, the Environment, and Livable Communities
Same subject as 11.543[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
See description under subject 11.543[J].
J. Coughlin

1.260[J] Logistics Systems
Same subject as 15.770[J], IDS.730[J], SCM.260[J]
Subject meets with SCM.271
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject SCM.260[J].
Y. Sheffi, C. Caplice

1.261[J] Case Studies in Logistics and Supply Chain Management
Same subject as 15.771[J], SCM.261[J]
Prereq: Permission of instructor
G (Spring)
3-0-6 units
See description under subject SCM.261[J].
J. Byrnes

1.263[J] Urban Last-Mile Logistics
Same subject as 11.263[J], SCM.293[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units
See description under subject SCM.293[J].
M. Winkenbach
1.265[J] Global Supply Chain Management
Same subject as 2.965[J], 15.765[J], SCM.265[J]
Prereq: 15.761, 15.778, SCM.260[J], SCM.261[J], or permission of instructor
G (Spring)
Not offered regularly; consult department
2-0-4 units
See description under subject SCM.265[J].

Staff

1.27 Studies in Transportation
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual advanced study of a topic in transportation systems, selected with the approval of the instructor.

Staff

Same subject as 15.764[J], IDS.250[J]
Prereq: (6.436[J] and (6.251[J] or 6.251[J])) or permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.
See description under subject 15.764[J].
D. Simchi-Levi, N. Trichakis, K. Zheng

1.273[J] Supply Chain Planning
Same subject as 15.762[J], IDS.735[J]
Prereq: 15.761 or SCM.260[J]
G (Spring; first half of term)
2-0-4 units
See description under subject 15.762[J].
D. Simchi-Levi

1.274[J] Manufacturing System and Supply Chain Design
Same subject as 15.763[J], IDS.736[J]
Prereq: 15.761, 15.778, or SCM.260[J]
G (Spring; second half of term)
2-0-4 units
See description under subject 15.763[J].
D. Simchi-Levi

1.275[J] Business and Operations Analytics
Same subject as IDS.305[J]
Prereq: Permission of instructor
G (Spring; first half of term)
2-0-4 units
See description under subject IDS.305[J].
D. Simchi-Levi

1.278[J] Analyzing and Accounting for Regional Economic Change
Same subject as 11.481[J]
Prereq: 14.03 and 14.04
G (Spring)
Not offered regularly; consult department
3-0-9 units
See description under subject 11.481[J].

Staff

1.285[J] Regional Socioeconomic Impact Analyses and Modeling
Same subject as 11.482[J]
Prereq: 11.481[J] or permission of instructor
G (Fall)
Not offered regularly; consult department
2-1-9 units
See description under subject 11.482[J].
K. R. Polenske

Same subject as 11.477[J]
Subject meets with 11.165
Prereq: 11.203, 14.01, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 11.477[J].
D. Hsu
Geoenvironmental and Geotechnical Engineering

1.322 Soil Behavior
Prereq: 1.361
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units

Detailed study of soil properties with emphasis on interpretation of field and laboratory test data and their use in soft-ground construction engineering. Includes: consolidation and secondary compression; basic strength principles; stress-strain strength behavior of clays, emphasizing effects of sample disturbance, anisotropy, and strain rate; strength and compression of granular soils; and engineering properties of compacted soils. Some knowledge of field and laboratory testing assumed; 1.37 desirable.
A. J. Whittle

1.351 Theoretical Soil Mechanics
Prereq: 1.361
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

A. J. Whittle

1.361 Advanced Soil Mechanics
Subject meets with 1.032
Prereq: 1.036
G (Fall; first half of term)
3-0-6 units

Covers topics in the characterization and nature of soils as multiphase materials; the principle of effective stress; hydraulic conductivity and groundwater seepage; shear strength and stability analyses; stress-deformation properties, consolidation theory and calculation of settlements for clays and sands.
A. Whittle

1.364 Advanced Geotechnical Engineering
Prereq: 1.361
G (Fall; second half of term)
3-0-6 units

Methodology for site characterization and geotechnical aspects of the design and construction of foundation systems. Topics include site investigation (with emphasis on in situ testing), shallow (footings and rafts) and deep (piles and caissons) foundations, excavation support systems, groundwater control, slope stability, soil improvement (compaction, soil reinforcement, etc.), and construction monitoring.
A. Whittle

1.38 Engineering Geology
Prereq:Permission of instructor
G (Fall)
3-1-8 units

Studies the effect of geologic features and processes on constructed facilities; interaction between the geologic environment and man-made structures, and human activities in general. Planning of subsurface exploration. Engineering geologic characterization of soil and rock, including joint surveys and aspects of sedimented and residual soils. Laboratory on basic geologic identification and mapping techniques. Extensive reading of case histories. Field trip.
H. H. Einstein

1.381 Rock Mechanics
Prereq: 1.361 and 1.38
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Introduces theoretical and experimental aspects of rock mechanics and prepares students for rock engineering. Includes review of laboratory and field testing; empirical and analytical methods for describing strength, deformability and conductivity of intact rock and rock masses; fracture mechanics and mechanics of discontinua, including flow through discontinua and hydraulic fracturing; and design and analysis of rock slopes and foundations on rock. Also discusses blasting design. Includes term paper/term project.
H. H. Einstein
1.383 Underground Construction
Prereq: 1.361, 1.38, or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-6 units
Provides familiarization with the most important aspects of planning, analysis, design, and construction of underground structures in soil and rock. Covers detailed engineering analysis and design, and major aspects of construction techniques and construction planning. Discusses general planning and economic problems. Includes a major design project involving all aspects of underground construction.

H. H. Einstein

1.39 Independent Study in Geotechnical Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

For graduate students desiring further individual study of topics in geotechnical engineering.
Information: A. J. Whittle

Materials and Structures

1.535 Mechanics of Materials
Subject meets with 1.035
Prereq: 1.050 or permission of instructor
G (Spring)
3-2-7 units
Introduces the structure and properties of natural and manufactured building materials, including rheology, elasticity, fracture mechanics, viscoelasticity, and plasticity. Emphasizes effects of molecular and nanoscopic structure, and interactions on macroscopic material behavior. Focuses on design of natural and structural materials. Discusses material aspects of sustainable development. Presents principles of experimental characterization techniques. Explores microscopic and macroscopic mechanical approaches to characterize structure and properties of materials. In laboratory and in-field sessions, students design and implement experimental approaches to characterize natural and building materials and study their interaction with the environment. Students taking graduate version complete additional assignments.

F. J. Ulm

Construction Engineering and Management

1.462[J] Entrepreneurship in Construction and Real Estate Development
Same subject as 11.345[J]
Prereq: Permission of instructor
G (Fall; first half of term)
2-0-4 units
See description under subject 11.345[J].

J. F. Kennedy

1.472[J] Innovative Project Delivery in the Public and Private Sectors
Same subject as 11.344[J]
Prereq: Permission of instructor
G (Spring; first half of term)
2-0-4 units
See description under subject 11.344[J].

C. M. Gordon
1.545 Atomistic Modeling and Simulation of Materials and Structures
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units
Covers multiscale atomistic modeling and simulation methods, with focus on mechanical properties (elasticity, plasticity, creep, fracture, fatigue) of a range of materials (metals, ceramics, proteins, biological materials, biomaterials). Topics include mechanics of materials (energy principles, nano-/micromechanics, deformation mechanisms, size effects, hierarchical biological structures) and atomistic modeling (chemistry, interatomic potentials, visualization, data analysis, numerical methods, supercomputing, algorithms). Includes an interactive computational project.

M. J. Buehler

1.562 Structural Design Project I
Prereq: None
G (Fall)
3-0-9 units
Students work in teams to design a long-span structure, emphasizing conceptual design and advanced structural analysis. Subject covers structural systems and construction methods, interdisciplinary collaboration, design strategies for resistance to static and dynamic loading, and simplified calculation methods to validate numerical simulations. Emphasis on oral and visual communication of engineering concepts and students present their projects to leading engineers for feedback.

G. Herning

1.563 Structural Design Project II
Prereq: None
G (Spring)
3-0-9 units
Students work in teams to design a tall building, emphasizing the design of vertical load systems, lateral load systems, and floor systems. Uses studies of precedent buildings and metrics of structural performance including material efficiency and embodied carbon to evaluate multiple design concepts. Simplified calculation methods are validated with advanced numerical simulations. Formal presentations will be used to improve oral and visual communication.

J. Ochsendorf

1.57 Mechanics of Materials: An Energy Approach
Prereq: 1.050 or permission of instructor
G (Fall)
Not offered regularly; consult department
3-2-7 units
An opportunity to update knowledge in continuum mechanics and constitutive behavior, and modeling of engineering materials based on thermodynamics of irreversible processes. Introduction to continuum mechanics and material modeling of engineering materials based on first energy principles: deformation and strain; momentum balance, stress, and stress states; elasticity and elasticity bounds; plasticity and yield design. Overarching theme is a unified mechanistic language using thermodynamics, which allows for understanding, modeling, and design of a broad range of engineering materials.

F. J. Ulm

1.570 Micromechanics and Durability of Solids
Prereq: (1.050 and 1.57) or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Introduction to fracture mechanics, poromechanics and micromechanics using a unified mechanistic approach based on energy principles for modeling a large range of man-made and natural engineering material behavior. Energy release and fracture energy, stress intensity factors and toughness, saturated and partially saturated poromechanics of deformable porous materials, Darcy’s law, linear micromechanics and application to porous materials, homogenization methods, chemomechanics of dissolution processes. In addition to assignments, emphasizes development of a consistent engineering science approach, culminating in a term paper.

F. J. Ulm
1.571 Modeling and Analysis of Structures  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Covers analytical and computer-based methods for the analysis of structural systems. Introduces strategies for the quantitative study of indeterminate and nonlinear structures. Topics provide insight into structural analysis software and the implementation of the finite element method. Emphasizes modeling complex structural behavior, such as elastic instability, local and global buckling, physical nonlinearity, geometric stiffness, and thermal expansion. Application examples cover a range of structural components and systems, with models and methods specific to the study of building frames, arches, shells, and cable-supported and tensile structures. Assignments provide experience with the construction of mathematical and finite element models, the derivation of closed-form solutions, and the effective use of structural analysis programs.  

Staff  

1.573[J] Structural Mechanics  
Same subject as 2.080[J]  
Prereq: 2.002  
G (Fall)  
4-0-8 units  
See description under subject 2.080[J].  
T. Wierzbicki, D. Parks  

1.575[J] Computational Structural Design and Optimization  
Same subject as 4.450[J]  
Subject meets with 4.451  
Prereq: ((1.000 or (6.0001 and 6.0002)) and (1.050, 2.001, or 4.462)) or permission of instructor  
G (Fall)  
Units arranged  
See description under subject 4.450[J]. Enrollment limited to 30.  
Consult C. Mueller  

1.581[J] Structural Dynamics  
Same subject as 2.060[J], 16.221[J]  
Subject meets with 1.058  
Prereq: 18.03 or permission of instructor  
G (Fall)  
3-1-8 units  
Examines response of structures to dynamic excitation: free vibration, harmonic loads, pulses and earthquakes. Covers systems of single- and multiple-degree-of-freedom, up to the continuum limit, by exact and approximate methods. Includes applications to buildings, ships, aircraft and offshore structures. Students taking graduate version complete additional assignments.  
T. Cohen  

1.582 Design of Steel Structures  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Provides ability to design and assess steel structures. Steel structures are taught at three levels: the overall structural system (multi-story buildings, wide-span buildings, bridges, masts, and towers); the components of a structural system (floor systems, plate girders, frames, and beams); and the details of structural components (connection types, welding, and bolting). Each level includes a balance among theoretical analysis, design requirements, and construction/cost considerations. Existing structures are used as worked examples.  
J. Ochsendorf, G. Herning  

1.589 Studies in Structural Design and Analysis  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged  
Can be repeated for credit.  
Individual study of advanced subjects under staff supervision. Content arranged to suit the particular requirements of the student and interested members of the staff.  
Information: O. Buyukozturk
Hydrodynamics and Coastal Engineering

1.61 Transport Processes in the Environment
Subject meets with 1.061
Prereq: 1.060
G (Fall)
3-1-8 units
Credit cannot also be received for 1.061A

Introduces mass transport in environmental flows, with emphasis on river and lake systems. Covers derivation and solutions to the differential form of mass conservation equations. Topics include molecular and turbulent diffusion, boundary layers, dissolution, bed-water exchange, air-water exchange, and particle transport. Meets with 1.061A first half of term. Students taking graduate version complete additional assignments.

H. M. Nepf

1.63[J] Advanced Fluid Dynamics
Same subject as 2.26[J]
Prereq: 18.085 and (2.25 or permission of instructor)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
4-0-8 units

See description under subject 2.26[J].
T. R. Akylas, G. H. McKinley, R. Stocker

1.631[J] Fluids and Diseases
Same subject as 2.250[J], HST.537[J]
Subject meets with 1.063
Prereq: None
G (Spring)
3-3-6 units

Designed for students in engineering and the quantitative sciences who want to explore applications of mathematics, physics and fluid dynamics to infectious diseases and health; and for students in epidemiology, environmental health, ecology, medicine, and systems modeling seeking to understand physical and spatial modeling, and the role of fluid dynamics and physical constraints on infectious diseases and pathologies. The first part of the class reviews modeling in epidemiology and data collection, and highlights concepts of spatial modeling and heterogeneity. The remainder highlights multi-scale dynamics, the role of fluids and fluid dynamics in physiology, and pathology in a range of infectious diseases. The laboratory portion entails activities aimed at integrating applied learning with theoretical concepts discussed in lectures and covered in problem sets. Students taking graduate version complete additional assignments.

L. Bourouiba

1.64 Physical Limnology
Subject meets with 1.064
Prereq: 1.061
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Provides an introduction to physical processes occurring in lakes and shallow surface water systems with emphasis on mechanisms affecting fate and transport. Topics include internal waves, differential heating and cooling, boundary mixing, turbulent mixing, and influence of vegetation. Begins with a review of Navier-Stokes equation. Students taking graduate version complete additional assignments.

H. M. Nepf

1.66 Problems in Water Resources and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Individual study in advanced topics as arranged between individual students and staff. Choice of subjects from theoretical, experimental, and practical phases of hydromechanics, hydraulic engineering, water resources, hydrology, and environmental engineering.

Staff

1.685[J] Nonlinear Dynamics and Waves
Same subject as 2.034[J], 18.377[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

See description under subject 2.034[J].
R. R. Rosales
1.686[J] Nonlinear Dynamics and Turbulence
Same subject as 2.033[J], 18.358[J]
Subject meets with 1.068
Prereq: 1.060A
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-2-7 units
Reviews theoretical notions of nonlinear dynamics, instabilities, and
waves with applications in fluid dynamics. Discusses hydrodynamic
instabilities leading to flow destabilization and transition to
turbulence. Focuses on physical turbulence and mixing from
homogeneous isotropic turbulence. Also covers topics such as
rotating and stratified flows as they arise in the environment, wave-
turbulence, and point source turbulent flows. Laboratory activities
integrate theoretical concepts covered in lectures and problem sets.
Students taking graduate version complete additional assignments.
L. Bourouiba

1.69 Introduction to Coastal Engineering
Prereq: 1.061
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
4-0-8 units
Basic dynamics of ocean surface waves; wave-driven, wind-driven,
and tidal currents; boundary layers and sediment transport; and
selected engineering applications. Formulation of the boundary-
value problem for surface waves, linear plane-wave solution,
shoaling, refraction, diffraction, statistical representation, and
elements of nonlinearity. Depth-averaged formulation and selected
solutions for sea level and currents driven by waves, winds, and
tides. Elements of boundary layers, initial sediment motion, and
bedload and suspended sediment transport. Alongshore sediment
transport and shoreline change. Emphasizes basic principles,
mathematical formulation and solution, and physical interpretation,
with selected applications and exposure to current research.
J. Trowbridge

1.692[J] Ocean Wave Interaction with Ships and Offshore Energy
Systems
Same subject as 2.24[J]
Prereq: 2.20 and 18.085
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units
See description under subject 2.24[J].
P. D. Sclavounos

1.699[J] Projects in Oceanographic Engineering
Same subject as 2.689[J]
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
See description under subject 2.689[J].
J. Preisig, Woods Hole Staff

Hydrology and Water Resource Systems

1.713[J] Land-Atmosphere Interactions
Same subject as 12.834[J]
Prereq: Permission of instructor
G (Spring)
2-0-4 units
Topics include the exchange of mass, heat and momentum between
the soil, vegetation or water surface and the overlying atmosphere;
flux and transport in the turbulent boundary layer; and coupled
balance of moisture and energy.
D. Entekhabi

1.714 Surface Hydrology
Prereq: 1.070B[J] or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Covers observations and theory of the physical processes involved in
the hydrologic cycle. Processes considered are rainfall, infiltration,
runoff generation, stream flow, evaporation, transpiration, and
rainfall interception.
E. A. B. Eltahir
1.72 Groundwater Hydrology
Subject meets with 1.072
Prereq: 1.061
G (Spring)
3-1-8 units

Presents the fundamentals of subsurface flow and transport, emphasizing the role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater. Topics include Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, storage properties, regional circulation, unsaturated flow, recharge, stream-aquifer interaction, well hydraulics, flow through fractured rock, numerical models, groundwater quality, contaminant transport processes, dispersion, decay, and adsorption. Includes laboratory and computer demonstrations. Students taking graduate version complete additional assignments.

C. Harvey

1.721 Advanced Subsurface Hydrology
Prereq: 1.72, 18.075, and permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units


C. Harvey

1.723 Computational Methods for Flow in Porous Media
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units


R. Juanes

1.727 Surface Water Ecosystems: Biogeochemistry and Chemical Transport
Prereq: (Chemistry (GIR), 1.018[J], and 1.060) or permission of instructor
G (Spring)
3-1-8 units

Addresses the nature of lakes, wetlands, and related natural waters, with a focus on their ecology and cycling of nutrients and pollutants. Topics include the hydrology of surface water systems, the nature of aquatic plant and animal communities, the carbon and nitrogen cycles, the behavior and fate of toxic metals and anthropogenic organic compounds in natural waters, and linkages between lakes and the atmosphere, groundwater, and soil. Discusses practical topics in lake and river management. Students participate in field trips to broaden their understanding of these topics.

H. Hemond

1.731 Water Resource Systems
Subject meets with 1.075
Prereq: 1.070B[J] or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Surveys optimization and simulation methods for management of water resources. Case studies illustrate linear, quadratic, nonlinear programming and real-time control. Applications include river basin planning, irrigation and agriculture, reservoir operations, capacity expansion, assimilation of remote sensing data, and sustainable resource development. Students taking graduate version complete additional assignments.

D. McLaughlin

1.74 Land, Water, Food, and Climate
Prereq: None
G (Spring)
3-0-3 units

Seminar examines food production in a changing world, with an emphasis on key scientific questions about the connections between natural resources, climate, and agriculture. Students read and discuss papers on a range of topics, including water and land resources, climate change, demography, agro-ecology, biotechnology, trade, and food security. Provides a broad and balanced perspective on one of the defining global issues of this century. Considers scientific controversies as well as areas of general agreement and examines practical solutions for addressing critical problems. Participants present reviews of selected papers and lead follow-up discussions. They also have a role in shaping subject content.

D. McLaughlin
Aquatic Sciences, Water Quality Control, and Environmental Management

1.76 Aquatic Chemistry
Prereq: Chemistry (GIR) or 5.60
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Quantitative treatment of chemical processes in aquatic systems such as lakes, oceans, rivers, estuaries, groundwaters, and wastewaters. A brief review of chemical thermodynamics is followed by discussion of acid-base, precipitation-dissolution, coordination, and reduction-oxidation reactions. Emphasis is on equilibrium calculations as a tool for understanding the variables that govern the chemical composition of aquatic systems and the fate of inorganic pollutants.
J. Seewald

1.78 Introduction to Soil Science
Subject meets with 1.078
Prereq: None
G (Fall)
Not offered regularly; consult department
3-1-8 units
Presents the physical, chemical, biological and genetic properties of soils, their global distribution, and response to management. Emphasizes factors controlling soil development, plant productivity, and the fate, cycling and bioavailability of soil nutrients and pollutants. Introduces Earth’s different soil types and their classification; links characteristics with contemporary and historic issues surrounding natural and managed soil systems. Topics include soil carbon cycling, water and fertilizer management, and challenges associated with soil salinity-sodicity, erosion, and pollution. Includes field trips to local sites to examine soil physical properties, classification, and function. Introductory biology and chemistry are recommended prerequisites. Students taking graduate version complete additional assignments.
B. Kocar

1.79 Rock-on-a-Chip: Microfluidic Technology for Visualization of Flow in Porous Media
Subject meets with 1.079
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-2-8 units
Introduces an innovative approach that uses 3D printing and microfluidic technology to characterize and visualize flow in porous media like soils and rocks. Covers single-phase flow and transport (laser fluorescence, particle image velocimetry), capillarity and wettability, multiphase flow, fracturing of granular media. In lab, students work in groups to unravel the physics and chemistry of flow in porous media, with applications to energy and environmental processes, such as groundwater resources, energy recovery, and carbon sequestration. Students taking graduate version complete additional assignments.
R. Juanes

1.801[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 11.021[J], 17.393[J], IDS.060[J]
Subject meets with 1.811[J], 11.630[J], 15.663[J], IDS.540[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
See description under subject IDS.060[J].
N. Ashford, C. Caldart

1.802[J] Regulation of Chemicals, Radiation, and Biotechnology
Same subject as 11.022[J], IDS.061[J]
Subject meets with 1.812[J], 10.805[J], 11.631[J], IDS.436[J], IDS.541[J]
Prereq: IDS.060[J] or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units
See description under subject IDS.061[J].
N. Ashford, C. Caldart

1.811[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 11.630[J], 15.663[J], IDS.540[J]
Subject meets with 1.801[J], 11.021[J], 17.393[J], IDS.060[J]
Prereq: None
G (Spring)
3-0-9 units
See description under subject IDS.540[J].
N. Ashford, C. Caldart
1.812[J] Regulation of Chemicals, Radiation, and Biotechnology
Same subject as 11.631[J], IDS.541[J]
Subject meets with 1.802[J], 10.805[J], 11.022[J], IDS.061[J],
IDS.436[J]
Prereq: IDS.540[J] or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
See description under subject IDS.541[J].
N. Ashford, C. Caldart

1.813[J] Technology, Globalization, and Sustainable Development
Same subject as 11.466[J], 15.657[J], IDS.437[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject IDS.437[J].
N. Ashford

1.818[J] Sustainable Energy
Same subject as 2.65[J], 10.391[J], 11.371[J], 22.811[J]
Subject meets with 2.650[J], 10.291[J], 22.081[J]
Prereq: Permission of instructor
G (Fall)
3-1-8 units
See description under subject 22.811[J].
M. W. Golay

1.83 Environmental Organic Chemistry
Subject meets with 1.831
Prereq: 5.60 and 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
Focuses on the processes affecting organic compounds in the environment. Uses physical chemical properties to predict chemical transfers between environmental compartments (air, water, sediments, and biota). Uses molecular structure-reactivity relationships to estimate chemical, photochemical, and biochemical transformation rates. Resulting process models are combined to predict environmental concentrations (and related biological exposures) of anthropogenic and natural organic compounds.
P. M. Gschwend

1.831 Environmental Organic Chemistry
Subject meets with 1.83
Prereq: 5.60 and 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
Focuses on the processes affecting organic compounds in the environment. Uses physical chemical properties to predict chemical transfers between environmental compartments (air, water, sediments, and biota). Uses molecular properties to estimate chemical, photochemical, and biochemical transformation rates. Resulting process models are combined to predict environmental concentrations (and related biological exposures) of anthropogenic and natural organic compounds.
P. M. Gschwend

1.84[J] Atmospheric Chemistry
Same subject as 10.817[J], 12.807[J]
Prereq: 5.60
G (Fall)
3-0-9 units
Provides a detailed overview of the chemical transformations that control the abundances of key trace species in the Earth’s atmosphere. Emphasizes the effects of human activity on air quality and climate. Topics include photochemistry, kinetics, and thermodynamics important to the chemistry of the atmosphere; stratospheric ozone depletion; oxidation chemistry of the troposphere; photochemical smog; aerosol chemistry; and sources and sinks of greenhouse gases and other climate forcers.
J. H. Kroll

1.841[J] Atmospheric Composition in the Changing Earth System
Same subject as 12.817[J]
Prereq: 1.84[J]
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Explores how atmospheric chemical composition both drives and responds to climate, with a particular focus on feedbacks via the biosphere. Topics include atmospheric nitrogen; DMS, sulfate, and CLAW; biogenic volatile organic compounds and secondary organic aerosol; wildfires and land use change; atmospheric methane and the oxidative capacity of the troposphere; and air quality and climate and geoengineering.
C. Heald
1.842[J] Aerosol and Cloud Microphysics and Chemistry
Same subject as 12.814[J]
Subject meets with 12.338
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
See description under subject 12.814[J].
D. Cziczo

1.86[J] Methods and Problems in Microbiology
Same subject as 7.492[J], 20.445[J]
Prereq: None
G (Fall)
3-0-9 units
See description under subject 7.492[J]. Preference to first-year Microbiology and Biology students.
M. Laub

1.87[J] Microbial Genetics and Evolution
Same subject as 7.493[J], 12.493[J], 20.446[J]
Prereq: 7.03, 7.05, or permission of instructor
G (Fall)
4-0-8 units
See description under subject 7.493[J].
A. D. Grossman, O. Cordero

1.871 Computational Ecology
Prereq: None
G (IAP)
2-0-7 units
Project-based class that provides practical experience in the analysis of community and population dynamics data. Emphasizes computational tools central to modern microbial ecology, such as agent-based simulations, and methods to infer ecological interactions and analyze ecological successions.
O. Cordero

1.873 Ecological Dynamics and Modeling
Subject meets with 1.087
Prereq: 18.06
G (Spring)
3-0-9 units
Centers on mathematical tools linking external perturbations with the structure and persistence of ecological communities - the ensemble of co-occurring and interacting species. Focuses on unstructured populations ranging from single, to pairs, to multiple species. Covers population dynamics, species interactions, stability, feasibility, species coexistence, and perturbations. Lectures address phenomenological and mechanistic understanding through graphical, analytical and mechanistic analysis. Students taking graduate version complete additional assignments.
S. Saavedra

1.89 Earth's Microbiomes
Subject meets with 1.089
Prereq: Biology (GIR)
G (Spring)
3-0-9 units
Provides a general introduction to the diverse roles of microorganisms in natural and artificial environments. Topics include energetics, and growth; evolution and gene flow; population and community dynamics; water and soil microbiology; biogeochemical cycling; and microorganisms in biodeterioration and bioremediation. 7.014 recommended as prerequisite; students taking graduate version complete additional assignments. Meets with 1.089A first half of term.
M. Polz, O. Cordero

1.899 Career Reengineering Program and Professional Development Workshops
Prereq: Permission of instructor
G (Spring)
1-0-0 units
For students in the 10-month Career Reengineering Program sponsored by the School of Engineering. Limited to CRP fellows.
Staff
Special Studies

**1.95[J] Teaching College-Level Science and Engineering**
Same subject as 5.95[J], 7.59[J], 8.395[J], 18.094[J]
Subject meets with 2.978
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-0-2 units
See description under subject 5.95[J].
J. Rankin

**1.968 Graduate Studies in Civil and Environmental Engineering**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual study, research, or laboratory investigations at the graduate level under faculty supervision.
*Consult Department Academic Programs Office*

**1.982 Research in Civil and Environmental Engineering**
Prereq: None
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For research assistants in the department, when assigned research is not used for thesis but is approved for academic credit. Credit for this subject may not be used for any degree granted by Course 1.
*Consult Department Academic Programs Office*

**1.984 Teaching Experience in Civil and Environmental Engineering**
Prereq: Permission of instructor
G (Fall, Spring)
0-3-0 units
Can be repeated for credit.
Provides classroom teaching experience under the supervision of faculty member(s). Students prepare instructional material, deliver lectures, grade assignments, and prepare a teaching portfolio to be submitted at the end of term. Concurrent enrollment in 1.95[J] strongly recommended. Enrollment limited by availability of suitable teaching assignments.
*Information: Academic Program Office*

**1.997 Practicum Training in Civil and Environmental Engineering**
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For graduate CEE students participating in curriculum-related, off-campus experiences in civil, environmental, and transportation engineering or related areas. Before enrolling, students must verify the internship arrangements by submitting a memo or email from the sponsoring company or organization and also from their Academic Advisor. At the conclusion of the training, the students will submit a final report for review and approval by their Academic Advisor. Can be taken for up to 3 units. Prior to enrolling, contact the CEE Academic Programs Office for procedures and restrictions.
*Consult Department Academic Programs Office*

**1.998 Practicum Training in Civil and Environmental Engineering**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For undergraduate CEE students participating in curriculum-related off-campus experiences in civil and environmental engineering or related areas. Before enrolling, students must have an offer from a company or organization and must have prior approval from their CEE academic advisor. At the conclusion of the training, the students will submit a final report for review and approval by their Academic Advisor. Can be taken for up to 3 units. Prior to enrolling, contact the CEE Academic Programs Office for procedures and restrictions.
*Consult Department Academic Programs Office*

**1.999 Undergraduate Studies in Civil and Environmental Engineering**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual study, research, or laboratory investigations under faculty supervision.
*Consult Department Academic Programs Office*
1. **EPE UPOP Engineering Practice Experience**

Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units

See description under subject 2.EPE. **Staff**

1. **EPW UPOP Engineering Practice Workshop**

Engineering School-Wide Elective Subject.
Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW
Prereq: None
U (Fall, IAP)
1-0-0 units

See description under subject 2.EPW. Enrollment limited. **Staff**

1. **THG Graduate Thesis**

Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of an SM, MEng, CE, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member. **Consult Department Academic Programs Office**

1. **THU Undergraduate Thesis**

Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a S.B. thesis; to be arranged by the student and an appropriate MIT faculty member. Intended for seniors. Student must submit an approved thesis proposal to the Academic Programs Office by the fifth week of the first term the student is registered for thesis. **Consult Department Academic Programs Office**

1. **UR Research in Civil and Environmental Engineering**

Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Individual research or laboratory study under faculty supervision. Also, opportunities in ongoing research program. Limited number of funded traineeships available. **Information: Consult Department Academic Programs Office**

1. **URG Research in Civil and Environmental Engineering**

Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Individual research or laboratory study under faculty supervision. Also opportunities in ongoing research program. **Consult Department Academic Programs Office**

1. **S82 Special Problems in Environmental Microbiology and Chemistry**

Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Advanced study of topics not covered in the regular subject listings, particularly seminar, laboratory, and experimental subjects offered by permanent or visiting faculty. Addresses topics in environmental microbiology, ecological genomics, microbial evolution and population genetics, oceanography, biogeochemical processes, environmental organic chemistry and aquatic chemistry. **S. W. Chisholm, M. F. Polz, E. J. Alm, P. M. Gschwend, H. F. Hemond**

1. **S977 Special Graduate Subject in Civil and Environmental Engineering**

Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Graduate subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum. **Consult Department Academic Programs Office**
1.978 Special Graduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Graduate subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum. 1.978 is taught P/D/F.

Department Academic Programs Office

1.979 Special Graduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Graduate subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum.
Consult Department Academic Programs Office

1.980 Special Graduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Graduate subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum.
Department Academic Programs Office

1.981 Special Graduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Graduate subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum.
Department Academic Programs Office

1.982 Special Graduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring; second half of term)
Units arranged
Graduate subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum.
Consult G. Herning

1.991 Special Undergraduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum.
Consult Department Academic Programs Office

1.992 Special Undergraduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum.
Consult Department Academic Programs Office

1.993 Special Undergraduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum.
Consult Department Academic Programs Office
Undergraduate Subjects

**CMS.100 Introduction to Media Studies**
Prereq: None
U (Fall, Spring)
3-3-6 units. HASS-H; CI-H

Offers an overview of the social, cultural, political, and economic impact of mediated communication on modern culture. Combines critical discussions with experiments working with different media. Media covered include radio, television, film, the printed word, and digital technologies. Topics include the nature and function of media, core media institutions, and media in transition. Enrollment limited.

J. Picker, W. Uricchio, S. Costanza-Chock

**CMS.300 Introduction to Videogame Theory**
Subject meets with CMS.841
Prereq: None
U (Fall)
3-3-6 units. HASS-H

Introduction to the interdisciplinary study of videogames as texts through an examination of their cultural, educational, and social functions in contemporary settings. Students play and analyze videogames while reading current research and theory from a variety of sources in the sciences, social sciences, humanities, and industry. Assignments focus on game analysis in the context of the theories discussed in class. Includes regular reading, writing, and presentation exercises. No prior programming experience required. Students taking graduate version complete additional assignments. Limited to 20.

M. Jakobsson

**CMS.301 Introduction to Game Design Methods**
Prereq: None
U (Spring)
5-0-7 units. HASS-A

Provides an introduction to the process of designing games and playful experiences. Familiarizes students with concepts, methods, techniques and tools used in the design of a wide variety of games. Focuses on aspects of the process such as rapid prototyping, play testing, and design iteration using a player-centered approach. Students work in project groups where they engage with a series of confined exercises, practice communicating design ideas, and discuss their own and others work in a constructive manner. No prior programming experience required. Limited to 15.

M. Jakobsson, S. Verrilli

**CMS.307 Critical Worldbuilding**
Subject meets with CMS.807
Prereq: None
U (Fall)
3-3-6 units. HASS-A

Studies the design and analysis of invented (or constructed) worlds for narrative media, such as television, films, comics, and literary texts. Provides the practical, historical and critical tools with which to understand the function and structure of imagined worlds. Examines world-building strategies in the various media and genres in order to develop a critical and creative repertoire. Participants create their own invented worlds. Students taking graduate version complete additional assignments. Limited to 13.

J. Diaz

**CMS.308 The Visual Story: Graphic Novel, Type to Tablet**
Subject meets with CMS.808
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A

Focuses on the interactions between graphic stories and media technologies from the rotary press of the late 19th century to contemporary touch screens, exploring the changing relations among narrative expression, reader experience and media form. Working with examples from Pulitzer’s Yellow Kid and McKay’s Little Nemo, through the classic comics (from DC superheroes to EC horror) and graphic novels, to interactive and non-linear texts (Cognitos Operation Ajax), examines such elements as graphic design, interface, and form as well as the circulation and economies of these various media-based texts. Students taking graduate version complete additional assignments.

J. Paradis

**CMS.309[J] Transmedia Storytelling: Modern Science Fiction**
Same subject as 21W.763[J]
Subject meets with CMS.809
Prereq: None
U (Spring)
3-2-7 units. HASS-A

See description under subject 21W.763[J].

H. Hendershot
**CMS.311[J] Media in Weimar and Nazi Germany**
Same subject as 21G.055[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
2-2-8 units. HASS-H; CI-H
See description under subject 21G.055[J]. Enrollment limited.
W. Uricchio

**CMS.313 Silent Film**
Subject meets with CMS.813
Prereq: None
U (Fall)
Not offered regularly; consult department
3-3-6 units. HASS-H
Examines how the key elements of today's films - composition, continuity editing, lighting, narrative structure - were originally created. Studies the history of cinema, from its origins in the late 19th century to the transition to sound in the late 1920s and early 1930s. Students view a range of films (both mainstream and experimental) from all over the world, with a particular focus on US productions. Emphasis on how color, sound, and other developments paved the way for today's technological innovations. Students taking graduate version complete additional assignments.
H. Hendershot

**CMS.314[J] Phantasmal Media: Computer-Based Art Theory and Practice**
Same subject as 21W.753[J]
Subject meets with CMS.814
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-A
Engages students in theory and practice of using computational techniques for developing expressive digital media works. Surveys approaches to understanding human imaginative processes, such as constructing concepts, metaphors, and narratives, and applies them to producing and understanding socially, culturally, and critically meaningful works in digital media. Readings engage a variety of theoretical perspectives from cognitive linguistics, literary and cultural theory, semiotics, digital media arts, and computer science. Students produce interactive narratives, games, and related forms of software art. Some programming and/or interactive web scripting experience (e.g., Flash, Javascript) is desirable. Students taking the graduate version complete a project requiring more in-depth theoretical engagement.
D. F. Harrell

**CMS.333[J] Production of Educational Videos: Skills for Communicating Academic and Professional Content**
Same subject as ES.333[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-1-8 units. HASS-E; CI-H
See description under subject ES.333[J]. Limited to 12; preference to students in ESG.
D. Custer

**CMS.334[J] South Asian America: Transnational Media, Culture, and History**
Same subject as 21W.788[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
See description under subject 21W.788[J]. Limited to 18.
V. Bald

**CMS.335[J] Short Attention Span Documentary**
Same subject as 21W.790[J]
Subject meets with 21W.890
Prereq: None
U (Fall)
3-0-9 units. HASS-A
See description under subject 21W.790[J]. Limited to 16.
V. Bald

**CMS.336[J] Social Justice and The Documentary Film**
Same subject as 21W.786[J]
Subject meets with CMS.836
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A
See description under subject 21W.786[J]. Limited to 18.
V. Bald
CMS.338 Innovation in Documentary: Technologies and Techniques
Subject meets with CMS.838
Prereq: CMS.100 or permission of instructor
U (Fall)
3-0-9 units. HASS-A

Discusses emerging technologies and techniques available to media-makers (e.g., location-based technologies, transmedia storytelling, crowdsourcing, and interactivity) and their implications on the film and television documentary. Studies the development of these tools and considers the many new directions in which they may take the genre. Includes screenings, meetings with documentary makers, and an experimental component in which students can explore new approaches to documentary production. Students taking graduate version complete additional assignments.
W. Uricchio

CMS.339 Virtual Reality and Immersive Media Production
Subject meets with CMS.839
Prereq: Permission of instructor
U (Spring)
3-0-9 units. HASS-A

Provides an overview of historical developments and current innovations in virtual reality (e.g., gear, software, and storytelling techniques) and looks into new trends in augmented, mixed and holographic reality. Includes practical instruction and a step-by-step exploration of the fundamentals of virtual reality creation - from new visual languages and grammars, to storyboarding, scripting, sound design and editing, to new and innovative ways to capture, scan and reproduce 360-degree images. Students taking graduate version complete additional assignments. Limited to 18.
S. Rodriguez

CMS.350[J] Topics and Methods in 21st-Century Journalism
Same subject as 21W.737[J]
Subject meets with CMS.850
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Gives a broad understanding of what it means to produce journalism today. Evaluates the limitations and strengths of specific types of media, ranging from New York Times stories to Twitter feeds. Provides students with tools to effectively communicate their own work and research to non-specialist audiences. Students submit assignments via an online portal, which mimics the style and substance of an online news source. Students taking graduate version complete additional assignments. Limited to 12.
S. Mnookin

CMS.356[J] Advertising and Media: Comparative Perspectives
Same subject as 21G.036[J]
Subject meets with 21G.190, CMS.888
Prereq: None
U (Spring)
3-0-9 units. HASS-H

See description under subject 21G.036[J].
J. Wang

CMS.360 Introduction to Civic Media
Subject meets with CMS.860
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Examines civic media in comparative, transnational and historical perspectives. Introduces various theoretical tools, research approaches, and project design methods. Students engage with multimedia texts on concepts such as citizen journalism, transmedia activism, media justice, and civic, public, radical, and tactical media. Case studies explore civic media across platforms (print, radio, broadcast, internet), contexts (from local to global, present-day to historical), and use (dialogic, contentious, hacktivist). As a final project, students develop a case study or project proposal. Students taking the graduate version complete additional assignments. Limited to 20.
S. Costanza-Chock

CMS.361 Networked Social Movements: Media and Mobilization
Subject meets with CMS.861
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Provides an overview of social movement studies as a body of theoretical and empirical work, with an emphasis on understanding the relationship between social movements and the media. Explores multiple methods of social movement investigation, including textual and media analysis, surveys, interviews, focus groups, participant observation, and co-research. Covers recent innovations in social movement theory, as well as new data sources and tools for research and analysis. Includes short papers, a literature review, and a final research project. Students taking graduate version complete additional assignments. Limited to 16.
S. Costanza-Chock
CMS.362 Civic Media Collaborative Design Studio
Subject meets with CMS.862
Prereq: One subject in CMS or MAS
U (Spring)
3-0-9 units. HASS-S
Can be repeated for credit.

Project-based studio focusing on collaborative design of civic media provides a service-learning opportunity for students interested in working with community organizations. Multidisciplinary teams create civic media projects based on real-world community needs. Covers co-design methods and best practices to include the user community in iterative stages of project ideation, design, implementation, testing, and evaluation. Students taking graduate version complete additional assignments. Limited to 16.
S. Costanza-Chock

CMS.376 History of Media and Technology
Subject meets with CMS.876
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H

Surveys the interrelated histories of communications media and technological development, from the emergence of 19th-century forms of mass print media and telegraphy, to sound capture and image-based forms (e.g., film, radio, and television), to the shift from analog to digital cultures. Examines how new forms of communication exert social, political, and cultural influences in the global context. Explores how technological innovation and accelerating media affect social values and behaviors in the popular and global adoption of a media device. Includes two papers and a research project on aspects of media history. Students taking graduate version complete additional assignments. Enrollment limited.
J. Paradis

CMS.400 Media Systems and Texts
Prereq: One subject in Comparative Media Studies or permission of instructor
U (Fall)
Not offered regularly; consult department
3-3-6 units. HASS-H

Explores theoretical, historical and critical approaches to the comparative study of media. Examines media from three perspectives: the historical evolution of particular media forms (media in transition); the migration of particular narratives across different media forms (trans-media texts); and the ways in which media texts and systems cross cultural and national boundaries (global crossings). Instruction and practice in written and oral communication provided.
J. Picker

CMS.405 Visual Design
Prereq: 21L.011 or CMS.100
U (Spring)
Not offered regularly; consult department
3-3-6 units. HASS-H

Examines the process of making and sharing visual artifacts using a trans-cultural, trans-historical, constructionist approach. Explores the relationship between perceived reality and the narrative imagination, how an author’s choice of medium and method constrains the work, how desire is integrated into the structure of a work, and how the cultural/economic opportunity for exhibition/distribution affects the realization of a work. Instruction and practice in written and oral communication provided. Limited to 20.
D. F. Harrell

CMS.407 Sound Studies
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Explores the ways in which humans experience the realm of sound and how perceptions and technologies of sound emerge from cultural, economic, and historical worlds. Examines how environmental, linguistic, and musical sounds are construed cross-culturally. Describes the rise of telephony, architectural acoustics, and sound recording, and the globalized travel of these technologies. Addresses questions of ownership, property, authorship, and copyright in the age of digital file sharing. Particular focus on how the sound/noise boundary is imagined, created and modeled across diverse sociocultural and scientific contexts. Auditory examples—sound art, environmental recordings, music—will be provided and invited. Instruction and practice in written and oral communication provided. Limited to 20.
J. Picker
CMS.586[J] Introduction to Education: Looking Forward and Looking Back on Education
Same subject as 11.124[J]
Prereq: None
U (Fall)
3-6-3 units. HASS-S; CI-H

One of two introductory subjects on teaching and learning science and mathematics in a variety of K-12 settings. Topics include education and media, education reform, the history of education, simulations, games, and the digital divide. Students gain practical experience through weekly visits to schools, classroom discussions, selected readings, and activities to develop a critical and broad understanding of past and current forces that shape the goals and processes of education, and explores the challenges and opportunities of teaching. Students work collaboratively and individually on papers, projects, and in-class presentations. Limited to 25.
E. Klopfer

CMS.587[J] Introduction to Education: Understanding and Evaluating Education
Same subject as 11.125[J]
Prereq: None
U (Spring)
3-6-3 units. HASS-S; CI-H

One of two introductory subjects on teaching and learning science and mathematics in a variety of K-12 settings. Topics include student misconceptions, formative assessment, standards and standardized testing, multiple intelligences, and educational technology. Students gain practical experience through weekly visits to schools, classroom discussions, selected readings, and activities to develop a critical and broad understanding of past and current forces that shape the goals and processes of education, and explores the challenges and opportunities of teaching. Students work collaboratively and individually on papers, projects, and in-class presentations. Limited to 25.
E. Klopfer

CMS.590[J] Design and Development of Games for Learning
Same subject as 11.127[J]
Subject meets with 11.252[J], CMS.863[J]
Prereq: None
U (Spring)
3-6-3 units. HASS-H

See description under subject 11.127[J].
E. Klopfer

CMS.591[J] Educational Theory and Practice I
Same subject as 11.129[J]
Prereq: None. Coreq: CMS.586[J]
U (Fall)
3-0-9 units. HASS-S

Concentrates on core set of skills and knowledge necessary for teaching in secondary schools. Topics include classroom management, student behavior and motivation, curriculum design, educational reform, and the teaching profession. Classroom observation is a key component. Assignments include readings from educational literature, written reflections on classroom observations, practice teaching and constructing curriculum. The first of the three-course sequence necessary to complete the Teacher Education Program. Limited to 15; preference to juniors and seniors.
G. Schwanbeck

CMS.592[J] Educational Theory and Practice II
Same subject as 11.130[J]
Prereq: CMS.591[J]
U (IAP)
3-0-9 units

Concentrates on the theory and psychology associated with student learning. Topics include educational theory, educational psychology, and theories of learning. Students assume responsibility for full-time teaching of two or more classes at their designated school. Class sessions focus on debriefing and problem-solving. Second of a three-course sequence necessary to complete the Teacher Education Program.
G. Schwanbeck

CMS.593[J] Educational Theory and Practice III
Same subject as 11.131[J]
Prereq: CMS.592[J]
U (Spring)
3-0-9 units. HASS-S

Students continue their IAP student teaching through mid March. Topics include educational psychology, theories of learning, and using technology and evaluating its effectiveness to enhance student learning. Assignments include readings from educational literature, written reflections on student teaching, presentations on class topics and creating a project that supports student learning at the school where the MIT student is teaching. This is the third of the three-course sequence necessary to complete the Teacher Education Program.
G. Schwanbeck
CMS.594 Education Technology Studio  
Subject meets with CMS.894  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall)  
3-0-9 units. HASS-S  
Uses media and technology to develop new forms of learning experiences for schools, workplace, and informal settings. Students participate in a range of projects that hone understanding and skills in learning science, instructional design, development, and evaluation. Topics vary but include developing new media and activities for massive open online courses, creating practice spaces for practitioners in the professions and humanities, and developing new approaches to assessment in complex learning environments. Students taking graduate version complete additional assignments.  
J. Reich

CMS.595 Learning, Media, and Technology  
Subject meets with CMS.895  
Prereq: None  
U (Fall)  
3-0-9 units. HASS-S  
Addresses new digital technologies that are transforming learning across the lifespan - from reading apps for toddlers, intelligent tutors for school children, and blended learning for college students, to MOOCs for adults and interest-based learning communities for hobbyists. Focuses on how these technologies shape people's lives and learning. Students explore how education technologies operate in complex social-technical systems, and acquire analytic tools and strategies that can be applied to other complex systems. They also refine their thinking about the opportunities, limits, and tradeoffs of educational technology. Students taking graduate version complete additional assignments.  
J. Reich

CMS.603 Independent Study  
Prereq: Permission of instructor  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.  
Opportunity for individual research in comparative media studies. Registration subject to prior arrangement for subject matter and supervision by a faculty member.  
Staff

CMS.604 Independent Study  
Prereq: Permission of instructor  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Opportunity for individual research in comparative media studies. Registration subject to prior arrangement for subject matter and supervision by a faculty member.  
Staff

CMS.605 Media Internship  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.  
Part-time internships arranged in Boston and the wider Northeast for students wishing to develop professional experience in a media production organization or industry. Students work with a CMS faculty advisor to produce a white paper on a research topic of interest based on their intern experience. Students planning to take this subject must contact the instructor before the end of the preceding term.  
Staff

CMS.606 Media Internship  
Prereq: None  
G (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.  
Part-time internships arranged in Boston and the wider Northeast for students wishing to develop professional experience in a media production organization or industry. Students work with a CMS/W faculty advisor to produce a white paper on a research topic of interest based on their intern experience. Students planning to take this subject must contact the instructor before the end of the preceding term.  
Staff
CMS.608 Game Design  
Subject meets with CMS.864  
Prereq: One subject in Comparative Media Studies or permission of instructor  
U (Fall)  
3-3-6 units. HASS-A  
Practical instruction in the design and analysis of non-digital games. Provides students the texts, tools, references, and historical context to analyze and compare game designs across a variety of genres. In teams, students design, develop, and thoroughly test their original games to better understand the interaction and evolution of game rules. Covers various genres and types of games, including sports, game shows, games of chance, card games, schoolyard games, board games, and role-playing games. Students taking the graduate version complete additional assignments. Limited to 20.  
P. Tan, R. Eberhardt

CMS.609[J] The Word Made Digital  
Same subject as 21W.764[J]  
Subject meets with CMS.846  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-A  
See description under subject 21W.764[J]. Limited to 18.  
N. Montfort

CMS.610 Media Industries and Systems: The Art, Science and Business of Games  
Subject meets with CMS.922  
Prereq: Two CMS subjects or permission of instructor  
U (Spring)  
Not offered regularly; consult department  
3-0-9 units. HASS-S  
Examines the interplay of art, science, law, and commerce in the production, marketing, distribution, and consumption of historic and contemporary videogames. Students create prototypes and develop marketing programs to illustrate the challenges of producing videogames in a professional context. Combines perspectives on media industries and systems with an examination of the creative process, development, and trends that shape content. Includes discussions with industry leaders in various areas. Students taking graduate version complete additional assignments.  
C. Weaver

CMS.611[J] Creating Video Games  
Same subject as 6.073[J]  
Prereq: 6.01, CMS.301, or CMS.608  
U (Spring)  
3-3-6 units. HASS-A  
Introduces students to the complexities of working in small, multidisciplinary teams to develop video games. Covers creative design and production methods, stressing design iteration and regular testing across all aspects of game development (design, visual arts, music, fiction, and programming). Assumes a familiarity with current video games, and the ability to discuss games critically. Previous experience in audio design, visual arts, or project management recommended. Limited to 24.  
P. Tan, S. Verrilli, R. Eberhardt, A. Grant

CMS.614[J] Network Cultures  
Same subject as 21W.791[J]  
Subject meets with CMS.867  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H  
Focuses on the social and cultural aspects of networked life through internet-related technologies (including computers, mobile devices, entertainment technologies, and emerging media forms). Theories and readings focus on the cultural, social, economic, and political aspects of internet use and design. Topics include online communication and communities, social media, gender and race in network spaces, activism and hacking, networked publics, remix culture and intellectual property. Instruction and practice in written and oral communication provided. Students taking the graduate version complete additional readings and assignments.  
T. L. Taylor

CMS.615 Games for Social Change  
Subject meets with CMS.815  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H  
Examines how various movements have tried over time to create games that enable players to enact social change. Students collaborate in teams to design and prototype games for social change and civic engagement. In a workshop setting, teams develop games and showcase them at an end-of-term open house. Features guest speakers from academia and industry as well as the nonprofit sector and the gaming community. Readings explore principals of game design and the social history of games. Students taking graduate version complete additional assignments.  
S. Osterweil
CMS.616[J] Games and Culture
Same subject as 21W.768[J], WGS.125[J]
Subject meets with CMS.868
Prereq: None
U (Fall)
3-0-9 units. HASS-S

Examines the social, cultural, economic, and political aspects of digital games. Topics include the culture of gameplay, gaming styles, communities, spectatorship and performance, gender and race within digital gaming, and the politics and economics of production processes, including co-creation and intellectual property. Students taking graduate version complete additional readings and assignments.
T. L. Taylor

CMS.617 Advanced Game Studio
Prereq: CMS.608 or CMS.611[J]
U (Fall)
3-3-6 units. HASS-A

Students join the class in pre-formed teams, which work under the supervision of experienced mentors to complete a term-long game creation project. Covers management best practices for software engineering teams; creative expression as a collaborative project; developing and evaluating prototypes for potential viability, and translating them into a final polished product; planning and running qualitative testing of design elements; and targeting and selecting an appropriate audience for testing. Includes regular reviews and critiques to discuss progress, design, and work plan. Culminates with public presentation of games. Limited to 15.
P. Tan, S. Verrilli

CMS.618[J] Interactive Narrative
Same subject as 21L.489[J], 21W.765[J]
Subject meets with CMS.845
Prereq: None
U (Fall)
3-0-9 units. HASS-A

See description under subject 21W.765[J].
N. Montfort

CMS.619[J] Gender and Media Studies
Same subject as WGS.111[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-H

See description under subject WGS.111[J].
K. Surkan

CMS.621 Fans and Fan Cultures
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Examines media audiences - specifically, fans - and the subcultures that evolve around them. Examines the different historical, contemporary and transnational understandings of fans. Explores products of fan culture, i.e., clubs, fiction, “vids,” activism, etc. Readings place these products within the context of various disciplines. Students consider the concept of the “aca-fan” and reflect on their own “fannish” practices. Requires several short papers. Students taking graduate version complete additional assignments. Limited to 20.
Staff

CMS.622 Applying Media Technologies in the Arts and Humanities
Prereq: None
U (Fall)
Not offered regularly; consult department
2-2-8 units. HASS-A

Introduces students to the use of new media technologies to design and develop fresh approaches to creating new content in the arts and humanities. Students explore the rapidly expanding world of contemporary media technologies through team work in which they choose from a selection of approaches such as mobile data, civic media, digital humanities, and game prototyping to create novel media objects or compositions. Readings include a selection of classic and contemporary critical and design works from the arts and humanities.
J. Paradis
CMS.627 Imagination, Computation, and Expression Studio
Subject meets with CMS.827
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A
Can be repeated for credit.
Aims to help students invent and analyze new forms of computer-based art, gaming, social media, interactive narrative, and related technologies. Students participate in a range of new and ongoing projects that are designed to hone skills in research, development, design, and evaluation. Topics vary from year to year; examples include cognitive science and artificial intelligence-based approaches to the arts; social aspects of game design; computing for social empowerment; and game character, avatar, and online profile design. May be repeated for credit with permission of instructor. Students taking graduate version complete additional assignments.
D. F. Harrell

CMS.628 Advanced Identity Representation
Subject meets with CMS.828
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A
Can be repeated for credit.
Studies and develops computational identity systems for games, social media, virtual worlds, and computer-based artwork. An interdisciplinary set of readings (cognitive science, computer science, art, and sociology) looks at both the underlying technology and the social/cultural aspects of identity. Includes topics such as developing improved characters, avatars, agents, social networking profiles, and online accounts. Engages students in on-going research projects. Explores how social categories are formed in digital media, including gender, class, and ethnicity, along with everyday social categories (such as those based on personality or shared media preferences). Experience required in one of the following: computer programming, graphic design, web development, interaction design, or social science research methods. Students taking graduate version complete additional assignments.
D. F. Harrell

CMS.631 Data Storytelling Studio
Subject meets with CMS.831, MAS.784
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A
Explores visualization methodologies to conceive and represent systems and data, e.g., financial, media, economic, political, etc. Covers basic methods for research, cleaning, and analysis of datasets. Introduces creative methods of data presentation and storytelling. Considers the emotional, aesthetic, ethical, and practical effects of different presentation methods as well as how to develop metrics for assessing impact. Work centers on readings, visualization exercises, and a final project. Students taking graduate version complete additional assignments.
R. Bhargava

CMS.633 Digital Humanities: Topics, Techniques, and Technologies
Subject meets with CMS.833
Prereq: None
U (Fall)
3-0-9 units. HASS-H
Examines theory and practice of using computational methods in the emerging field of digital humanities. Develops an understanding of key digital humanities concepts such as data representation, digital archives, information visualization, and user interaction through the study of contemporary research in conjunction with working on real-world projects for scholarly, educational, and public needs. Students create prototypes, write design papers, and conduct user studies. Some programming and design experience is helpful but not required. Students taking graduate version complete additional assignments.
K. Fendt
CMS.634 Designing Interactions
Subject meets with 4.569[J], CMS.834[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-3-6 units. HASS-E
Can be repeated for credit.
Explores the future of mobile interactions and pervasive computing, taking into consideration design, technological, social and business aspects. Discusses theoretical works on human-computer interaction, mobile media and interaction design, and covers research and design methods. Students work in multidisciplinary teams and participate in user-centric design projects aimed to study, imagine and prototype concepts illustrating the future of mobile applications and ubiquitous computing. Students taking graduate version complete additional assignments. Repeatable for credit with permission of instructor. Limited to 12.
F. Casalegno, T. Nagakura

CMS.701 Current Debates in Media
Subject meets with CMS.901
Prereq: CMS.100
U (Fall, Spring)
3-0-9 units. HASS-H
Addresses important, current debates in media with in-depth discussion of popular perceptions and policy implications. Students use multiple perspectives to analyze texts emanating from these debates, and present their findings through discussions and reports. Explores emerging topics (e.g., piracy and IP regimes, net neutrality, media effects, social media and social change, and changing literacies) across media forms and from various historical, transcultural, and methodological perspectives. Examines the framing of these issues, their ethical and policy implications, and strategies for repositioning the debate. Instruction and practice in written and oral communication provided. Students taking graduate version complete additional assignments.
L. Parks, C. Peterson

CMS.S60 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
U (Fall; partial term)
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

CMS.S61 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
U (Fall)
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

CMS.S62 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

CMS.S63 Special Subject: Comparative Media Studies
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

CMS.THT Comparative Media Studies Pre-Thesis Tutorial
Prereq: Permission of advisor
U (Fall, IAP, Spring, Summer)
1-0-5 units
Student works with an advisor to define his/her thesis. By the end of the term, student must have a substantial outline and bibliography for thesis and must have selected a three-person thesis committee. Advisor must approve outline and bibliography.
Staff
CMS.THU Undergraduate Thesis in Comparative Media Studies
Prereq: CMS.THT
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

The CMS Undergraduate Thesis is a substantial research project or comparable exercise. A written thesis ranges in length from 35 to 50 pages. Digital projects are assessed on the quality of research and argumentation, as well as presentation, and must include a substantial written component. Student gives an oral presentation of his/her thesis at the end of the term. Thesis is not required for CMS majors.

Staff

CMS.UR Research in Comparative Media Studies
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.

Staff

CMS.URG Research in Comparative Media Studies
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.

Staff

Graduate Subjects

CMS.790 Media Theories and Methods I
Prereq: Permission of instructor
G (Fall)
3-3-6 units

An advanced introduction to core theoretical and methodological issues in comparative media studies. Topics covered typically include the nature of theory, the gathering and evaluation of evidence, the relationship of media to reality, formal approaches to media analysis, the ethnographic documentation of media audiences, cultural hierarchy and taste, modes of production, models of readership and spectatorship.

W. Uricchio

CMS.791 Media Theories and Methods II
Prereq: CMS.790
G (Spring)
3-3-6 units

An advanced introduction to core theoretical and methodological issues in comparative media studies. Topics covered typically include globalization, propaganda and persuasion, social and political effects of media change, political economy and the institutional analysis of media ownership, online communities, privacy and intellectual property, and the role of news and information within democratic cultures.

H. Hendershot

CMS.796 Major Media Texts
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-3-6 units

Intensive close study and analysis of historically significant media "texts" that have been considered landmarks or have sustained extensive critical and scholarly discussion. Such texts may include oral epic, story cycles, plays, novels, films, opera, television drama and digital works. Emphasizes close reading from a variety of contextual and aesthetic perspectives. Syllabus varies each year, and may be organized around works that have launched new modes and genres, works that reflect upon their own media practices, or on stories that migrate from one medium to another. At least one of the assigned texts is collaboratively taught, and visiting lectures and discussions are a regular feature of the subject.

L. Parks

CMS.801 Media in Transition
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Centers on historical eras in which the form and function of media technologies were radically transformed. Includes consideration of the "Gutenberg Revolution," the rise of modern mass media, and the "digital revolution," among other case studies of media transformation and cultural change. Readings in cultural and social history and historiographic method.

E. Schiappa
COMPARATIVE MEDIA STUDIES / WRITING (CMS)

CMS.807 Critical Worldbuilding
Subject meets with CMS.307
Prereq: None
G (Fall)
3-3-6 units

Studies the design and analysis of invented (or constructed) worlds for narrative media, such as television, films, comics, and literary texts. Provides the practical, historical and critical tools with which to understand the function and structure of imagined worlds. Examines world-building strategies in the various media and genres in order to develop a critical and creative repertoire. Participants create their own invented worlds. Students taking graduate version complete additional assignments. Limited to 13.
J. Diaz

CMS.808 The Visual Story: Graphic Novel, Type to Tablet
Subject meets with CMS.308
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Focuses on the interactions between graphic stories and media technologies from the rotary press of the late 19th century to contemporary touch screens, exploring the changing relations among narrative expression, reader experience and media form. Working with examples from Pulitzer's Yellow Kid and McKay's Little Nemo, through the classic comics (from DC superheroes to EC horror) and graphic novels to interactive and non-linear texts (Cognito's Operation Ajax), the course examines such elements as graphic design, interface and form as well as the circulation and economies of these various media-based texts.
J. Paradis

CMS.809 Transmedia Storytelling: Modern Science Fiction
Subject meets with 21W.763[J], CMS.309[J]
Prereq: None
G (Spring)
3-2-7 units

Explores transmedia storytelling by investigating how science fiction stories are told across different media, such as the short story, the novel, the screenplay, moving image, and games. Students consider issues of aesthetics, authorship, and genre, while also contextualizing discussion within the broader framework of the political issues raised by film, TV, and other kinds of science fiction texts. Students taking graduate version complete additional assignments.
H. Hendershot

CMS.813 Silent Film
Subject meets with CMS.313
Prereq: None
G (Spring)
Not offered regularly; consult department
3-3-6 units

Examines how the key elements of today's films - composition, continuity editing, lighting, narrative structure - were originally created. Studies the history of cinema, from its origins in the late 19th century to the transition to sound in the late 1920s and early 1930s. Students view a range of films (both mainstream and experimental) from all over the world, with a particular focus on US productions. Emphasis on how color, sound, and other developments paved the way for today's technological innovations. Students taking graduate version complete additional assignments.
H. Hendershot

CMS.814 Phantasmal Media: Computer-Based Art Theory and Practice
Subject meets with 21W.753[J], CMS.314[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units

Engages students in theory and practice of using computational techniques for developing expressive digital media works. Surveys approaches to understanding human imaginative processes, such as constructing concepts, metaphors, and narratives, and applies them to producing and understanding socially, culturally, and critically meaningful works in digital media. Readings engage a variety of theoretical perspectives from cognitive linguistics, literary and cultural theory, semiotics, digital media arts, and computer science. Students produce interactive narratives, games, and related forms of software art. Some programming and/or interactive web scripting experience (e.g., Flash, Javascript) is desirable. Students taking the graduate version complete a project requiring more in-depth theoretical engagement.
D. F. Harrell

2019–2020 MIT Subject Descriptions | 205
CMS.815 Games for Social Change
Subject meets with CMS.615
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Students will collaborate in teams to design and prototype games for social change and civic engagement. Run as a workshop in which student teams develop their games and showcase them at a semester-end open house. Features guest speakers from academia and industry as well as the non-profit sector and the gaming community. Readings will explore principals of game design, and the social history of games. Graduate students will complete additional assignments.
S. Osterweil

CMS.821 Fans and Fan Cultures
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units
Examines media audiences - specifically, fans - and the subcultures that evolve around them. Examines the different historical, contemporary and transnational understandings of fans. Explores products of fan culture, i.e., clubs, fiction, “vids,” activism, etc. Readings place these products within the context of various disciplines. Students consider the concept of the “aca-fan” and reflect on their own “fannish” practices. Requires several short papers. Students taking graduate version complete additional assignments. Limited to 20.
Staff

CMS.827 Imagination, Computation, and Expression Studio
Subject meets with CMS.627
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.
Aims to help students invent and analyze new forms of computer-based art, gaming, social media, interactive narrative, and related technologies. Students participate in a range of new and ongoing projects that are designed to hone skills in research, development, design, and evaluation. Topics vary from year to year; examples include cognitive science and artificial intelligence-based approaches to the arts; social aspects of game design; computing for social empowerment; and game character, avatar, and online profile design. May be repeated for credit with permission of instructor. Students taking graduate version complete additional assignments.
D. F. Harrell

CMS.828 Advanced Identity Representation
Subject meets with CMS.628
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.
Studies and develops computational identity systems for games, social media, virtual worlds, and computer-based artwork. An interdisciplinary set of readings (cognitive science, computer science, art, and sociology) looks at both the underlying technology and the social/cultural aspects of identity. Includes topics such as developing improved characters, avatars, agents, social networking profiles, and online accounts. Engages students in on-going research projects. Explores how social categories are formed in digital media, including gender, class, and ethnicity, along with everyday social categories (such as those based on personality or shared media preferences). Experience required in one of the following: computer programming, graphic design, web development, interaction design, or social science research methods. Students taking graduate version complete additional assignments.
D. F. Harrell

CMS.830 Studies in Film
Subject meets with 21L.706
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall, Spring)
3-3-6 units
Can be repeated for credit.
Intensive study of films from particular periods, genres, or directors. Instruction and practice in oral and written communication provided. Previous topics include Global Horror Film, Film Remixes, Film Narrative, and Heroic Cinema. Students taking graduate version complete different assignments. Limited to 12.
P. Donaldson, E. Brinkema
CMS.831 Data Storytelling Studio  
Subject meets with CMS.631, MAS.784  
Prereq: None  
G (Spring)  
3-0-9 units  
Explores visualization methodologies to conceive and represent systems and data, e.g., financial, media, economic, political, etc. Covers basic methods for research, cleaning, and analysis of datasets. Introduces creative methods of data presentation and storytelling. Considers the emotional, aesthetic, ethical, and practical effects of different presentation methods as well as how to develop metrics for assessing impact. Work centers on readings, visualization exercises, and a final project. Students taking graduate version complete additional assignments.  
R. Bhargava

CMS.833 Digital Humanities: Topics, Techniques, and Technologies  
Subject meets with CMS.633  
Prereq: None  
G (Fall)  
3-0-9 units  
Examines theory and practice of using computational methods in the emerging field of digital humanities. Develops an understanding of key digital humanities concepts such as data representation, digital archives, information visualization, and user interaction through the study of contemporary research in conjunction with working on real-world projects for scholarly, educational, and public needs. Students create prototypes, write design papers, and conduct user studies. Some programming and design experience is helpful but not required. Students taking graduate version complete additional assignments.  
K. Fendt

CMS.834[J] Designing Interactions  
Same subject as 4.569[J]  
Subject meets with CMS.634  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-3-6 units  
Can be repeated for credit.  
Explores the future of mobile interactions and pervasive computing, taking into consideration design, technological, social and business aspects. Discusses theoretical works on human-computer interaction, mobile media and interaction design, and covers research and design methods. Students work in multidisciplinary teams and participate in user-centric design projects aimed to study, imagine and prototype concepts illustrating the future of mobile applications and ubiquitous computing. Students taking graduate version complete additional assignments. Repeatable for credit with permission of instructor. Limited to 12.  
F. Casalegno, T. Nagakura

CMS.836 Social Justice and The Documentary Film  
Subject meets with 21W.786[J], CMS.336[J]  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Explores the history and current state of social-issue documentary. Examines how cultural and political upheaval and technological change have converged at different moments to bring about new waves of activist documentary filmmaking. Particular focus on films and other non-fiction media of the present and recent past. Students screen and analyze a series of key films and work in groups to produce their own short documentary using digital video and computer-based editing. Students taking graduate version complete additional assignments. Limited to 18.  
V. Bald
CMS.837 Film, Music, and Social Change: Intersections of Media and Society
Subject meets with 21W.787
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-9 units
Examines films from the 1950s onward that document music subcultures and moments of social upheaval. Combines screening films about free jazz, glam rock, punk, reggae, hip-hop, and other genres with an examination of critical/scholarly writings to illuminate the connections between film, popular music, and processes of social change. Students critique each film in terms of the social, political, and cultural world it documents, and the historical context and effects of the film’s reception. Students taking graduate version complete additional assignments. Limited to 18.
V. Bald

CMS.838 Innovation in Documentary: Technologies and Techniques
Subject meets with CMS.338
Prereq: CMS.100 or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Discusses emerging technologies and techniques available to mediakakers (e.g., location-based technologies, transmedia storytelling, crowdsourcing, and interactivity) and their implications on the film and television documentary. Studies the development of these tools and considers the many new directions in which they may take the genre. Includes screenings, meetings with documentary makers, and an experimental component in which students can explore new approaches to documentary production. Students taking graduate version complete additional assignments.
W. Uricchio

CMS.839 Virtual Reality and Immersive Media Production
Subject meets with CMS.339
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Provides an overview of historical developments and current innovations in virtual reality (e.g., gear, software, and storytelling techniques) and looks into new trends in augmented, mixed and holographic reality. Includes practical instruction and a step-by-step exploration of the fundamentals of virtual reality creation - from new visual languages and grammars, to storyboarding, scripting, sound design and editing, to new and innovative ways to capture, scan and reproduce 360-degree images. Students taking graduate version complete additional assignments. Limited to 18.
S. Rodriguez

CMS.840 Literature and Film
Subject meets with 21L.435
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-3-6 units
Can be repeated for credit.
Investigates relationships between the two media, including film adaptations as well as works linked by genre, topic, and style. Explores how artworks challenge and cross cultural, political, and aesthetic boundaries. Students taking graduate version complete additional assignments.
K. Surkan

CMS.841 Introduction to Videogame Theory
Subject meets with CMS.300
Prereq: None
G (Fall)
3-3-6 units
Introduction to the interdisciplinary study of videogames as texts through an examination of their cultural, educational, and social functions in contemporary settings. Students play and analyze videogames while reading current research and theory from a variety of sources in the sciences, social sciences, humanities, and industry. Assignments focus on game analysis in the context of the theories discussed in class. Includes regular reading, writing, and presentation exercises. No prior programming experience required. Students taking graduate version complete additional assignments. Limited to 20.
M. Jakobsson
**CMS.842 Playful and Social Interaction Design Exploration**
Prereq: None  
G (Spring)  
3-0-9 units

Explores the role of technology in relation to playful and social interaction. Deepens understanding of the potential and limitations of iterative design and rapid prototyping used as research methods. Familiarizes students with the theoretical foundations of interaction design and explorative design research, as well as practice methods applied to working with physical and digital design materials.  
*M. Jakobsson*

**CMS.844 Exploratory Programming for the Arts and Humanities**
Prereq: None  
G (Fall)  
3-1-8 units

Introduces programming through "free projects" in which students choose (or discover) the direction of their project through exploration. Covers the fundamentals of programming and how to develop a programming practice. Students complete analytical and generative projects, using different media. Examines how to think with computation, how computation and media interact, and how computation can be understood as a part of culture. No background in programming required. Limited to 18.  
*N. Montfort*

**CMS.845 Interactive Narrative**
Subject meets with 21L.489[J], 21W.765[J], CMS.618[J]  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units

Provides a workshop environment for understanding interactive narrative (print and digital) through critical writing, narrative theory, and creative practice. Covers important multisequential books, hypertexts, and interactive fictions. Students write critically, and give presentations, about specific works; write a short multisequential fiction; and develop a digital narrative system, which involves significant writing and either programming or the structuring of text. Programming ability helpful. Graduate students complete additional assignments.  
*N. Montfort*

**CMS.846 The Word Made Digital**
Subject meets with 21W.764[J], CMS.609[J]  
Prereq: None  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units

Considers the many uses of text, language, and writing in creative digital media. Focuses on non-narrative uses of text, such as in information display, visual and lyrical settings, and human-legible computer code. Considers the use of text within the context of computing and different computing platforms. Draws on concepts and approaches from poetics, the material history of texts, and computer science. Assignments include individual and group writing projects, which involve reading and modifying computer programs. Previous programming experience and writing coursework helpful. Students taking graduate version complete additional assignments. Limited to 18.  
*N. Montfort*

**CMS.848 Apocalyptic Storytelling**
Subject meets with 21W.748  
Prereq: Permission of instructor  
Acad Year 2019-2020: G (Fall)  
Acad Year 2020-2021: Not offered  
3-0-9 units

Focuses on the critical making of apocalyptic, post-apocalyptic and dystopian stories across various narrative media. Considers the long history of Western apocalypticism as well as the uses and abuses of apocalypticism across time. Examines a wide variety of influential texts in order to enhance students' creative and theoretical repertoires. Students create their own apocalyptic stories and present on selected texts. Investigates conventions such as plague, zombies, nuclear destruction, robot uprising, alien invasion, environmental collapse, and supernatural calamities. Considers questions of race, gender, sexuality, colonialism, trauma, memory, witness, and genocide. Intended for students with prior creative writing experience. Students taking graduate version complete additional assignments. Limited to 15.  
*J. Diaz*
CMS.850 Topics and Methods in 21st Century Journalism
Subject meets with 21W.737[J], CMS.350[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units

Gives a broad understanding of what it means to produce journalism today. Evaluates the limitations and strengths of specific types of media, ranging from New York Times stories to Twitter feeds. Provides students with tools to effectively communicate their own work and research to non-specialist audiences. Students submit assignments via an online portal, which mimics the style and substance of an online news source. Students taking graduate version complete additional assignments. Limited to 12.
S. Mnookin

CMS.860 Introduction to Civic Media
Subject meets with CMS.360
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Examines civic media in comparative, transnational and historical perspective. Introduces various theoretical tools, research approaches, and project design methods. Students engage with multimedia texts on concepts such as citizen journalism, transmedia activism, media justice, and civic, public, radical, and tactical media. Case studies explore civic media across platforms (print, radio, broadcast, internet), contexts (from local to global, present-day to historical), and use (dialogic, contentious, hacktivist). As a final project, students develop a case study or project proposal. Students taking the graduate version complete additional assignments. Limited to 20.
S. Costanza-Chock

CMS.861 Networked Social Movements: Media and Mobilization
Subject meets with CMS.361
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Provides an overview of social movement studies as a body of theoretical and empirical work, with an emphasis on understanding the relationship between social movements and the media. Explores multiple methods of social movement investigation, including textual and media analysis, surveys, interviews, focus groups, participant observation, and co-research. Covers recent innovations in social movement theory, as well as new data sources and tools for research and analysis. Includes short papers, a literature review, and a final research project. Students taking graduate version complete additional assignments. Limited to 16.
S. Costanza-Chock

CMS.862 Civic Media Collaborative Design Studio
Subject meets with CMS.362
Prereq: One subject in CMS or MAS
G (Spring)
3-0-9 units
Can be repeated for credit.

Project-based studio focusing on collaborative design of civic media provides a service-learning opportunity for students interested in working with community organizations. Multidisciplinary teams create civic media projects based on real-world community needs. Covers co-design methods and best practices to include the user community in iterative stages of project ideation, design, implementation, testing, and evaluation. Students taking graduate version complete additional assignments. Limited to 16.
S. Costanza-Chock

CMS.863[J] Design and Development of Games for Learning
Same subject as 11.252[J]
Subject meets with 11.127[J], CMS.590[J]
Prereq: None
G (Spring)
3-6-3 units

See description under subject 11.252[J].
E. Klopfer
CMS.864 Game Design
Subject meets with CMS.608
Prereq: One subject in Comparative Media Studies or permission of instructor
G (Fall)
3-3-6 units
Practical instruction in the design and analysis of non-digital games. Provides students the texts, tools, references, and historical context to analyze and compare game designs across a variety of genres. In teams, students design, develop, and thoroughly test their original games to better understand the interaction and evolution of game rules. Covers various genres and types of games, including sports, game shows, games of chance, card games, schoolyard games, board games, and role-playing games. Students taking the graduate version complete additional assignments. Limited to 20.

P. Tan, R. Eberhardt

CMS.867 Network Cultures
Subject meets with 21W.791[J], CMS.614[J]
Prereq: None
G (Spring)
3-0-9 units
Focuses on the social and cultural aspects of networked life through internet-related technologies (including computers, mobile devices, entertainment technologies, and emerging media forms). Theories and readings focus on the cultural, social, economic, and political aspects of internet use and design. Topics include online communication and communities, social media, gender and race in network spaces, activism and hacking, networked publics, remix culture and intellectual property. Students taking the graduate version complete additional readings and assignments.

T. L. Taylor

CMS.868 Games and Culture
Subject meets with 21W.768[J], CMS.616[J], WGS.125[J]
Prereq: None
G (Fall)
3-0-9 units
Examines the social, cultural, economic, and political aspects of digital games. Topics include the culture of gameplay, gaming styles, communities, spectatorship and performance, gender and race within digital gaming, and the politics and economics of production processes, including co-creation and intellectual property. Students taking graduate version complete additional readings and assignments.

T. L. Taylor

CMS.871 Media in Cultural Context
Subject meets with 21L.715
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Seminar uses case studies to examine specific media or media configurations and the larger social, cultural, economic, political, or technological contexts within which they operate. Organized around recurring themes in media history, as well as specific genres, movements, media, or historical moments. Previously taught topics include Gendered Genres: Horror and Maternal Melodramas; Comics, Cartoons, and Graphic Storytelling; and Exploring Children's Culture. Students taking graduate version complete additional assignments. Approved for credit in Women's and Gender Studies when content meets the requirements for subjects in that program. Limited to 12.

M. Marks

CMS.874[J] Visualizing Japan in the Modern World
Same subject as 21G.027[J]
Subject meets with 21G.590
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H
See description under subject 21G.027[J]. Enrollment limited.

S. Miyagawa

CMS.876 History of Media and Technology
Subject meets with CMS.376
Prereq: None
G (Fall)
3-0-9 units
Surveys the interrelated histories of communications media and technological development, from the emergence of 19th-century forms of mass print media and telegraphy, to sound capture and image-based forms (e.g., film, radio, and television), to the shift from analog to digital cultures. Examines how new forms of communication exert social, political, and cultural influences in the global context. Explores how technological innovation and accelerating media affect social values and behaviors in the popular and global adoption of a media device. Includes two papers and a research project on aspects of media history. Students taking graduate version complete additional assignments.

J. Paradis
CMS.888 Advertising and Media: Comparative Perspectives
Subject meets with 21G.036[J], 21G.190, CMS.356[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Compares modern and contemporary advertising culture in China, the US, and other emerging markets. First half focuses on branding in the old media environment; second half introduces the changing practice of advertising in the new media environment. Topics include branding and positioning, media planning, social media campaigns, cause marketing 2.0, social TV, and mobility marketing. Required lab work includes interactive sessions in branding a team product for the US (or a European country) and China markets. Taught in English and requires no knowledge of Chinese. Students taking graduate version complete additional assignments.
J. Wang

CMS.894 Education Technology Studio
Subject meets with CMS.594
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Uses media and technology to develop new forms of learning experiences for schools, workplace, and informal settings. Students participate in a range of projects that hone understanding and skills in learning science, instructional design, development, and evaluation. Topics vary but include developing new media and activities for massive open online courses, creating practice spaces for practitioners in the professions and humanities, and developing new approaches to assessment in complex learning environments. Students taking graduate version complete additional assignments.
J. Reich

CMS.895 Learning, Media, and Technology
Subject meets with CMS.595
Prereq: None
G (Fall)
3-0-9 units
Addresses new digital technologies that are transforming learning across the lifespan - from reading apps for toddlers, intelligent tutors for school children, and blended learning for college students, to MOOCs for adults and interest-based learning communities for hobbyists. Focuses on how these technologies shape people's lives and learning. Students explore how education technologies operate in complex social-technical systems, and acquire analytic tools and strategies that can be applied to other complex systems. They also refine their thinking about the opportunities, limits, and tradeoffs of educational technology. Students taking graduate version complete additional assignments.
J. Reich

CMS.901 Current Debates in Media
Subject meets with CMS.701
Prereq: None
Acad Year 2019-2020: G (Fall, Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Addresses important, current debates in media with in-depth discussion of popular perceptions and policy implications. Students use multiple perspectives to analyze texts emanating from these debates, and present their findings through discussions and reports. Explores emerging topics (e.g., piracy and IP regimes, net neutrality, media effects, social media and social change, and changing literacies) across media forms and from various historical, transcultural, and methodological perspectives. Examines the framing of these issues, their ethical and policy implications, and strategies for repositioning the debate. Students taking graduate version complete additional assignments.
L. Parks, C. Peterson
**CMS.915 Understanding Television**  
Subject meets with 21L.432  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Can be repeated for credit.

A cultural approach to television’s evolution as a technology and system of representation. Considers television as a system of storytelling and mythmaking, and as a cultural practice studied from anthropological, literary, and cinematic perspectives. Focuses on prime-time commercial broadcasting, the medium’s technological and economic history, and theoretical perspectives. Considerable television viewing and readings in media theory and cultural interpretation are required. Previously taught topics include American Television: A Cultural History. Students taking graduate version complete additional assignments.

*D. Thorburn*

**CMS.920 Popular Culture and Narrative**  
Subject meets with 21L.430  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Can be repeated for credit.

Examines relationships between popular culture and art, focusing on problems of evaluation and audience, and the uses of different media within a broader social context. Typically treats a range of narrative and dramatic works as well as films. Previously taught topics include Elements of Style; Gender, Sexuality and Popular Narrative. Students taking graduate version complete additional assignments. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program.  
*May be repeated for credit with permission of instructor.*

*Staff*

**CMS.922 Media Industries and Systems: The Art, Science and Business of Games**  
Subject meets with CMS.610  
Prereq: Permission of instructor  
G (Spring)  
Not offered regularly; consult department  
3-0-9 units

Examines the interplay of art, science, law, and commerce in the production, marketing, distribution, and consumption of historic and contemporary videogames. Students create prototypes and develop marketing programs to illustrate the challenges of producing videogames in a professional context. Combines perspectives on media industries and systems with an examination of the creative process, development, and trends that shape content. Includes discussions with industry leaders in various areas. Students taking graduate version complete additional assignments.

*Staff*

**CMS.925 Film Music**  
Subject meets with 21M.284  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units

Surveys styles and dramatic functions of music for silent films of the 1910s-20s, and music in sound films from the 1930s to the present. Close attention given to landmark scores by American and European composers, including Korngold, Steiner, Rozsa, Prokofiev, Copland, Herrmann, Rota, Morricone, and Williams. Subsidiary topics include new trends in contemporary film-scoring, pop scores, the impact of electronics, and specialized genres (e.g., animation). Students taking the graduate version complete different assignments. Some background in the study of film and/or music is expected.

*M. Marks*

**CMS.935 Documentary Photography and Photojournalism: Still Images of a World in Motion**  
Subject meets with 21W.749  
Prereq: Permission of instructor  
G (Fall, Spring)  
Not offered regularly; consult department  
3-0-9 units

Meets with 21W.749, but assignments differ.

*B. D. Colen*
CMS.950 Workshop I
Prereq: Permission of instructor
G (Fall)
4-2-6 units
Provides an opportunity for direct project development experience and emphasizes intellectual growth as well as the acquisition of technical skills. Students attend regular meetings to present and critique their work and discuss its implications.

J. Paradis

CMS.951 Workshop II
Prereq: CMS.950
G (Spring)
Not offered regularly; consult department
4-2-6 units
A continuation of Workshop I. Provides an opportunity for direct project development experience and emphasizes intellectual growth as well as the acquisition of technical skills. Students attend regular meetings to present and critique their work and discuss its implications.

Staff

CMS.990 Colloquium in Comparative Media
Prereq: None
G (Fall, Spring)
2-0-1 units
Can be repeated for credit.

Exposes students to the perspectives of scholars, activists, mediamakers, policymakers, and industry leaders on cutting edge issues in media. Registered CMS graduate students only.

Staff

CMS.992 Portfolio in Comparative Media
Prereq: CMS.950 or permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Students work individually with an advisor to produce a portfolio project which combines technical skills and a substantial intellectual component.

Staff

CMS.993 Teaching in Comparative Media
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

For qualified graduate students interested in teaching. Offers experience in classroom and/or tutorial teaching under the supervision of a Comparative Media Studies faculty member.

Staff

CMS.994 Independent Study
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for individual research in comparative media studies. Registration subject to prior arrangement for subject matter and supervision by a faculty member.

Staff

CMS.995 Independent Study
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for individual research in comparative media studies. Registration subject to prior arrangement for subject matter and supervision by a faculty member.

Staff

CMS.S96 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
G (Fall; partial term)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic that is not covered in the regular curriculum.

Staff

CMS.S97 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic that is not covered in the regular curriculum.

L. Koslov
CMS.S98 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

CMS.S99 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

CMS.THG Master's Thesis
Prereq: Permission of advisor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Completion of a graduate thesis, to be arranged with a faculty member, who becomes the thesis supervisor. Required of all CMS students.
Staff
COMPARATIVE MEDIA STUDIES / WRITING (COURSE 21W)

The Program in Writing offers introductory writing as well as advanced coursework in these areas: 1) Creative Writing; 2) Science Writing; and 3) Digital Media.

Creative Writing

Introductory

21W.011 Writing and Rhetoric: Rhetoric and Contemporary Issues
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.012, 21W.013, 21W.014, 21W.015, 21W.016

Provides the opportunity for students - as readers, viewers, writers, and speakers - to engage with social and ethical issues they care deeply about. Explores perspectives on a range of social issues, such as the responsibilities of citizens, freedom of expression, poverty and homelessness, mental illness, the challenges of an aging society, the politics of food, and racial and gender inequality. Discusses rhetorical strategies that aim to increase awareness of social problems; to educate the public about different perspectives on contemporary issues; and to persuade readers of the value of particular positions on, or solutions to, social problems. Students analyze selected texts and photographs, as well as documentary and feature films, that represent or dramatize social problems or issues. Students also write essays about social and ethical issues of their own choice. Limited to 18.

A. Walsh

21W.012 Writing and Rhetoric: Food for Thought
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.011, 21W.013, 21W.014, 21W.015, 21W.016

Explores many of the issues that surround food as both material fact and personal and cultural symbol. Includes non-fiction works on topics such as family meals, food's ability to awaken us to "our own powers of enjoyment" (M.F.K. Fisher), and eating as an "agricultural act" (W. Berry). Students read Michael Pollan's best-selling book In Defense of Food and discuss the issues it raises about America's food supply and eating habits, as well as the rhetorical strategies it employs. Assignments include narratives, analytical essays, and research-based essays. Limited to 18.

S. Carlisle

21W.013 Writing and Rhetoric: Introduction to Contemporary Rhetoric
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.011, 21W.012, 21W.014, 21W.015, 21W.016

Considers how rhetoric shapes current events in politics, science, and society. Students study rhetoric as a theoretical framework for developing persuasive arguments, as a method of analyzing written, oral, and visual texts, and as a mode of human inquiry. Assignments include analytical, persuasive, and research-based essays, as well as oral presentations, group discussions, and debates. Readings drawn from political speeches, scientific arguments, and popular media. Limited to 18.

L. Harrison-Lepera

21W.014 Writing and Rhetoric: Exploring Visual Media
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.011, 21W.012, 21W.013, 21W.015, 21W.016

Explores the rhetoric of visual media and the meaning of the digital revolution. Students analyze readings and films and discuss the power of media in defining social issues and shaping ideas of self, family, and community. They also write essays that sharpen skills in analyzing visual rhetoric, developing and supporting arguments, and using sources. Limited to 18.

A. Walsh

21W.015 Writing and Rhetoric: Writing about Sports
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.011, 21W.012, 21W.013, 21W.014, 21W.016

Examines the role of sports in our individual lives and American culture at large. Considers a broad range of issues, such as heroism and ethical conundrums, gender equality, steroids, and the proper role of sports in college life. Examples of high-quality, descriptive and analytic sports writing serve as the focus for class discussion and as models for student essays. Limited to 18.

A. Karatsolis
21W.016 Writing and Rhetoric: Designing Meaning
Prereq: None
U (Fall)
2-2-8 units. HASS-H; CI-HW
Credit cannot also be received for 21W.011, 21W.012, 21W.013, 21W.014, 21W.015

Explores how we use rhetoric in text, visuals, and other modes to make meaning. Uses analysis, composition, and debate about rhetorical strategies to develop theoretical and empirical knowledge of how design choices shape our texts and our understanding of the world. In lab, students experiment with rhetorical strategies and assess their effects. Limited to 18.
S. Lane

21W.021 Writing and Experience: MIT Inside, Live
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.022

Acting as participant-observers, students investigate MIT’s history and culture through visits to the Institute’s archives and museums, relevant readings, and depictions of MIT in popular culture. Students chronicle their experiences and insights through a variety of writing projects, culminating in the completion of a portfolio. Limited to 18.
J. Graziano

21W.022 Writing and Experience: Reading and Writing Autobiography
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.021

Draws on a range of autobiographical writing as examples for students to analyze. Students write essays that focus on their own experience, exploring topics such as intellectual growth and development, the childhood and high school years, life at MIT, the influence of place upon one’s personality and character, and the role politics and religion play in one’s life. Emphasizes clarity, specificity, and structure; investigates various modes of writing (narrative, analytical, expository) and their suitability for different purposes. Limited to 18.
L. Harrison Lepera, N. Jackson, S. Carlisle, S. Carlisle, L. Harrison Lepera, A. Walsh

21W.031 Science Writing and New Media: Explorations in Communicating about Science and Technology
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.034, 21W.035, 21W.036

Examines principles of good writing, focusing on those associated with scientific and technical writing. Considers the effects of new media as an avenue for communicating about science. Students discuss scientific articles and essays and work in small groups to critique each other’s writing. Assignments include a critical review, a science essay for the general public, and a research or service project proposal. Students choose topics that reflect their background and interests. Formal and informal presentations and group discussions develop oral communication skills. Limited to 18.
J. Melvold

21W.034 Science Writing and New Media: Perspectives on Medicine and Public Health
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.035, 21W.036

Public health topics, such as AIDS, asthma, malaria control, obesity, and sleep deprivation, provide a unifying focus as students explore diverse modes of science writing. Readings include essays by such writers as Atul Gawande, Danielle Ofri, Jerome Groopman, and William Carlos Williams, as well as peer-reviewed journal articles. Assignments include a critical review, a scientific literature review, a brochure suitable for general distribution, an autobiographical narrative, a resume, a job application letter, and oral presentations. Limited to 18.
C. Taft

21W.035 Science Writing and New Media: Elements of Science Writing for the Public
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.034, 21W.036

Provides an introduction to writing about science (including medicine, technology, and engineering) for general readers. Emphasizes background research as a foundation for strong science writing. Students read works by accomplished science writers. Each assignment focuses on a different popular form, such as news article, interview, essay, and short feature. Limited to 18.
J. Berezin, A. Carleton, K. Boiko
21W.036 Science Writing and New Media: Writing and the Environment
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.034, 21W.035
Develops written and oral communication skills through the study and practice of environmental science writing. Covers a wide range of genres, including such standard forms as the scientific literature review. Students adapt the content of their papers and oral presentations to the distinctive needs of specific audiences. Assignments provide thematic coherence and a basis for independent student research. Limited to 18.
C. Taft

21W.041[J] Writing About Literature
Same subject as 21L.000[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW
See description under subject 21L.000[J]. Enrollment limited.
W. Kelley, I. Lipkowitz

21W.042[J] Writing with Shakespeare
Same subject as 21L.010[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW
See description under subject 21L.010[J].
D. Henderson

Advanced

21W.735 Writing and Reading the Essay
Prereq: Writing sample and permission of instructor
U (Spring)
3-0-9 units. HASS-H; CI-H
Exploration of formal and informal modes of writing nonfiction prose. Extensive practice in composition, revision, and editing. Reading in the literature of the essay from the Renaissance to the present, with an emphasis on modern writers. Classes alternate between discussion of published readings and workshops on student work. Individual conferences. Limited to 18.

21W.740 Writing Autobiography and Biography
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Writing an autobiography is a vehicle for improving one’s style while studying the nuances of the language. Literary works are read with an emphasis on different forms of autobiography. Students examine various stages of life, significant transitions, personal struggles, and memories translated into narrative prose, and discuss: what it means for autobiographer and biographer to develop a personal voice; and the problems of reality and fiction in autobiography and biography.
K. Manning

21W.741[J] Black Matters: Introduction to Black Studies
Same subject as 24.912[J], 21H.106[J], 21L.008[J], WGS.190[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-A, HASS-H; CI-H
See description under subject 24.912[J].
M. Degraff

21W.742[J] Writing about Race
Same subject as WGS.231[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
The issue of race and racial identity have preoccupied many writers throughout the history of the US. Students read Jessica Abel, Diana Abu-Jaber, Lynda Barry, Felicia Luna Lemus, James McBride, Sigrid Nunez, Ruth Ozeki, Danzy Senna, Gloria Anzaldúa, Judith Ortiz Cofer, Carmit Delman, Stefanie Dunning, Cherrie Moraga, Hiram Perez and others, and consider the story of race in its peculiarly American dimensions. The reading, along with the writing of members of the class, is the focus of class discussions. Oral presentations on subjects of individual interest are also part of the class activities. Students explore race and ethnicity in personal essays, pieces of cultural criticism or analysis, or (with permission of instructor) fiction. All written work is read and responded to in class workshops and subsequently revised. Enrollment limited.
K. Ragusa
21W.743 Voice and Meaning: Speaking to Readers through Memoir
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-E
Explores the memoir genre with particular attention to the relationships between form and content, fact and truth, self and community, art and "healing," coming to voice and breaking silence. Readings include works by Nick Flynn, Meena Alexander, Art Spiegelman, James McBride, Ruth Ozeki, and Cheryl Strayed, with a focus on the ways in which these writers make meaning out of specific events or moments in their own lives as a way of engaging with larger questions of family, race, history, loss, and survivorship. Drawing on lessons taken from these works, students write a short memoir of their own. Limited to 18.
K. Ragusa

21W.744 The Art of Comic Book Writing
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Students create short scripts and full-length comic book narratives across a variety of genres, while analyzing a wide range of comics (corporate and independent, print and web). Focuses on scripts; drawing skills not required, but illustrations or storyboards are welcome. Special attention to questions of gender, race, ethnicity, and sexuality in both critical and creative work. Limited to 13.
M. Liu

21W.745 Advanced Essay Workshop
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H
Can be repeated for credit.
For students with experience in writing essays and nonfiction prose. Focuses on negotiating and representing identities grounded in gender, race, class, nationality, and sexuality in prose that is expository, exploratory, investigative, persuasive, lyrical, or incantatory. Authors include James Baldwin, Minnie Bruce Pratt, Audre Lorde, Richard Rodriguez, Alice Walker, John Edgar Wideman, Diana Hume George, bell hooks, Margaret Atwood, Patricia J. Williams, and others. Designed to help students build upon their strengths as writers and to expand their repertoire of styles and approaches in essay writing. Approved for credit in Women's and Gender Studies when content meets the requirements for subjects in that program. Limited to 18.
Staff

21W.747 Rhetoric
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-H
For students with a special interest in learning how to make forceful arguments in written form. Studies the forms and structures of argumentation, including organization of ideas, awareness of audience, methods of persuasion, evidence, factual vs. emotional argument, figures of speech, and historical forms and uses of arguments. Limited to 18 per section.
S. Strang, A. Karatsolis

21W.748 Apocalyptic Storytelling
Subject meets with CMS.848
Prereq: Permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A
Focuses on the critical making of apocalyptic, post-apocalyptic and dystopian stories across various narrative media. Considers the long history of Western apocalypticism as well as the uses and abuses of apocalypticism across time. Examines a wide variety of influential texts in order to enhance students' creative and theoretical repertoires. Students create their own apocalyptic stories and present on selected texts. Investigates conventions such as plague, zombies, nuclear destruction, robot uprising, alien invasion, environmental collapse, and supernatural calamities. Considers questions of race, gender, sexuality, colonialism, trauma, memory, witness, and genocide. Intended for students with prior creative writing experience. Students taking graduate version complete additional assignments. Limited to 15.
J. Diaz

21W.754 Playwriting Fundamentals
Same subject as 21M.604
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A
See description under subject 21M.604.
K. Urban
21W.755 Writing and Reading Short Stories
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A

An introduction to writing fiction. Students write their own stories and study essays and short stories by contemporary authors from around the world. Discussion focuses on students' writing and on assigned works in their historical and social contexts.

S. Lewitt, M. Nathan

21W.756 Writing and Reading Poems
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-A

Examination of the formal structural and textual variety in poetry. Extensive practice in the making of poems and the analysis of both students' manuscripts and texts from 16th- through 20th-century literature. Attempts to make relevant the traditional elements of poetry and their contemporary alternatives. Weekly writing assignments, including some exercises in prosody.

Staff

21W.757 Fiction Workshop
Prereq: 21W.755
U (Fall)
3-0-9 units. HASS-A
Can be repeated for credit.

Intermediate class for students with some experience in writing fiction. Students write short stories and complete other writing exercises. Readings include short story collections by contemporary writers such as Sandra Cisneros, Benjamin Percy, Leila Lalami, Laura Pritchett, Bret Anthony Johnston, and Edward P. Jones. Discussions focus on sources of story material, characterization, setting, architecture, point of view, narrative voice, and concrete detail.

J. Diaz

21W.758 Genre Fiction Workshop
Prereq: Permission of instructor
U (Fall)
3-0-9 units. HASS-A

Students read texts in genres such as fantasy, science fiction, historical fiction, noir, and horror, typically focusing on one genre exclusively in a given semester. Formats may include short stories, novels, films, TV shows and other narrative media. Considers genre protocols and how to write within the restrictions and freedoms associated with each genre. Students write fiction within a genre (or "between" genres) for roundtable workshopping. Intended for students with prior creative writing experience. Limited to 15.

S. Lewitt

21W.759 Writing Science Fiction
Prereq: None
U (Spring)
3-0-9 units. HASS-A

Students write and read science fiction and analyze and discuss stories written for the class. For the first eight weeks, readings in contemporary science fiction accompany lectures and formal writing assignments intended to illuminate various aspects of writing craft as well as the particular problems of writing science fiction. The rest of the term is given to roundtable workshops on students' stories.

S. Lewitt

21W.762 Poetry Workshop
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A
Can be repeated for credit.

For students with some previous experience in poetry writing. Frequent assignments stress use of language, diction, word choice, line breaks, imagery, mood, and tone. Considers the functions of memory, imagination, dreams, poetic impulses. Throughout the term, students examine the work of published poets. Revision stressed.

E. Barrett

21W.769[J] Playwrights Lab
Same subject as 21M.785[J]
Subject meets with 21M.789
Prereq: 21M.604[J] or permission of instructor
U (Spring)
4-0-8 units. HASS-A
Can be repeated for credit.

See description under subject 21M.785[J]. Limited to 10.

K. Urban
21W.770 Advanced Fiction Workshop
Prereq: Permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A
Can be repeated for credit.

For students with some experience in writing fiction. Write longer works of fiction and short stories which are related or interconnected. Read short story collections by individual writers, such as Sandra Cisneros, Raymond Carver, Edward P. Jones, and Tillie Olsen, and discuss them critically and analytically, with attention to the ways in which the writers' choices about component parts contribute to meaning. In-class exercises and weekly workshops of student work focus on sources of story material, characterization, structure, narrative voice, point of view and concrete detail. Concentration on revision.

H. Lee

21W.771 Advanced Poetry Workshop
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 units. HASS-A
Can be repeated for credit.

For students experienced in writing poems. Regular reading of published contemporary poets and weekly submission of manuscripts for class review and criticism. Students expected to do a substantial amount of rewriting and revision. Classwork supplemented with individual conferences.

E. Funkhouser

21W.773 Writing Longer Fiction
Prereq: A fiction workshop or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A

Designed for students who have some experience in writing fiction and want to try longer forms like the novella and novel. Students interested in writing a novel are expected to produce at least two chapters and an outline of the complete work. Readings include several novels from Fitzgerald to the present, and novellas from Gogol's The Overcoat to current examples. Students discuss one another's writing in a roundtable workshop, with a strong emphasis on revision.

Staff

Science Writing

Introductory

21W.031 Science Writing and New Media: Explorations in Communicating about Science and Technology
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.034, 21W.035, 21W.036

Examines principles of good writing, focusing on those associated with scientific and technical writing. Considers the effects of new media as an avenue for communicating about science. Students discuss scientific articles and essays and work in small groups to critique each other's writing. Assignments include a critical review, a science essay for the general public, and a research or service project proposal. Students choose topics that reflect their background and interests. Formal and informal presentations and group discussions develop oral communication skills. Limited to 18.

J. Melvold

21W.034 Science Writing and New Media: Perspectives on Medicine and Public Health
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.035, 21W.036

Public health topics, such as AIDS, asthma, malaria control, obesity, and sleep deprivation, provide a unifying focus as students explore diverse modes of science writing. Readings include essays by such writers as Atul Gawande, Danielle Ofri, Jerome Groopman, and William Carlos Williams, as well as peer-reviewed journal articles. Assignments include a critical review, a scientific literature review, a brochure suitable for general distribution, an autobiographical narrative, a resume, a job application letter, and oral presentations. Limited to 18.

C. Taft
21W.035 Science Writing and New Media: Elements of Science Writing for the Public
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.034, 21W.036
Provides an introduction to writing about science (including medicine, technology, and engineering) for general readers. Emphasizes background research as a foundation for strong science writing. Students read works by accomplished science writers. Each assignment focuses on a different popular form, such as news article, interview, essay, and short feature. Limited to 18.
J. Berezin, A. Carleton, K. Boiko

Advanced

Same subject as ES.729[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
3-1-8 units. HASS-E; CI-H
See description under subject ES.729[J]. Limited to 18; preference to ESG students.
D. Custer

21W.734[J] Objectification: How to Write (and Talk, and Think) about Objects
Same subject as MAS.377[J]
Subject meets with MAS.677
Prereq: None
U (Spring)
2-0-7 units. HASS-H; CI-H
See description under subject MAS.377[J]. Enrollment limited.
V. M. Bove, Jr., N. Jackson

21W.737[J] Topics and Methods in 21st-Century Journalism
Same subject as CMS.350[J]
Subject meets with CMS.850
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H
See description under subject CMS.350[J]. Limited to 12.
S. Mnookin

21W.738[J] Intersectional Feminist Memoir (New)
Same subject as WGS.238[J]
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H
See description under subject WGS.238[J].
K. Ragusa

21W.739[J] Darwin and Design
Same subject as 21L.022[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H
See description under subject 21L.022[J].
A. Kibel

21W.746 Humanistic Perspectives on Medicine: From Ancient Greece to Modern America
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H
For students with experience in nonfiction prose and interest in the non-science side of medicine. Advanced study of the art of essay (form, style, techniques of persuasion) and practice of that form. Students required to write substantial essays and revise their work. Students read and discuss the writings of distinguished physicians from antiquity to the late 20th century. Limited to 18.
K. Manning

21W.749 Documentary Photography and Photojournalism: Still Images of a World in Motion
Subject meets with CMS.935
Prereq: Permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-A
Designed to increase students’ understanding of, appreciation for, and ability to do documentary photography and photojournalism. Each three-hour class is divided between a discussion of issues and readings, and a group critique of students’ projects. Students must have their own photographic equipment and be responsible for processing and printing; either by student or commercial lab. Students must show basic proficiency with their equipment. Readings include Susan Sontag, Robert Coles, Ken Light, Eugene Richards, and others. Previous photographic experience required. Limited to 15.
B. D. Colen
**21W.775 Writing about Nature and Environmental Issues**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H; CI-H  

Focuses on traditional nature writing and the environmentalist essay. Students keep a web log as a journal. Writings are drawn from the tradition of nature writing and from contemporary forms of the environmentalist essay. Authors include Henry Thoreau, Loren Eiseley, Annie Dillard, Chet Raymo, Sue Hubbel, Rachel Carson, Bill McKibben, and Terry Tempest Williams. Limited to 18.  
C. Taft

**21W.777 Science Writing in Contemporary Society**  
Prereq: None  
U (Spring)  
3-0-9 units. HASS-H  

Drawing in part from their own interests and ideas, students write about science within various cultural contexts using an array of literary and reportorial tools. Studies the work of contemporary science writers, such as David Quammen and Atul Gawande, and examines the ways in which science and technology are treated in media and popular culture. Discussions focus on students’ writing and address topics such as false equivalency, covering controversy, and the attenuation of initial observations. Emphasizes long-form narratives; also looks at blogs, social media, and other modes of communication. Not a technical writing class.  
T. Levenson

**21W.778 Science Journalism**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H; CI-H  

An introduction to print daily journalism and news writing, focusing on science news writing in general, and medical writing in particular. Emphasis is on writing clearly and accurately under deadline pressure. Class discussions involve the realities of modern journalism, how newsrooms function, and the science news coverage in daily publications. Discussions of, and practice in, interviewing and various modes of reporting. In class, students write numerous science news stories on deadline. There are additional longer writing assignments outside of class. Enrollment limited.  
B. D. Colen

**21W.792 Science Writing Internship**  
Prereq: None  
U (Fall, Spring)  
0-12-0 units  
Can be repeated for credit.  

Students developing professional writing and publishing skills in part-time internships with Boston area media companies can apply to receive credit. Students planning to take this subject must contact the instructor by the end of November (if they are applying for spring semester) or the end of May (if they are applying for the fall semester).  
Staff

**Digital Media**

*Advanced*

**21W.750 Experimental Writing**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-A  

Students use innovative compositional techniques, focusing on new writing methods rather than on traditional lyrical or narrative concerns. Writing experiments, conducted individually, collaboratively and during class meetings, culminate in chapbook-sized projects. Students read, listen to, and create different types of work, including sound poetry, cut-ups, constrained and Oulipian writing, uncreative writing, sticker literature, false translations, artists’ books, and digital projects.  
N. Montfort

**21W.752 Making Documentary: Audio, Video, and More**  
Subject meets with 21W.824  
Prereq: 21A.550[J], 21W.786[J], or permission of instructor  
U (Spring)  
3-6-3 units. HASS-A  

Focuses on the technical demands of long-form storytelling in sound and picture. Students build practical writing and production skills through a series of assignments: still photo-text works, audio-only documentaries, short video projects (4-6 minutes), and a semester-long, team-produced video science documentary (12-15 minutes). Readings, screenings and written work hone students’ analytical capacity. Students taking the graduate version complete additional assignments. Students from the Graduate Program in Science Writing center their work on topics in science, technology, engineering, and/or medicine.  
T. Levenson
21W.753[J] Phantasmal Media: Computer-Based Art Theory and Practice
Same subject as CMS.314[J]
Subject meets with CMS.814
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-A
See description under subject CMS.314[J].
D. F. Harrell

21W.763[J] Transmedia Storytelling: Modern Science Fiction
Same subject as CMS.309[J]
Subject meets with CMS.809
Prereq: None
U (Spring)
3-2-7 units. HASS-A
Explores transmedia storytelling by investigating how science fiction stories are told across different media, such as the short story, the novel, the screenplay, moving image, and games. Students consider issues of aesthetics, authorship, and genre, while also contextualizing discussion within the broader framework of the political issues raised by film, TV, and other kinds of science fiction texts. Students taking graduate version complete additional assignments.
H. Hendershot

21W.764[J] The Word Made Digital
Same subject as CMS.609[J]
Subject meets with CMS.846
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A
Video games, digital art and literature, online texts, and source code are analyzed in the contexts of history, culture, and computing platforms. Approaches from poetics and computer science are used to understand the non-narrative digital uses of text. Students undertake critical writing and creative computer projects to encounter digital writing through practice. This involves reading and modifying computer programs; therefore previous programming experience, although not required, will be helpful. Students taking graduate version complete additional assignments. Limited to 18.
N. Montfort

21W.765[J] Interactive Narrative
Same subject as 21L.489[J], CMS.618[J]
Subject meets with CMS.845
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Provides a workshop environment for understanding interactive narrative (print and digital) through critical writing, narrative theory, and creative practice. Covers important multisequential books, hypertexts, and interactive fictions. Students write critically, and give presentations, about specific works; write a short multisequential fiction; and develop a digital narrative system, which involves significant writing and either programming or the structuring of text. Programming ability helpful.
N. Montfort

21W.768[J] Games and Culture
Same subject as CMS.616[J], WGS.125[J]
Subject meets with CMS.868
Prereq: None
U (Fall)
3-0-9 units. HASS-S
See description under subject CMS.616[J].
T. L. Taylor

21W.786[J] Social Justice and The Documentary Film
Same subject as CMS.336[J]
Subject meets with CMS.836
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A
Explores the history and current state of social-issue documentary. Examines how cultural and political upheaval and technological change have converged at different moments to bring about new waves of activist documentary film production. Particular focus on films and other non-fiction media of the present and recent past. Students screen and analyze a series of key films and work in groups to produce their own short documentary using digital video and computer-based editing. Students taking graduate version complete additional assignments. Limited to 18.
V. Bald
21W.787 Film, Music, and Social Change: Intersections of Media and Society
Subject meets with CMS.837
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Examines films from the 1950s onward that document music subcultures and moments of social upheaval. Combines screening films about free jazz, glam rock, punk, reggae, hip-hop, and other genres with an examination of critical/scholarly writings to illuminate the connections between film, popular music, and processes of social change. Students critique each film in terms of the social, political, and cultural world it documents, and the historical context and effects of the film's reception. Students taking graduate version complete additional assignments. Limited to 18.

V. Bald

21W.788[J] South Asian America: Transnational Media, Culture, and History
Same subject as CMS.334[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Examines the history of South Asian immigration, sojourning, and settlement from the 1880s to the present. Focuses on the US as one node in the global circulation, not only of people, but of media, culture and ideas, through a broader South Asian diaspora. Considers the concept of "global media" historically; emphasis on how ideas about, and self-representations of, South Asians have circulated via books, political pamphlets, performance, film, video/cassette tapes, and the internet. Students analyze and discuss scholarly writings, archival documents, memoirs, fiction, blogs and films, and write papers drawing on course materials, lectures, and discussions. Limited to 18.

V. Bald

21W.790[J] Short Attention Span Documentary
Same subject as CMS.335[J]
Subject meets with 21W.890
Prereq: None
U (Fall)
3-0-9 units. HASS-A

Focuses on the production of short (1- to 5-minute) digital video documentaries: a form of non-fiction filmmaking that has proliferated in recent years due to the ubiquity of palm-sized and mobile phone cameras and the rise of web-based platforms, such as YouTube. Students shoot, edit, workshop and revise a series of short videos meant to engage audiences in a topic, introduce them to new ideas, and/or persuade them. Screenings and discussions cover key principles of documentary film - narrative, style, pace, point of view, argument, character development - examining how they function and change in short format. Students taking graduate version complete additional assignments. Limited to 16.

V. Bald

21W.791[J] Network Cultures
Same subject as CMS.614[J]
Subject meets with CMS.867
Prereq: None
U (Spring)
3-0-9 units. HASS-H

See description under subject CMS.614[J].

T. L. Taylor

Additional Subjects

21W.798, 21W.799 Independent Study in Writing
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Primarily for students pursuing advanced writing projects with the assistance of a member of the Writing Program. Students electing this subject must secure the approval of the director of the Writing Program and its Committee on Curriculum. Normal maximum is 6 units; exceptional 9-unit projects occasionally approved. HASS credit awarded only by individual petition to the Subcommittee on the HASS Requirement; minimum of 9 units required for HASS credit. 21W.798 is P/D/F.

Staff
21W.S60 Special Subject: Writing
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

21W.THT Writing Pre-Thesis Tutorial
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Definition of and early stage work on a thesis project leading to 21W.THU. Taken during the first term of a student's two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Required of all students pursuing a full major in Course 21W. Joint majors register for 21.THT.
Staff

21W.THU Writing Program Thesis
Prereq: 21W.THT
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Completion of work on the senior major thesis under the supervision of a faculty tutor. Includes oral presentation of the thesis progress early in the term, assembling and revising the final text, and a final meeting with a committee of faculty evaluators to discuss the successes and limitations of the project. Required of students pursuing a full major in Course 21W. Joint majors register for 21.THU.
Staff

21W.UR Research in Writing
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.
Staff

21W.URG Research in Writing
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.
Staff

Graduate Subjects

21W.794 Graduate Technical Writing Workshop
Prereq: Permission of instructor
G (IAP)
2-0-1 units
Designed to improve the student's ability to communicate technical information. Covers the basics of working with sources, including summarizing and paraphrasing, synthesizing source materials, citing, quoting, and avoiding plagiarism. Also covers how to write an abstract and a literature review. Limited to graduate engineering students based on results of the Graduate Writing Exam.
Staff

Same subject as STS.477[J]
Prereq: 21H.991
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examination of different "voices" used to consider issues of scientific, technological, and social concern. Students write frequently and choose among a variety of non-fiction forms: historical writing, social analysis, political criticism, and policy reports. Instruction in expressing ideas clearly and in organizing a thesis-length work. Reading and writing on three case studies drawn from the history of science; the cultural study of technology and science; and policy issues.
K. Manning

21W.823 Lab Experience for Science Writers
Prereq: 21W.825
G (Fall, IAP, Spring)
0-2-1 units
During the fall or IAP, students conduct 20 hours of observation in a lab of their choosing that is outside their previous scientific experience. Participation in the work of the lab encouraged. In the spring, students make an in-class presentation and submit a written report of publication quality. Preference to students in the Graduate Program in Science Writing.
T. Levenson, M. Bartusiak
21W.824 Making Documentary: Audio, Video, and More
Subject meets with 21W.752
Prereq: 21A.550[J], 21W.786[J], or permission of instructor
G (Spring)
3-6-3 units

Focuses on the technical demands of long-form storytelling in sound and picture. Students build practical writing and production skills through a series of assignments: still photo-text works, audio-only documentaries, short video projects (4-6 minutes), and a semester-long, team-produced video science documentary (12-15 minutes). Readings, screenings and written work hone students' analytical capacity. Students taking the graduate version complete additional assignments. Students from the Graduate Program in Science Writing center their work on topics in science, technology, engineering, and/or medicine.

T. Levenson

21W.825 Advanced Science Writing Seminar I
Prereq: Permission of instructor
G (Fall)
6-0-18 units

First term of year-long graduate sequence in science writing offers students intensive workshops and critiques of their own writing, and that of published books, articles, and essays; discussions of ethical and professional issues; study of science and scientists in historical and social context; analysis of recent events in science and technology. Emphasis throughout on developing skills and habits of mind that enable the science writer to tackle scientifically formidable material and write about it for ordinary readers. Topics include the tools of research, conceived in its broadest sense-including interviewing, websites, archives, scientific journal articles; science journalism, including culture of the newsroom and magazine-style journalism; science essays. Considerable attention to science writing's audiences, markets, and publics and the special requirements of each.

Staff

21W.826 Advanced Science Writing Seminar II
Prereq: 21W.825 or permission of instructor
G (Spring)
3-0-9 units

Topics include research for writers, science journalism, and essays; literary science writing, and the social and historical context of science and technology. Includes seminars, lectures, and student writing workshops. Special emphasis on the science essay and on literary and imaginative science writing that employs traditionally fictive devices in nonfiction, including scene-setting and storytelling. Assignments cover science essays, writing on particular disciplines, and investigative and critical science journalism.

Graduate Program Faculty

21W.890 Short Attention Span Documentary
Subject meets with 21W.790[J], CMS.335[J]
Prereq: None
G (Fall)
3-0-9 units

Focuses on the production of short (1- to 5-minute) digital video documentaries: a form of non-fiction filmmaking that has proliferated in recent years due to the ubiquity of palm-sized and mobile phone cameras and the rise of web-based platforms, such as YouTube. Students shoot, edit, workshop and revise a series of short videos meant to engage audiences in a topic, introduce them to new ideas, and/or persuade them. Screenings and discussions cover key principles of documentary film - narrative, style, pace, point of view, argument, character development - examining how they function and change in short format. Students taking graduate version complete additional assignments. Limited to 16.

R. Adams

21W.892 Science Writing Internship
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-12-0 units

Field placements tailored to the individual backgrounds of the students enrolled, involving varying degrees of faculty participation and supervision.

Graduate Program Faculty

21W.898 Graduate Independent Study in Writing
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Opportunity for advanced independent study of writing under regular supervision by a faculty member. Projects require prior approval, as well as a written proposal and a final report.

Consult Staff

21W.899 Graduate Independent Study in Writing
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for advanced independent study of writing under regular supervision by a faculty member. Projects require prior approval, as well as a written proposal and a final report.

Consult Staff
21W.S96 Special Subject: Writing
Prereq: None
G (IAP)
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic that is not covered in the regular curriculum.

Staff

21W.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
6-0-18 units
Can be repeated for credit.

Research and writing of thesis in consultation with faculty, including individual meetings and group seminars, undertaken over the course of one year.

S. Mnookin
Computational and Systems Biology

CSB.100[J] Topics in Computational and Systems Biology
Same subject as 7.89[J]
Prereq: Permission of instructor
G (Fall)
2-0-10 units

Seminar based on research literature. Papers covered are selected to illustrate important problems and varied approaches in the field of computational and systems biology, and to provide students a framework from which to evaluate new developments. Preference to first-year CSB PhD students.

C. Burge

CSB.110 Research Rotations in Computational and Systems Biology
Prereq: Permission of instructor
G (Fall, Spring)
0-12-0 units
Can be repeated for credit.

Students carry out research rotations with MIT faculty members or principal investigators working in the field of computational and systems biology. Generally three one-month long rotations are pursued that together span theoretical and experimental approaches. Open only to CSB PhD students.

Staff

CSB.190 Research Problems in Computational and Systems Biology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Directed research in the field of computational and systems biology. Open only to CSB PhD students.

Staff

CSB.199 Teaching Experience in Computational Systems Biology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For qualified graduate students in the CSB graduate program interested in teaching. Classroom or laboratory teaching under the supervision of a faculty member.

Staff

CSB.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of PhD thesis; to be arranged by the student and the MIT faculty advisor.

Information: Faculty Advisor
Concourse Science Subjects

Chemistry

CC.511 Principles of Chemical Science
Prereq: None. Coreq: CC.010 or CC.A10
U (Fall)
5-0-7 units. CHEMISTRY
Credit cannot also be received for 3.091, 5.111, 5.112, ES.5111, ES.5112
Equivalent to 5.111; see 5.111 for description. Limited to students in Concourse.
E. Taylor

CC.512 Organic Chemistry I
Prereq: Chemistry (GIR); Coreq: CC.010, CC.011, or CC.A10
U (Spring)
5-0-7 units. REST
Credit cannot also be received for 5.12
Equivalent to 5.12; See 5.12 for description. Limited to students in Concourse.
E. Taylor

Mathematics

CC.1802 Calculus
Prereq: Calculus I (GIR); Coreq: CC.010, CC.011, or CC.A10
U (Fall)
5-0-7 units. CALC II
Credit cannot also be received for 18.02, 18.022, 18.02A, ES.1802, ES.182A
Equivalent to 18.02; see 18.02 for description. Limited to students in Concourse.
R. Winters

CC.1803 Differential Equations
Prereq: None. Coreq: Calculus II (GIR) and (CC.010, CC.011, or CC.A10)
U (Spring)
5-0-7 units. REST
Credit cannot also be received for 18.03, ES.1803
Equivalent to 18.03; see 18.03 for description. Limited to students in Concourse.
R. Winters

Physics

CC.801 Physics I
Subject meets with CC.8012
Prereq: None. Coreq: CC.010 or CC.A10
U (Fall)
5-0-7 units. PHYSICS I
Equivalent to 8.01; see 8.01 for description. Limited to students in Concourse.
S. Drasco

CC.8012 Physics I
Subject meets with CC.801
Prereq: None. Coreq: CC.010 or CC.A10
U (Fall)
Not offered regularly; consult department
5-0-7 units. PHYSICS I
Equivalent to 8.012; see 8.012 for description. Limited to students in Concourse.
J. Bloomfield

CC.802 Physics II
Subject meets with CC.8022
Prereq: Calculus I (GIR) and Physics I (GIR); Coreq: CC.010, CC.011, or CC.A10
U (Spring)
5-0-7 units. PHYSICS II
Equivalent to 8.02; see 8.02 for description. Limited to students in Concourse.
S. Drasco

CC.8022 Physics II
Subject meets with CC.802
Prereq: Physics I (GIR); Coreq: Calculus II (GIR)
U (Spring)
Not offered regularly; consult department
5-0-7 units. PHYSICS II
Equivalent to 8.022; see 8.022 for description. Limited to students in Concourse.
S. Drasco
**Concourse HASS Subjects**

**CC.110 Becoming Human: Ancient Greek Perspectives on the Good Life**
Prereq: None. Coreq: CC.010 or CC.A10
U (Fall)
3-0-9 units. HASS-H; CI-H

Explores the question of the good life in the major literary and philosophic thinkers of ancient Greece. Considers topics such as justice, moral virtue, friendship, love, and the life of the mind both for an individual and as part of society. Students debate the classical Greek answers to these questions and consider ways in which these answers apply to our present lives. Includes selected works by authors such as Homer, Sophocles, Euripides, Aristophanes, Plato, Aristotle, and Epicurus. Limited to students in Concourse.  
*L. Rabieh*

**CC.111[J] Modern Conceptions of Freedom**
Same subject as 17.04[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H

Students read early modern political theorists, and trace the growth of the value of freedom. Examines the modern definition of freedom, and the obligations that people accept in honoring it. Also investigates how these obligations are captured in the principles of our political association. Studies how the centrality of freedom plays out in the political thought of such authors as Hobbes, Locke, Rousseau, Burke and Montesquieu. Students also debate which notions of freedom inspire and sustain the American experiment by carefully reading the documents and arguments of the founding of the United States. Preference to students in Concourse.  
*L. Rabieh*

**CC.116 How to Rule the World: The Promises and Pitfalls of Politics, War, and Empire**
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-H; CI-H

Explores the ambitions and constraints of political rule in order to understand how transformational leaders have (or should have) managed both in the service of good government. Employs normative and empirical methods to assess effective leadership, with particular attention to trade-offs between justice and security and to competing notions of justice itself. Includes case studies and various foundational texts that address the theme of great political leadership. Drawing on the texts, students discern different criteria for good rule and assess both the adequacy of those criteria and whether case studies support them. Preference to Concourse students.  
*L. Rabieh*

**CC.117[J] Humane Warfare: Ancient and Medieval Perspectives on Ethics in War**
Same subject as 17.05[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H

Explores questions of justice and ethics in war by focusing on primary texts of pre-modern works of history, philosophy, literature, and Biblical interpretation. Readings from antiquity include Thucydides, Aristophanes, and Cicero. Examination of the Biblical tradition of just war, itself informed by the classical tradition, includes readings from early and Medieval Christian and Islamic thinkers and proceeds through the early Renaissance, with the beginning of a formalized doctrine of just war theory. Readings about current ethical dilemmas of war are discussed throughout and are given sustained attention at the end of the term. Preference to Concourse students.  
*L. Rabieh*

**CC.120[J] Making Books in the Renaissance and Today**
Same subject as 21H.343[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-A

See description under subject 21H.343[J]. Limited to 12.  
*E. Zimmer*
Concourse Seminars

CC.010 Seminar I
Subject meets with CC.A10
Prereq: Permission of instructor
U (Fall)
2-0-4 units
Can be repeated for credit.
The key academic integration in which philosophical, historical, and sociological topics are connected with modern science. Combination of outside speakers and Concourse faculty lead weekly luncheon discussion. Limited to Concourse students.
Staff

CC.011 Seminar II
Prereq: None
U (Spring)
2-0-1 units
Can be repeated for credit.
Researchers from across MIT join the Concourse seminar to explore the topic of “Thinking Across the Disciplines.” Concourse faculty lead weekly luncheon discussions with our guests from the wider MIT faculty. Preference to students in Concourse.
Staff

CC.012 Continuing Conversations
Prereq: None
U (Fall, Spring)
2-0-1 units
Can be repeated for credit.
Close reading and vigorous discussion of an important book or theme, chosen to explore philosophical, ethical, and political questions that span the ages and disciplines. Readings and themes vary by term. Past examples include Aristotle’s Physics, Plato’s dialogue on knowledge, the Theaetetus, and a variety of writings that exemplify liberalism and conservatism in the American tradition. Preference to Concourse students.
L. Rabieh, A. McCants

Concourse Teaching and Research

CC.200 Concourse Program Undergraduate Teaching
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Tutoring, leadership of study and review groups, seminars and recitations in the Concourse Program, under the supervision of senior Concourse staff. Limited to students in Concourse.
Staff

CC.210 Independent Study
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and a final report. Limited to students in Concourse.
Staff

CC.220 Independent Study
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.
Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and a final report. Limited to students in Concourse.
Staff

CC.UR Undergraduate Research
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
For students wishing to pursue undergraduate research opportunities in Concourse. Limited to students in Concourse.
Staff
Concourse Special Subjects

CC.S10 Special Subject: Concourse
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May be repeated for credit with permission of instructor. Preference to students in Concourse.

Staff

CC.S11 Special Subject: Concourse
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May be repeated for credit with permission of instructor. Preference to students in Concourse.

Staff

CC.S20, CC.S21 Special Subject: Concourse
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May be repeated for credit with permission of instructor. Preference to students in Concourse.

Staff

CC.S81 Special Subject: Exploring Mathematical Mechanics (New)
Prereq: None. Coreq: Physics I (GIR)
U (Fall)
2-0-1 units

This exploratory seminar offers students a deeper mathematical introduction to classical mechanics than they receive in the standard CC.801 subject. The extra material shares some topics with the mainstream subject 8.012, but here pursued in an exploratory context. In addition, toward the end of the semester, students will be introduced to the basic principles of special and general relativity. Meets twice weekly to discuss physics concepts that go beyond the 8.01 lectures as well as to work on more advanced kinds of problems. This seminar hopes to further engage students already interested in majoring in physics, as well as those who wish simply to explore what physics has to offer. Licensed for academic year 2019-2020 by the Committee on Curricula. Subject can count toward the 9-unit discovery-focused credit limit for first year students. Limited to students enrolled in Concourse.

R. Lang
IDS.012[J] Statistics, Computation and Applications
Same subject as 6.419[J]
Subject meets with 6.439[J], IDS.131[J]
Prereq: ((2.087, 6.0002, 6.01, 18.03, or 18.06) and (6.008, 6.041, 14.30, 16.09, or 18.05)) or permission of instructor
U (Fall)
3-1-8 units

Hands-on analysis of data demonstrates the interplay between statistics and computation. Includes four modules, each centered on a specific data set, and introduced by a domain expert. Provides instruction in specific, relevant analysis methods and corresponding algorithmic aspects. Potential modules may include medical data, gene regulation, social networks, finance data (time series), traffic, transportation, weather forecasting, policy, or industrial web applications. Projects address a large-scale data analysis question. Students taking graduate version complete additional assignments. Enrollment limited; priority to Statistics and Data Science minors, and to juniors and seniors.
S. Jegelka

IDS.013[J] Statistical Thinking and Data Analysis
Same subject as 15.075[J]
Prereq: 6.041B or 15.0791
U (Spring)
3-1-8 units. Institute LAB
Credit cannot also be received for 18.650[J], 18.6501, IDS.014[J]
See description under subject 15.075[J].
R. Mazumder

IDS.014[J] Fundamentals of Statistics
Same subject as 18.650[J]
Subject meets with 18.6501
Prereq: 18.600 or 6.041
U (Fall, Spring)
4-0-8 units
Credit cannot also be received for 15.075[J], IDS.013[J]
See description under subject 18.650[J].
Fall: P. Rigollet. Spring: T. Maunu

IDS.045[J] System Safety
Same subject as 16.63[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. REST
See description under subject 16.63[J].
N. Leveson

IDS.055[J] Science, Technology, and Public Policy
Same subject as 17.309[J], STS.082[J]
Prereq: None
U (Spring)
4-0-8 units. HASS-S; CI-H
Credit cannot also be received for 17.310[J], IDS.412[J], STS.482[J]
See description under subject 17.309[J].
K. Oye, N. Selin

IDS.060[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 1.801[J], 11.021[J], 17.393[J]
Subject meets with 1.811[J], 11.630[J], 15.663[J], IDS.540[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Reviews and analyzes federal and state regulation of air and water pollution, hazardous waste, green-house gas emissions, and the production and use of toxic chemicals. Analyzes pollution as an economic problem and the failure of markets. Explores the role of science and economics in legal decisions. Emphasizes use of legal mechanisms and alternative approaches (such as economic incentives and voluntary approaches) to control pollution and encourage chemical accident and pollution prevention. Focuses on the major federal legislation, the underlying administrative system, and the common law in analyzing environmental policy, economic consequences, and the role of the courts. Discusses classical pollutants and toxic industrial chemicals, green-house gas emissions, community right-to-know, and environmental justice. Develops basic legal skills: how to read/understand cases, regulations, and statutes. Students taking graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart
IDS.061[J] Regulation of Chemicals, Radiation, and Biotechnology
Same subject as 1.802[J], 11.022[J]
Subject meets with 1.812[J], 10.805[J], 11.631[J], IDS.436[J], IDS.541[J]
Prereq: IDS.060[J] or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units
Focuses on policy design and evaluation in the regulation of hazardous substances and processes. Includes risk assessment, industrial chemicals, pesticides, food contaminants, pharmaceuticals, radiation and radioactive wastes, product safety, workplace hazards, indoor air pollution, biotechnology, victims' compensation, and administrative law. Health and economic consequences of regulation, as well as its potential to spur technological change, are discussed for each regulatory regime. Students taking the graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart

IDS.062[J] Global Environmental Negotiations
Same subject as 12.346[J]
Subject meets with 12.846[J], IDS.525[J]
Prereq: Permission of instructor
U (Fall)
Not offered regularly; consult department
2-0-4 units
Practical introduction to global environmental negotiations designed for science and engineering students. Covers basic issues in international negotiations, such as North-South conflict, implementation and compliance, trade, and historical perspective on global environmental treaties. Offers hands-on practice in developing and interpreting international agreements through role-play simulations and observation of ongoing climate change negotiating processes. Students taking graduate version complete additional assignments.
N. E. Selin

IDS.063[J] People and the Planet: Environmental Governance and Science
Same subject as 12.387[J], 15.874[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-6 units
See description under subject 12.387[J].
N. Selin, S. Solomon, J. Sterman

IDS.064 Engineering, Economics and Regulation of the Electric Power Sector
Subject meets with 6.695[J], 15.032[J], IDS.505[J]
Prereq: 14.01, 22.081[J], IDS.060[J], or permission of instructor
U (Spring)
3-0-9 units
Provides an in-depth and interdisciplinary look at electric power systems, focusing on regulation as the link among engineering, economic, legal, and environmental viewpoints. Topics include electricity markets, incentive regulation of network utilities, retail competition, tariff design, distributed generation, rural electrification, multinational electricity markets, environmental impacts, and the future of utilities and strategic sustainability issues under both traditional and competitive regulatory frameworks. Background in policy, microeconomics, or engineering desirable. Students taking graduate version complete additional assignments.
I. Perez-Arriaga

IDS.131[J] Statistics, Computation and Applications
Same subject as 6.439[J]
Subject meets with 6.419[J], IDS.012[J]
Prereq: ((2.087, 6.0002, 6.01, 18.03, or 18.06) and (6.008, 6.041, 14.30, 16.09, or 18.05)) or permission of instructor
G (Fall)
3-1-8 units
Hands-on analysis of data demonstrates the interplay between statistics and computation. Includes four modules, each centered on a specific data set, and introduced by a domain expert. Provides instruction in specific, relevant analysis methods and corresponding algorithmic aspects. Potential modules may include medical data, gene regulation, social networks, finance data (time series), traffic, transportation, weather forecasting, policy, or industrial web applications. Projects address a large-scale data analysis question. Students taking graduate version complete additional assignments. Limited enrollment; priority to Statistics and Data Science minors and to juniors and seniors.
S. Jegelka
Same subject as 6.244[J]
Prereq: 6.431 and 18.06
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Provides instruction in the geometric, algebraic and combinatorial perspective on graphical models. Presents methods for learning the underlying graph and inferring its parameters. Topics include exponential families, duality theory, conic duality, polyhedral geometry, undirected graphical models, Bayesian networks, Markov properties, total positivity of distributions, hidden variables, and tensor decompositions.
C. Uhler

IDS.145[J] Data Mining: Finding the Models and Predictions that Create Value
Same subject as 15.062[J]
Subject meets with 15.0621
Prereq: 15.060, 15.075[J], or permission of instructor
G (Fall; second half of term)
2-0-4 units
See description under subject 15.062[J].
R. E. Welsch

IDS.147[J] Statistical Learning and Data Mining
Same subject as 15.077[J]
Prereq: None
G (Spring)
4-0-8 units
See description under subject 15.077[J].
R. E. Welsch

IDS.160[J] Mathematical Statistics (New)
Same subject as 9.521[J]
Prereq: (6.436[J], 18.06, and 18.6501) or permission of instructor
G (Spring)
4-0-8 units
See description under subject 9.521[J].
S. Rakhlin

IDS.190 Doctoral Seminar in Statistics and Data Science
Prereq: None
G (Fall)
1-0-2 units
Interdisciplinary seminar explores diverse topics in statistics and data science. Restricted to students in the Interdisciplinary Doctoral Program in Statistics.
Consult D. Shah

IDS.200[J] Optimization Methods
Same subject as 6.255[J], 15.093[J]
Subject meets with 6.215
Prereq: 18.06
G (Fall)
4-0-8 units
See description under subject 15.093[J].
D. Bertsimas, P. Parrilo

Same subject as 1.271[J], 15.764[J]
Prereq: (6.436[J] and (6.251[J] or 6.251[J])) or permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.
See description under subject 15.764[J].
D. Simchi-Levi, N. Trichakis, K. Zheng

IDS.305[J] Business and Operations Analytics
Same subject as 1.275[J]
Prereq: Permission of instructor
G (Spring; first half of term)
2-0-4 units
Provides instruction on identifying, evaluating, and capturing business analytics opportunities that create value. Also provides basic instruction in analytics methods and case study analysis of organizations that successfully deployed these techniques.
D. Simchi-Levi
IDS.330 Real Options for Product and Systems Design
Prereq: IDS.333 or permission of instructor
G (Spring; second half of term)
3-0-3 units

Focuses on implementation of flexibility (real options) in the design of products and systems. Applies the methods presented in IDS.333: recognition of uncertainty, identification of best opportunities for flexibility, and valuation of these options and their effective implementation. Students' work culminates in a dynamic business plan for design and deployment of products, start-ups, ongoing management of operations, or policy plans. Students bring their own project concept, which they will analyze during the class. Useful complement to thesis or research projects.

R. de Neufville

IDS.332 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject.
Offered under: 1.146, 16.861, IDS.332
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Credit cannot also be received for IDS.333

Practical-oriented subject that builds upon theory and methods and culminates in extended application. Covers methods to identify, value, and implement flexibility in design (real options). Topics include definition of uncertainties, simulation of performance for scenarios, screening models to identify desirable flexibility, decision analysis, and multidimensional economic evaluation. Students demonstrate proficiency through an extended application to a system design of their choice. Complements research or thesis projects. Meets with IDS.333 first half of term. Enrollment limited.

R. de Neufville

IDS.333 Risk and Decision Analysis
Prereq: None
G (Fall; first half of term)
3-0-3 units

Credit cannot also be received for 1.146, 16.861, IDS.332

Focuses on design choices and decisions under uncertainty. Topics include identification and description of uncertainties using probability distributions; the calculation of commensurate measures of value, such as expected net present values; Monte Carlo simulation and risk analysis; and the use of decision analysis to explore alternative strategies and identify optimal initial choices. Presents applied analysis of practical examples from a variety of engineering systems using spreadsheet and decision analysis software. Meets with IDS.333 first half of term.

R. de Neufville

IDS.336[J] Systems Architecting Applied to Enterprises
Same subject as 16.855[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Focuses on principles and practices for architecting new and evolving sociotechnical enterprises. Includes reading and discussions of enterprise theory, contemporary challenges, and case studies of evolving enterprises. Covers frameworks and methods for ecosystem analysis, stakeholder analysis, architecture design and evaluation, and implementation strategies. Students work in small teams on projects to design a future architecture for a selected real-world enterprise.

D. Rhodes

IDS.337[J] Aerospace Biomedical and Life Support Engineering
Same subject as 16.423[J], HST.515[J]
Prereq: 16.06, 16.400, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

See description under subject 16.423[J].

D. J. Newman

IDS.338[J] Multidisciplinary Design Optimization
Same subject as 16.888[J]
Prereq: 18.085 or permission of instructor
G (Spring)
3-1-8 units


O. de Weck
IDS.339[J] Space Systems Engineering
Same subject as 16.89[J]
Prereq: 16.851 or permission of instructor
G (Spring)
4-2-6 units

See description under subject 16.89[J].
E. F. Crawley, J. A. Hoffman

IDS.340[J] System Safety Concepts
Same subject as 16.863[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

See description under subject 16.863[J].
N. G. Leveson

IDS.341[J] Concepts in the Engineering of Software
Same subject as 16.355[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

See description under subject 16.355[J].
N. G. Leveson

IDS.345[J] Digital Evolution: Managing Web 3.0
Same subject as 15.565[J]
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-6 units

See description under subject 15.565[J].
S. Madnick

IDS.410 Modeling and Assessment for Policy
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-6 units

Explores how scientific information and quantitative models can be used to inform policy decision-making. Develops an understanding of quantitative modeling techniques and their role in the policy process through case studies and interactive activities. Addresses issues such as analysis of scientific assessment processes, uses of integrated assessment models, public perception of quantitative information, methods for dealing with uncertainties, and design choices in building policy-relevant models. Examples focus on models and information used in Earth system governance.
N. E. Selin

IDS.411 Concepts and Research in Technology and Policy
Prereq: Permission of instructor
G (Fall)
3-0-6 units
Core integrative subject, with substantive participation from a series of guest faculty lecturers, examines key technology-policy concepts. Explores alternative framings of roles of technology in policy, emphasizing the implications of these alternatives upon problem-solving in the area. Exercises prepare students to apply these concepts in the framing of their thesis research. Preference to first-year students in the Technology and Policy Program.
F. Field

IDS.412[J] Science, Technology, and Public Policy
Same subject as 17.310[J], STS.482[J]
Prereq: Permission of instructor
G (Spring)
4-0-8 units
Credit cannot also be received for 17.309[J], IDS.055[J], STS.082[J]
See description under subject 17.310[J].
K. Oye, N. Selin

IDS.435[J] Law, Technology, and Public Policy
Same subject as 15.655[J]
Prereq: None
G (Fall)
3-0-9 units
Examines the relationship between law and technological change, and the ways in which law, economics, and technological change shape public policy. Addresses how law can be used to influence and guide technological change; responses of the legal system to environmental, safety, social and ethical problems created by new or existing technology; how law and markets interact to limit or encourage technological development; and how law can affect distribution of wealth and social justice. Covers climate change; genetic engineering; telecommunications; industrial automation; the effect of health, safety, and environmental regulation on technological innovation; the impacts of intellectual property law on innovation and equity; pharmaceuticals; nanotechnology; cost/benefit analysis as a decision tool; public participation in governmental decisions affecting science and technology; corporate influence on technology; and law and economics as competing paradigms to encourage sustainability. Permission of instructor required for freshmen and sophomores.
N. Ashford, C. Caldart
Same subject as 10.805[J]
Subject meets with 1.802[J], 1.812[J], 11.022[J], 11.631[J], IDS.061[J], IDS.541[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
Addresses relationship between technology-related problems and the law applicable to work environment. National Labor Relations Act, Occupational Safety and Health Act. Toxic Substances Control Act, state worker’s compensation, and suits by workers in the courts discussed. Problems related to occupational health and safety, collective bargaining as a mechanism for altering technology in the workplace, job alienation, productivity, and the organization of work addressed. Prior courses or experience in the environmental, public health, or law-related areas.
N. A. Ashford, C. C. Caidart

IDS.437[J] Technology, Globalization, and Sustainable Development
Same subject as 1.813[J], 11.466[J], 15.657[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Investigates sustainable development, taking a broad view to include not only a healthy economic base, but also a sound environment, stable employment, adequate purchasing power, distributional equity, national self-reliance, and maintenance of cultural integrity. Explores national, multinational, and international political and legal mechanisms to further sustainable development through transformation of the industrial state. Addresses the importance of technological innovation and the financial crisis of 2008.
N. Ashford

IDS.449 Technology Policy Internship Seminar
Prereq: IDS.411 or permission of instructor
G (Fall)
1-1-1 units
Can be repeated for credit.
Seminar examines what technology policy is in practice. Considers the question of “Who achieves what, when, how, and why?” regarding technology policy. Students who completed summer internships present and dissect their experiences with special reference to specific cases in which they participated.
F. Field

IDS.505[J] Engineering, Economics and Regulation of the Electric Power Sector
Same subject as 6.695[J], 15.032[J]
Subject meets with IDS.064
Prereq: 14.01, 22.081[J], IDS.060[J], or permission of instructor
G (Spring)
3-0-9 units
Provides an in-depth and interdisciplinary look at electric power systems, focusing on regulation as the link among engineering, economic, legal, and environmental viewpoints. Topics include electricity markets, incentive regulation of network utilities, retail competition, tariff design, distributed generation, rural electrification, multinational electricity markets, environmental impacts, and the future of utilities and strategic sustainability issues under both traditional and competitive regulatory frameworks. Background in policy, microeconomics, or engineering desirable. Students taking graduate version complete additional assignments.
I. Perez-Arriaga

IDS.521 Energy Systems and Climate Change Mitigation
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Reviews the contributions of energy systems to global greenhouse gas emissions, and the levers for reducing those emissions. Lectures and projects focus on evaluating energy systems against climate policy goals, using performance metrics such as cost, carbon intensity, and others. Student projects explore pathways for realizing emissions reduction scenarios. Projects address the climate change mitigation potential of energy technologies, technological and behavioral change trajectories, and technology and policy portfolios.
J. Trancik
IDS.522 Mapping and Evaluating New Energy Technologies
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Project-based seminar covers recent developments in energy conversion and storage technologies. Merits of alternative technologies are debated based on their environmental performance and cost, and their potential improvement and scalability. Project teams develop quantitative models and interactive visualization tools to inform the future development of these technologies. Models may probe how the impact of a technology depends on assumptions about future advancements in materials or device design. Other projects may develop models for rational design choices (the selection of a particular material or processing technique) based on economic and environmental performance and physical constraints.
J. Trancik

IDS.524[J] People and the Planet: Environmental Histories and Engineering
Same subject as 11.204[J]
Subject meets with 11.004[J], STS.033[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-3-6 units
See description under subject 11.204[J].
J. Knox-Hayes, A. Slocum, R. Scheffler, J. Trancik

IDS.525[J] Global Environmental Negotiations
Same subject as 12.846[J]
Subject meets with 12.346[J], IDS.062[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
2-0-4 units
Practical introduction to global environmental negotiations designed for science and engineering students. Covers basic issues in international negotiations, such as North-South conflict, implementation and compliance, trade, and historical perspective on global environmental treaties. Offers hands-on practice in developing and interpreting international agreements through role-play simulations and observation of ongoing climate change negotiating processes. Students taking graduate version complete additional assignments.
N. Selin

IDS.526[J] Sustainability Science and Engineering
Same subject as 12.845[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-6 units
Introduces and develops core ideas and concepts in the field of sustainability science and engineering from an engineering systems perspective. Takes an interdisciplinary approach to discuss case studies of sustainability systems research. Exposes students to techniques for sustainability research across engineering, natural and social science disciplines. Term projects focus on applying techniques.
N. E. Selin

IDS.540[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 1.811[J], 11.630[J], 15.663[J]
Subject meets with 1.801[J], 11.021[J], 17.393[J], IDS.060[J]
Prereq: None
G (Spring)
3-0-9 units
Reviews and analyzes federal and state regulation of air and water pollution, hazardous waste, green-house gas emissions, and the production and use of toxic chemicals. Analyzes pollution as an economic problem and the failure of markets. Explores the role of science and economics in legal decisions. Emphasizes use of legal mechanisms and alternative approaches (such as economic incentives and voluntary approaches) to control pollution and encourage chemical accident and pollution prevention. Focuses on the major federal legislation, the underlying administrative system, and the common law in analyzing environmental policy, economic consequences, and the role of the courts. Discusses classical pollutants and toxic industrial chemicals, green-house gas emissions, community right-to-know, and environmental justice. Develops basic legal skills: how to read/understand cases, regulations, and statutes. Students taking graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart
IDS.541[J] Regulation of Chemicals, Radiation, and Biotechnology
Same subject as 1.812[J], 11.631[J]
Subject meets with 1.802[J], 10.805[J], 11.022[J], IDS.061[J], IDS.436[J]
Prereq: IDS.540[J] or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Focuses on policy design and evaluation in the regulation of hazardous substances and processes. Includes risk assessment, industrial chemicals, pesticides, food contaminants, pharmaceuticals, radiation and radioactive wastes, product safety, workplace hazards, indoor air pollution, biotechnology, victims' compensation, and administrative law. Health and economic consequences of regulation, as well as its potential to spur technological change, are discussed for each regulator regime. Students taking the graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart

IDS.620[J] Principles and Practice of Drug Development
Same subject as 7.547[J], 10.547[J], 15.136[J], HST.920[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units
See description under subject 15.136[J].
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

IDS.670[J] Planning and Design of Airport Systems
Same subject as 1.231[J], 16.781[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 1.231[J].
R. de Neufville, A. R. Odoni

Same subject as 1.203[J], 15.073[J]
Prereq: 6.041B or 18.600
G (Fall)
3-0-9 units
See description under subject 15.073[J].
A. Barnett

IDS.720[J] Tools for Analysis: Design for Real Estate and Infrastructure Development
Same subject as 11.434[J], 15.428[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units
See description under subject 11.434[J].
D. Geltner, R. de Neufville

IDS.730[J] Logistics Systems
Same subject as 1.260[J], 15.770[J], SCM.260[J]
Subject meets with SCM.271
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject SCM.260[J].
Y. Sheffi, C. Caplice

IDS.735[J] Supply Chain Planning
Same subject as 1.273[J], 15.762[J]
Prereq: 15.761 or SCM.260[J]
G (Spring; first half of term)
2-0-4 units
See description under subject 15.762[J].
D. Simchi-Levi

IDS.736[J] Manufacturing System and Supply Chain Design
Same subject as 1.274[J], 15.763[J]
Prereq: 15.761, 15.778, or SCM.260[J]
G (Spring; second half of term)
2-0-4 units
See description under subject 15.763[J].
D. Simchi-Levi

IDS.900 Doctoral Seminar in Social and Engineering Systems
Prereq: Permission of instructor
G (Fall)
2-0-1 units
Introduces doctoral students to IDSS research areas. Preference to first-year students in SES.
A. Abadie, A. Jadbabaie
IDS.910 Leadership Development
Prereq: Permission of instructor
G (Fall; partial term)
Not offered regularly; consult department
1-1-1 units
Seminar environment created to develop leadership capabilities, and
to take advantage of leadership opportunities. An initial Outward
Bound experience builds trust, teamwork and communications.
Readings and assignments emphasize the characteristics of desired
leadership skills. Global leaders participate in the Leadership
Lunch series to share their experiences and recommendations.
Discussions explore leadership development. Culminates in a
personal leadership plan. Restricted to entering students in the
Technology and Policy program or instructor permission.

IDS.950 Independent Study in Data, Systems, and Society
Prereq: Permission of IDSS Academic Office
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For graduate students in IDSS. Individual study in data, systems, and
society. Intended to expose student to expert-level domain material.
Supervised by a member of MIT’s teaching staff.
Consult IDSS Academic Office

IDS.951 Independent Study in Technology and Policy
Prereq: Permission of TPP Education Office
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For graduate students in TPP. Individual study in technology and
policy. Intended to expose student to expert-level domain material.
Supervised by a member of MIT’s teaching staff.
Consult TPP Education Office

IDS.955 Practical Experience in Data, Systems, and Society
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For IDSS doctoral students participating in off-
campus internship experiences in data, systems, and society. Before
registering for this subject, students must have an employment offer
from a company or organization, must identify a research supervisor,
and must receive prior approval from the IDSS Academic Office.
Upon completion of the experience, student must submit a letter
from the employer describing the goals accomplished, along with
a substantive final report from the student approved by the MIT
supervisor.
Consult IDSS Academic Office

IDS.956 Practical Experience in Technology and Policy
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
For TPP students participating in off-campus internship experiences
in technology and policy. Before registering for this subject, students
must have an employment offer from a company or organization,
must identify a research supervisor, and must receive prior approval
from the TPP Education Office. Upon completion of the internship,
student must submit a letter from the employer describing the work
accomplished, along with a substantive final report from the student
approved by the MIT supervisor.
Consult TPP Education Office

IDS.960 Teaching in Data, Systems, and Society
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
For Teaching Assistants in IDSS, in cases where teaching assignment
is approved for academic credit. Laboratory, tutorial, or classroom
teaching under supervision of a faculty member. Credit for this
subject may not be used for any degree granted by IDSS.
Consult IDSS Academic Office
IDS.961 Teaching in Technology and Policy
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
For Teaching Assistants in TPP, in cases where teaching assignment is approved for academic credit. Laboratory, tutorial, or classroom teaching under supervision of a faculty member. Credit for this subject may not be used for any degree granted by IDSS.
Consult TPP Academic Office

IDS.970 Research in Data, Systems, and Society
Prereq: None
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For Research Assistants in IDSS when assigned research is not used for thesis, but is approved for academic credit. Credit for this subject may not be used for any degree granted by IDSS.
Consult IDSS Academic Office

IDS.971 Research in Technology and Policy
Prereq: None
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For research assistants in TPP when assigned research is not used for thesis, but is approved for academic credit. Credit for this subject may not be used for any degree granted by IDSS.
Consult TPP Academic Office

IDS.S00 Special Undergraduate Subject in Data, Systems, and Society
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for study of topics in Data, Systems, and Society not otherwise included in the curriculum. Offerings initiated by faculty on an ad hoc basis subject to IDSS approval.
Consult IDSS Academic Office

IDS.S01 Special Undergraduate Subject in Data, Systems, and Society
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for study of topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad hoc basis subject to IDSS approval.
Consult IDSS Academic Office

IDS.S10 Special Undergraduate Subject in Data, Systems, and Society
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for study of topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad hoc basis subject to IDSS approval.
Consult IDSS Academic Office

IDS.S11 Special Undergraduate Subject in Data, Systems, and Society
Prereq: None
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for study of topics in Data, Systems, and Society not otherwise included in the curriculum. Offerings initiated by faculty on an ad hoc basis subject to IDSS approval.
Consult IDSS Academic Office

IDS.S20 Special Graduate Subject in Data, Systems, and Society
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for study of advanced topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad hoc basis subject to IDSS approval.
Consult IDSS Academic Office
IDS.S21 Special Graduate Subject in Data, Systems, and Society
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for study of advanced topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to IDSS approval.

Information: Consult IDSS Academic Office

IDS.S22 Special Graduate Subject in Data, Systems, and Society
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for study of advanced topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to IDSS approval.

Consult IDSS Academic Office

IDS.S23 Special Graduate Subject in Data, Systems, and Society
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for study of advanced topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to IDSS approval.

Consult IDSS Academic Office

IDS.S24 Special Graduate Subject in Data, Systems, and Society
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for study of advanced topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to IDSS approval.

Consult IDSS Academic Office

IDS.S30 Special Graduate Subject in Data, Systems, and Society
Prereq: None
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for study of advanced topics in Data, Systems, and Society not otherwise included in the curriculum. Offerings are initiated by faculty on an ad-hoc basis subject to IDSS approval.

Staff

IDS.S31 Special Graduate Subject in Data, Systems, and Society
Prereq: None
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for individual or group study of advanced topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to IDSS approval.

Consult IDSS Academic Office

IDS.S32 Special Graduate Subject in Data, Systems, and Society
Prereq: None
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for individual or group study of advanced topics in Data, Systems, and Society not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to IDSS approval.

Consult IDSS Academic Office

IDS.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research, leading to the writing of an SM or PhD thesis to be arranged by the student with a member of the IDSS faculty. A minimum of 24 thesis units are required for the SM degree.

Consult IDSS Academic Office
IDS.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Undergraduate research opportunities in Data, Systems, and Society.

IDSS Academic Office

IDS.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Undergraduate research opportunities in Data, Systems, and Society.

Consult IDSS Academic Office
Undergraduate Subjects

Core and General Science Subjects

12.00 Frontiers and Careers in Earth, Planets, Climate, and Life
Prereq: None
U (Spring)
2-0-0 units
Provides a broad overview of topics, technologies, and career paths at the forefront of Earth, Atmospheric and Planetary Sciences. Introduces the complex interplay between physics, mathematics, chemistry, biology, and computational methods used to study processes associated with a changing Earth and climate, distant planets, and life. Sessions guided by faculty members discussing current research problems, and by EAPS alumni describing how their careers have evolved. Subject can count toward the 9-unit discovery-focused credit limit for first year students.
T. Herring

12.000 Solving Complex Problems
Prereq: None
U (Fall)
1-2-6 units
Provides an opportunity for entering freshmen to gain firsthand experience in integrating the work of small teams to develop effective solutions to complex problems in Earth system science and engineering. Each year’s class explores a different problem in detail through the study of complementary case histories and the development of creative solution strategies. Includes exercises in website development, written and oral communication, and team building. Subject required for students in the Terrascope freshman program, but participation in Terrascope is not required of all 12.000 students. Students who pass 12.000 are eligible to participate in the Terrascope field trip the following spring. Limited to freshmen.
D. McGee, A. Epstein

12.001 Introduction to Geology
Prereq: None
U (Fall)
3-4-5 units. REST
Major minerals and rock types, rock-forming processes, and time scales. Temperatures, pressures, compositions, structure of the Earth, and measurement techniques. Geologic structures and relationships observable in the field. Sediment movement and landform development by moving water, wind, and ice. Crustal processes and planetary evolution in terms of global plate tectonics with an emphasis on ductile and brittle processes. Includes laboratory exercises on minerals, rocks, mapping, plate tectonics, rheology, glaciers. Two one-day field trips (optional).
O. Jagoutz, J. T. Perron

12.002 Introduction to Geophysics and Planetary Science
Prereq: Calculus II (GIR) and Physics II (GIR)
U (Spring)
3-1-8 units. REST
Study of the structure, composition, and physical processes governing the terrestrial planets, including their formation and basic orbital properties. Topics include plate tectonics, earthquakes, seismic waves, rheology, impact cratering, gravity and magnetic fields, heat flux, thermal structure, mantle convection, deep interiors, planetary magnetism, and core dynamics. Suitable for majors and non-majors seeking general background in geophysics and planetary structure.
L. H. Royden, B. Weiss

12.003 Introduction to Atmosphere, Ocean, and Climate Dynamics
Prereq: Calculus II (GIR) and Physics I (GIR)
U (Fall)
3-0-9 units. REST
Introduces the dynamical processes that govern the atmosphere, oceans, and climate. Topics include Earth’s radiation budget, convection and clouds, the circulation of the atmosphere and ocean, and climate change. Illustrates underlying mechanisms through laboratory demonstrations with a rotating table, and through analysis of atmospheric and oceanic data.
T. Cronin
12.005 Applications of Continuum Mechanics to Earth, Atmospheric, and Planetary Sciences
Prereq: Calculus II (GIR) and Physics II (GIR); Coreq: 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-2-7 units
Practical applications of the continuum concept for deformation of solids and fluids, emphasizing force balance. Stress tensor, infinitesimal and finite strain, and rotation tensors are developed. Constitutive relations applicable to geological materials, including elastic, viscous, brittle, and plastic deformation. Laboratory component provides specific examples of elastic and inelastic mechanical behavior of rocks and illustrates several methods of measurement in the laboratory. Graduate students complete additional assignments.
B. Hager

12.006[J] Nonlinear Dynamics: Chaos
Same subject as 2.050[J], 18.353[J]
Prereq: Physics II (GIR) and (18.03 or 18.032)
U (Fall)
3-0-9 units
M. Durey

12.007 Geobiology: History of Life on Earth
Prereq: None
U (Spring)
3-0-9 units
Surveys the interactive Earth system: biology in geologic, environmental and climate change throughout Earth's history. Introduces the concept of "life as a geological agent" and examines the interaction between biology and the Earth system during the roughly 4 billion years since life first appeared. Topics include the origin of the solar system and the early Earth atmosphere; the origin and evolution of life and its influence on climate up through and including the modern age and the problem of global warming; the global carbon cycle; and astrobiology.
T. Bosak, G. Fournier

12.009[J] Nonlinear Dynamics: The Natural Environment
Same subject as 18.352[J]
Prereq: Calculus II (GIR) and Physics I (GIR); Coreq: 18.03
U (Spring)
3-0-9 units
Analyzes cooperative processes that shape the natural environment, now and in the geologic past. Emphasizes the development of theoretical models that relate the physical and biological worlds, the comparison of theory to observational data, and associated mathematical methods. Topics include carbon cycle dynamics; ecosystem structure, stability and complexity; mass extinctions; biosphere-geosphere coevolution; and climate change. Employs techniques such as stability analysis; scaling; null model construction; time series and network analysis.
D. H. Rothman

12.010 Computational Methods of Scientific Programming
Prereq: Calculus II (GIR) and Physics I (GIR)
U (Fall)
4-0-8 units
Introduces programming languages and techniques used by physical scientists: FORTRAN, C, C++, MatLab, and Mathematica. Emphasis on program design, algorithm development and verification, and comparative advantages and disadvantages of different languages. Students first learn the basic usage of each language, common types of problems encountered, and techniques for solving a variety of problems encountered in contemporary research: examination of data with visualization techniques, numerical analysis, and methods of dissemination and verification. No prior programming experience is required.
T. Herring, C. Hill

12.011[J] Archaeological Science
Same subject as 3.985[J], 5.24[J]
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 units. HASS-S
See description under subject 3.985[J].
H. N. Lechtman
**12.012 MatLab, Statistics, Regression, Signal Processing**  
Subject meets with 12.444  
Prereq: None. Coreq: 18.06  
U (Fall)  
3-0-9 units  

Introduces the basic tools needed for data analysis and interpretation in the Geosciences, as well as other sciences. Composed of four modules, targeted at introducing students to the basic concepts and applications in each module. MatLab: Principles and practice in its uses, script and function modules, basic approaches to solving problems. Statistics: Correlation, means, dispersion, precision, accuracy, distributions, central limit theorem, skewness, probability, Chi-Square, Gaussian and other common distributions used in hypothesis testing. Regression: Random and grid search methods, basic least squares and algorithms applicable to regression, inversion and parameter estimation. Signal Processing: Analog and digital signals, Z-transform, Fourier series, fast Fourier transforms, spectral analysis leakage and bias, digital filtering. Students taking the graduate version complete different assignments.  
F. D. Morgan, T. A. Herring, S. Ravela

**12.021 Earth Science, Energy, and the Environment**  
Prereq: Calculus I (GIR), Chemistry (GIR), and Physics I (GIR)  
U (Fall)  
3-1-8 units  

Provides understanding of the Earth System most relevant to production of our planet’s natural energy resources, including the physics, chemistry, and biology of conventional and alternative energy sources. Includes a broad overview of traditional and alternative energy sources: hydrocarbons (conventional and unconventional), nuclear, geothermal, hydroelectric, and wind and tides, along with their potentials and limitations. Develops detailed knowledge of the formation, concentration, and production of fossil and nuclear fuels, as well as the waste products associated with their consumption. An examination of conventional and alternative energy sources includes the environmental issues associated with the exploitation of these resources, both regional and global.  
B. H. Hager

Same subject as 1.018[J], 7.30[J]  
Prereq: None  
U (Fall)  
4-0-8 units. REST  

See description under subject 1.018[J].  
M. Follows, D. Des Marais

**12.086 Modeling Environmental Complexity**  
Subject meets with 12.586  
Prereq: 18.03  
U (Fall)  
3-0-9 units  

Introduction to mathematical and physical models of environmental processes. Emphasis on the development of macroscopic continuum or statistical descriptions of complex microscopic dynamics. Problems of interest include: random walks and statistical geometry of landscapes; percolation theory and transport in disordered media; fractals, scaling, and universality; ecological dynamics and the structure of ecosystems, food webs, and other natural networks; kinetics of biogeochemical cycles. Appropriate for advanced undergraduates. Beginning graduate students are encouraged to register for 12.586. Students taking the graduate version complete different assignments.  
D. H. Rothman

**12.090 Current Topics in Earth, Atmospheric, and Planetary Sciences**  
Prereq: Permission of instructor  
U (Fall)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  

Laboratory or field work in earth, atmospheric, and planetary sciences. Consult with department Education Office.  
EAPS Faculty

**12.091 Current Topics in Earth, Atmospheric, and Planetary Sciences**  
Prereq: Permission of instructor  
Acad Year 2019-2020: U (IAP)  
Acad Year 2020-2021: Not offered  
Units arranged [P/D/F]  
Can be repeated for credit.  

Laboratory or field work in earth, atmospheric, and planetary sciences. Consult with department Education Office.  
EAPS Faculty

**12.092 Current Topics in Geology and Geochemistry**  
Prereq: None  
U (Fall, IAP, Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  

Laboratory or field work in geology and geochemistry. Consult with department Education Office.  
Staff
12.093 Current Topics in Geology and Geochemistry
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory or field work in geology and geochemistry. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

12.094 Current Topics in Geophysics
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Laboratory or field work in geophysics. Consult with department Education Office.
EAPS Faculty

12.095 Current Topics in Geophysics
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory or field work in geophysics. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

12.096 Current Topics in Atmospheric Science and Oceanography
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Laboratory or field work in atmospheric science and oceanography. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

12.097 Current Topics in Atmospheric Science and Oceanography
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory or field work in atmospheric science and oceanography. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

12.098 Current Topics in Planetary Science
Prereq: Permission of instructor
U (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Laboratory or field work in planetary science. To be arranged with department faculty. Consult with department Education Office.
EAPS Staff

12.099 Current Topics in Planetary Science
Prereq: Permission of instructor
U (Fall)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory or field work in planetary science. To be arranged with department faculty. Consult with department Education Office.
EAPS Faculty

Geology and Geochemistry

12.104 Geochemistry of Natural Waters
Subject meets with 12.494
Prereq: Calculus II (GIR)
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-2-7 units
Equips students with the fundamental skills to identify major controls on the chemistry of waters on the Earth. Students examine key concepts, theories and practical tools (e.g., pH, Eh, alkalinity, surface charge, speciation, and carbonate equilibrium) and apply them as tools to understand and make predictions for the biogeochemical cycles of the Earth systems. Students taking graduate version complete additional assignments.
S. Ono
**12.108 Structure of Earth Materials**  
Prereq: Chemistry (GIR)  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall)  
3-4-5 units  
Provides a comprehensive introduction to crystalline structure, crystal chemistry, and bonding in rock-forming minerals. Introduces the theory relating crystal structure and crystal symmetry to physical properties such as refractive index, elastic modulus, and seismic velocity. Surveys the distribution of silicate, oxide, and metallic minerals in the interiors and on the surfaces of planets, and discusses the processes that led to their formation.  
T. L. Grove

**12.109 Petrology**  
Prereq: 12.108  
Acad Year 2019-2020: U (Fall)  
Acad Year 2020-2021: Not offered  
3-6-6 units  
Surveys the distribution, chemical composition, and mineral associations in rocks of the Earth's crust and upper mantle, and establishes its relation to tectonic environment. Emphasis is on the use of chemistry and physics to interpret rock forming processes. Topics include dynamics of crust and mantle melting as preserved in the chemical composition of igneous rocks and minerals, the long-term record of global climate change as preserved in the minerals of sedimentary rocks, and the time-temperature-depth record preserved in minerals of metamorphosed crustal rocks.  
T. L. Grove

**12.11 Nature's Sandbox: A Record of Great Moments in Earth History**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (IAP)  
2-0-0 units  
Designed for students curious about Earth Systems. Covers how sediments and the sedimentary rock record preserve information about events in Earth History and ancient climates and oceans. Serves as an introduction to the subjects 12.110A Sedimentary Environments and 12.110B Sedimentology in the Field.  
K. Bergmann

**12.110A Sedimentary Environments**  
Subject meets with 12.465A  
Prereq: 12.001 or 12.11  
U (Spring; first half of term)  
2-1-3 units. Partial Lab  
Covers the basic concepts of sedimentation from the properties of individual grains to large-scale basin analysis. Lectures cover sediment textures and composition, fluid flow and sediment transport, and formation of sedimentary structures. Depositional models, for both modern and ancient environments are a major component and are studied in detail with an eye toward interpretation of depositional processes and reconstructing paleoenvironments from the rock record. Satisfies 6 units of Institute Laboratory credit. Students taking graduate version complete additional assignments.  
K. Bergmann

**12.110B Sedimentology in the Field**  
Subject meets with 12.465B  
Prereq: 12.110A  
U (Spring; second half of term)  
2-2-5 units. Partial Lab  
Can be repeated for credit.  
Examines the fundamentals of sedimentary deposits and geological reasoning through first hand fieldwork. Students practice methods of modern geological field study off-campus during a required trip over spring break making field observations, measuring stratigraphic sections and making a sedimentological map. Relevant topics introduced are map and figure making in ArcGIS and Adobe Illustrator and sedimentary petrology. Culminates in an oral and written report built around data gathered in the field. Field sites and intervals of geologic time studied rotate annually and include Precambrian, Phanerozoic and Modern depositional environments. Satisfies 6 units of Institute Laboratory credit. May be taken multiple times for credit. Students taking graduate version complete additional assignments.  
K. Bergmann
12.113 Structural Geology
Prereq: 12.001
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-3-6 units
Introduces mechanics of rock deformation. Discusses recognition, interpretation, and mechanics of faults, folds, structural features of igneous and metamorphic rocks, and superposed deformations. Introduces regional structural geology and tectonics. Laboratory includes techniques of structural analysis, recognition and interpretation of structures on geologic maps, and construction of interpretive cross sections.
O. Jagoutz

12.115 Field Geology
Prereq: 12.113
Acad Year 2019-2020: U (IAP)
Acad Year 2020-2021: Not offered
0-9-0 units. Partial Lab
Introduction to the methods of modern geological field study off-campus during an intensive two-week experience. Exercises include geological and geomorphological mapping on topographic and photographic base maps of a wide variety of bedrock and surficial rocks. Where feasible, geochemical and geophysical field measurements are correlated with geology. Location is usually in the western US. Contact department regarding travel fee and resources for funding opportunities. Meets with 12.482 when offered concurrently. Satisfies 9 units of Institute Laboratory credit.
O. Jagoutz

12.116 Analysis of Geologic Data
Prereq: 12.115
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
0-2-4 units. Partial Lab
Includes in-depth laboratory analysis of samples, interpretation of geological data, and where possible, geophysical and geochemical data. Includes the preparation of reports based on the field studies conducted in 12.115 during January; report generally exceeds 30 pages in length and includes one major revision and rewrite. Instruction in writing techniques provided. Contact department regarding travel fee and resources for funding opportunities. Satisfies 3 units of Institute Laboratory credit.
O. Jagoutz

12.117A Field Geobiology I
Subject meets with 12.487A
Prereq: None. Coreq: 12.001 or 12.007
Acad Year 2019-2020: U (Spring; first half of term)
Acad Year 2020-2021: Not offered
2-1-3 units
Examines basic biological processes that operate in sediments. Lectures cover biological, physical and chemical processes that influence the formation and stabilization of sediments, including biomineralization, weathering, erosion, the formation of sedimentary structures and interactions with sediments, flow, and the cycles of nutrients. Lab covers analytical methods used to examine microbial processes, bioinformatic methods used to analyze microbial communities, and techniques used to analyze sediment grain sizes and chemistry. Readings and discussions provide preparation for the 12.117B field trip to a modern sedimentary environment. Enables students to interpret processes in modern sedimentary environments, reconstruct similar processes in the rock record, collect appropriate samples in the field, and analyze microbiological data. Students taking graduate version complete additional assignments.
T. Bosak

12.117B Field Geobiology II
Subject meets with 12.487B
Prereq: 12.117A
Acad Year 2019-2020: U (Spring; second half of term)
Acad Year 2020-2021: Not offered
2-2-5 units
Can be repeated for credit.
Teaches fundamentals of field observations and reasoning in geobiology/sedimentology during a required trip to a modern sedimentary environment over spring break, followed by laboratory analyses of collected samples. Students make observations, develop hypotheses, collect samples required to test their hypotheses and interact with lecturers and students investigating the sedimentology of the site. Upon return to MIT, students work on field samples to characterize the sediments, use the preliminary data to develop an understanding of the field site, and write research reports. Students taking graduate version write proposals that present a research question based on the field observations and subsequent analyses. Meets with 12.110B and 12.465B when those subjects examine modern sedimentary environments.
T. Bosak
12.119 Analytical Techniques for Studying Environmental and Geologic Samples
Prereq: None
U (Spring)
2-6-4 units. Institute LAB

Focuses on analytical facilities that are used to determine elemental and isotopic abundances in soils, rocks, minerals, and fluids. Emphasis is on isotopic ratios Sr, Nd, and Pb, whose isotopic ratios can be used for geochronology, and abundances of trace elements such as Rb, Sr, Cu, Cd, Hg, rare-earths, Pb, Th, and U. Analytical techniques include mass spectrometry, emission spectrometry, atomic absorption, neutron activation, and electron microprobe. A major lab project utilizes these techniques to address specific environmental and geologic problems.
E. Boyle

12.12 Nature's Sandbox: The History of Ancient Environments, Climate, and Life
Prereq: None
U (Spring; second half of term)
1-1-1 units

Series of field adventures to survey Earth’s history and landscape through a combination of online and in-person instruction, with virtual field trips to Svalbard, Norway, the Death Valley area and Northern Minnesota. In these key sites, students explore the interactions between Earth’s surface environments and life, and critical transitions in each. Includes weekly in-class paper discussions and experiential exercises. Three optional one-day field trips provide opportunity to explore the amazing sedimentary record preserved close to MIT. Subject can count toward the 9-unit discovery-focused credit limit for first year students.
K. Bergmann

12.141 Electron Microprobe Analysis
Prereq: None
U (IAP)
1-1-4 units

Introduction to the theory of x-ray microanalysis through the electron microprobe including ZAF matrix corrections. Techniques to be discussed are wavelength and energy dispersive spectrometry, scanning backscattered electron, secondary electron, cathodoluminescence, and x-ray imaging. Lab sessions involve use of the electron microprobe.
T. Grove, N. Chatterjee

12.158 Molecular Biogeochemistry
Subject meets with 12.458
Prereq: Permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-6 units

Covers all aspects of molecular biosignatures, such as their pathways of lipid biosynthesis, the distribution patterns of lipid biosynthetic pathways with regard to phylogeny and physiology, isotopic contents, occurrence in modern organisms and environments, diagenetic pathways, analytical techniques and the occurrence of molecular fossils through the geological record. Students analyze in depth the recent literature on chemical fossils. Lectures provide background on the subject matter. Basic knowledge of organic chemistry required. Students taking graduate version complete additional assignments.
R. Summons

12.163 Geomorphology
Subject meets with 12.463
Prereq: (Calculus I (GIR), Physics I (GIR), and 12.001) or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-3-6 units

Quantitative examination of processes that shape Earth’s surface. Introduction to fluvial, hillslope, and glacial mechanics. Essentials of weathering, soil formation, runoff, erosion, slope stability, sediment transport, and river morphology. Landscape evolution in response to climatic and tectonic forcing. Application of terrestrial theory to planetary surfaces. Additional instruction in geographic information systems (GIS) and remote sensing analysis, field measurement techniques, and numerical modeling of surface processes. Students taking the graduate version complete different assignments.
T. Perron
12.170 Essentials of Geology
Subject meets with 12.470
Prereq: (Calculus II (GIR) and Physics II (GIR)) or permission of instructor
U (Fall)
Not offered regularly; consult department
4.0-8 units

Studies the geology of planetary interiors and surfaces, including plate tectonics, as a unifying theory of terrestrial geology, surface processes, and the Earth's interior. Covers igneous, metamorphic, and sedimentary processes associated with tectonic settings and the typical rock suites created; mineral and rock identification; and causes of compositional differences on many scales (mineral grains, rocks, regions of the Earth, different planets). Also addresses conditions required for melting and melting processes; rock structure and field techniques; and Earth history. Treatment of these topics includes discussions of the geochemical, petrologic, geochronological, experimental, or field techniques used to investigate them; the limitations of current geological techniques and geological controversies; and major geological expeditions, experiments, and studies from the past, along with their premises and results. Students taking graduate version complete additional assignments.

EAPS Staff

12.174 Biogeochemistry of Natural and Perturbed Systems
Prereq: Chemistry (GIR)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3.0-5 units. Institute LAB

Presents the fundamentals of chemical cycles in the environment and their interactions with microbial populations. Students investigate the natural cycling of carbon, oxygen, and nutrients in the oceans and on land. Also emphasizes anthropogenic perturbations to natural dynamics and how the environment is reshaped by human activities. Students work in teams to develop and conduct immersive research projects in the Boston area, analyzing their local environment for chemical and microbial signatures of both natural and anthropogenic origin.

A. R. Babbin

12.177 Astrobiology, Origins and Early Evolution of Life
Subject meets with 12.477
Prereq: Biology (GIR), Chemistry (GIR), or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3.0-9 units

Provides an understanding of major areas of research into the problem of the origin of life on the early Earth from an astrobiological perspective. Topics include the timing, setting and conditions for the origin of life on the Hadean Earth; roles of planetary and extra-planetary processes; defining life; prebiotic chemistry; origins of nucleic acids and peptides; evolution of cellularity, replication, metabolism, and translation; establishment of the genetic code; biogenesis vs. ecogenesis; the nature of the last common ancestor of life; conceptualizing the "tree of life;" and the early evolution of the ancestors of bacteria, archaea, and eukaryal lineages. Students taking graduate version complete an extra project.

G. Fournier

12.178 The Phylogenomic Planetary Record (New)
Subject meets with 12.478
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3.0-9 units

Introduces the tools of sequence-based phylogenetic analysis and molecular evolution in the context of studying events in Earth's deep past that have been preserved by genomes. Topics include basic concepts of cladistics, phylogeny and sequence evolution, construction of phylogenetic trees of genes and microbial lineages, molecular clocks, dating, and ancestral sequence reconstruction. Special attention to the evolutionary history of microbial metabolisms and their relationship to global biogeochemical cycles across Earth's history. Students taking graduate version complete additional assignments.

G. Fournier
Geophysics

12.201 Essentials of Global Geophysics
Subject meets with 12.501
Prereq: Physics II (GIR) and 18.03
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
4-0-8 units

Overview of basic topics in solid-earth geophysics, such as the Earth’s rotation, gravity and magnetic field, seismology, and thermal structure. Formulation of physical principles presented in three one-hour lectures per week. Current applications discussed in an additional one-hour tutorial each week. Students taking graduate version complete different assignments.

R. van der Hilst

12.202 Flow, Deformation, and Fracture in Earth and Other Terrestrial Bodies (New)
Subject meets with 12.502
Prereq: Calculus II (GIR) and Physics I (GIR)
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-2-7 units

Covers fundamentals of deformation and fracture of solids and the flow of viscous fluids. Explores spatial scales from molecular to planetary, and time scales from fractions of a second to millions of years, to understand how and why natural materials on Earth and other terrestrial bodies respond to applied forces. Introduces anelasticity, granular mechanics, poroelasticity, rate-and-state friction, transport properties of Earth materials (Darcy’s law, Fick’s law), brittle-ductile transitions, creep of polycrystalline materials, stored energy and dissipation, and convection. Prepares students to gather, analyze and interpret data using existing theoretical models. Through a significant laboratory component, students obtain practical experience with experimental measurements and test their acquired theoretical knowledge. Students taking graduate version complete different assignments.

B. Minchew, M. Pec

12.203 Mechanics of Earth (New)
Subject meets with 12.503
Prereq: Calculus II (GIR) and Physics I (GIR)
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-2-7 units

Covers topics in the deformation and fracture of solids and the flow of viscous fluids. Explores spatial scales from molecular to planetary, and time scales from fractions of a second to millions of years, to understand how and why natural materials on Earth and other terrestrial bodies respond to applied forces. Introduces anelasticity, granular mechanics, poroelasticity, rate-and-state friction, transport properties of Earth materials (Darcy’s law, Fick’s law), brittle-ductile transitions, creep of polycrystalline materials, stored energy and dissipation, and convection. Prepares students to gather, analyze and interpret data using existing theoretical models. Through a significant laboratory component, students obtain practical experience with experimental measurements and test their acquired theoretical knowledge. Students taking graduate version complete different assignments.

B. Minchew, M. Pec

12.207[J] Nonlinear Dynamics: Continuum Systems
Same subject as 1.062[J], 18.354[J]
Subject meets with 18.354[J]
Prereq: Physics II (GIR) and (18.03 or 18.032)
U (Spring)
3-0-9 units

See description under subject 18.354[J].

J. Dunkel

12.213 Alternate Energy Sources
Prereq: None
U (IAP)
Not offered regularly; consult department
1-4-1 units
Can be repeated for credit.

Explores a number of alternative energy sources such as geothermal energy (heat from the Earth’s interior), wind, natural gas, and solar energy. Includes a field trip to visit sites where alternative energy is being harvested or generated. Content and focus of subject varies from year to year.

F. D. Morgan
12.214 Essentials of Applied Geophysics
Subject meets with 12.507
Prereq: 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-3-6 units
Introduces the application of geophysical methods to all aspects of near-surface environmental and engineering geophysics, including the exploration for petroleum, water, and minerals. Topics include seismic, electrical, electromagnetic, ground penetrating radar, magnetics, gravity, rock physics and chemistry, borehole geophysics and the global positioning system (GPS). Uses a quantitative approach to emphasize basic principles and a physical/chemical understanding of each method. Discusses specific illustrative field examples. Lab work is mainly devoted to local field work and equipment preparation for the IAP Field Geophysics class. Students taking the graduate version complete additional assignments.
F. D. Morgan, T. A. Herring, B. H. Hager

Atmospheres, Oceans, and Climate

12.300[J] Global Change Science
Same subject as 1.071[J]
Prereq: 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
See description under subject 1.071[J].
E. A. B. Eltahir

12.301 Climate Science
Subject meets with 12.842
Prereq: Chemistry (GIR), 18.03, or permission of instructor
U (Fall)
4-0-8 units
Introduction to climate studies, including beginnings of the solar system, time scales, and climate in human history; methods for detecting climate change, including proxies, ice cores, instrumental records, and time series analysis; physical and chemical processes in climate, including primordial atmosphere, ozone chemistry, carbon and oxygen cycles, and heat and water budgets; internal feedback mechanisms, including ice, aerosols, water vapor, clouds, and ocean circulation; climate forcing, including orbital variations, volcanism, plate tectonics, and solar variability; climate models and mechanisms of variability, including energy balance, coupled models, and global ocean and atmosphere models; and outstanding problems. Students taking the graduate version complete different assignments.
K. Emanuel, E. Boyle

12.306 Atmospheric Physics and Chemistry
Subject meets with 10.571[J], 12.806[J]
Prereq: (18.075 and (5.60 or 5.61)) or permission of instructor
U (Spring)
3-0-9 units
Introduction to the physics and chemistry of the atmosphere including experience with computer codes. Aerosols and theories of their formation, evolution, and removal. Gas and aerosol transport from urban to continental scales. Coupled models of radiation, transport, and chemistry. Solution of inverse problems to deduce emissions and removal rates. Emissions control technology and costs. Applications to air pollution and climate. Students taking the graduate version complete different assignments.
R. G. Prinn

12.307 Weather and Climate Laboratory
Prereq: Calculus II (GIR) and Physics I (GIR)
U (Spring)
1-4-7 units. Institute LAB
Engages students in projects involving rotating tank laboratory experiments, analysis of data on the sphere, and report writing and presentation. Project themes explore fundamentals of climate science and make contact points with major contemporary environmental challenges facing mankind. Examples include heat and moisture transport in the atmosphere; weather and weather extremes; aerosols, dust, and atmospheric pollution; ocean circulation and transport and plastics in the ocean. Develops skills for how to deal with noisy, imperfect data. Provides instruction and practice in written and oral communication.
L. Illari, J. Marshall

12.310 An Introduction to Weather Forecasting
Prereq: Calculus I (GIR) and Physics I (GIR)
U (IAP)
1-1-4 units
Basic principles of synoptic meteorology and weather forecasting. Analysis of hourly weather data and numerical weather prediction models. Regular preparation of weather forecasts.
L. Illari
12.315 Atmospheric Radiation and Convection
Subject meets with 12.815
Prereq: 12.390 or permission of instructor
U (Spring)
3-0-9 units
Introduction to the physics of atmospheric radiation, remote sensing, and convection, including use of computer codes. Radiative transfer equation including emission and scattering, spectroscopy, Mie theory, and numerical solutions. Physics of dry and moist convection, including moist thermodynamics. Radiative-convective equilibrium. Solution of inverse problems in remote sensing of atmospheric temperature and composition. Students taking graduate version complete different assignments.
T. Cronin

12.318 Introduction to Atmospheric Data and Large-scale Dynamics
Subject meets with 12.818
Prereq: None. Coreq: 12.390
U (Fall)
3-3-6 units
Provides a general introduction to meteorological data and analysis techniques, and their use in the MIT Synoptic Laboratory to study the phenomenology and dynamics of large-scale atmospheric flow. Illustrates balance concepts as applied to the dynamics of frontal and synoptic scales, using real-time upper-air and surface station data and gridded analyzed fields. Uses advanced meteorological software packages to access, manipulate, and graphically display the data. Students taking graduate version complete different assignments.
L. Illari

12.320A[J] Introduction to Hydrology and Water Resources
Same subject as 1.070A[J]
Prereq: 1.060A; Coreq: 1.061A and 1.106
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall; first half of term)
2-0-4 units
See description under subject 1.070A[J].
D. Entekhabi

12.320B[J] Introduction to Hydrology Modeling
Same subject as 1.070B[J]
Prereq: 1.070A[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall; second half of term)
2-0-4 units
See description under subject 1.070B[J].
D. Entekhabi

12.330[J] Fluid Physics
Same subject as 8.292[J]
Prereq: 5.60, 8.044, or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 8.292[J].
Staff

12.335 Experimental Atmospheric Chemistry
Subject meets with 12.835
Prereq: Chemistry (GIR)
U (Fall)
2-4-6 units. Institute LAB
Introduces the atmospheric chemistry involved in climate change, air pollution, and ozone depletion using a combination of interactive laboratory and field studies and simple computer models. Uses instruments for trace gas and aerosol measurements and methods for inferring fundamental information from these measurements. Provides instruction and practice in written and oral communication. Students taking the graduate version complete different assignments.
R. Prinn, S. Ono

12.336[J] Air Pollution and Atmospheric Chemistry
Same subject as 1.085[J]
Prereq: 18.03
U (Fall)
3-0-9 units
See description under subject 1.085[J].
C. Heald
12.338 Aerosol and Cloud Microphysics and Chemistry
Subject meets with 1.842[J], 12.814[J]
Prereq: 1.085[J], 12.335, or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units
Focuses on understanding how aerosol particles form droplets or ice crystals during several atmospheric processes: determining Earth’s radiative balance; heterogeneous chemistry and acid rain; understanding where, when and how much precipitation occurs. Provides tools for understanding the physics of aerosol and cloud element motion; the interaction of particles with water vapor, including phase changes and droplet and ice nucleation; the chemical composition of particles and the effect on cloud formation processes; and the effect of cloud processing on aerosol chemistry. Discusses relevant topics of contemporary interest, e.g., geoengineering and weather modification and volcanic effects. Students taking the graduate version complete different assignments.
D. Cziczo

12.349 Mechanisms and Models of the Global Carbon Cycle
Subject meets with 12.849
Prereq: Calculus II (GIR) and Physics I (GIR)
U (Spring)
3-0-9 units
Addresses changes in the ocean, terrestrial biosphere and rocks modulation of atmospheric carbon dioxide on timescales from months to millions of years. Includes feedbacks between carbon cycle and climate. Combines hands-on data analysis with the formulation of simple models rooted in basic physical, chemical and biological principles. Students create individual “toy” global carbon cycle models. Students taking graduate version complete different assignments.
M. Follows

12.346[J] Global Environmental Negotiations
Same subject as IDS.062[J]
Subject meets with 12.846[J], IDS.525[J]
Prereq: Permission of instructor
U (Fall)
Not offered regularly; consult department
2-0-4 units
See description under subject IDS.062[J].
N. E. Selin

Same subject as 15.026[J]
Subject meets with 12.848[J], 15.023[J]
Prereq: (Calculus II (GIR), 5.60, and 14.01) or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-6 units
See description under subject 15.026[J].
R. G. Prinn

12.372 Elements of Modern Oceanography
Subject meets with 12.702
Prereq: Permission of instructor
U (Fall)
3-0-9 units
Examines a series of crosscutting topics that exemplify current directions in interdisciplinary oceanography. Focuses on current themes in oceanography, their interdisciplinary nature, and the role of ocean sciences in society. Introduces core concepts across the disciplines of biological, physical, and chemical oceanography as well as marine geology. Emphasizes the interdisciplinary aspects of these core concepts, the kinds of approaches and modes of thinking common to all of the disciplines, and the technological developments underpinning current advances. Students taking graduate version complete different assignments.
G. Lawson, A. Kirincich (WHOI)
12.373 Field Oceanography
Subject meets with 12.777
Prereq: Biology (GIR), Chemistry (GIR), and permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-4-5 units
Provides an introduction to the biogeochemistry of the ocean, and the field techniques and methods used in its study. Emphasizes biogeochemistry and the interrelated nature of elemental cycling, but also examines physical transport and air-sea gas exchange. Covers multiple aspects related to field instrumentation and measurements, including nutrients, oxygen, the carbon system, temperature, and salinity. Presents microbial analyses, such as metagenomics. Includes an optional spring break field trip aboard a research vessel. Students work in groups to propose a project over the week-long voyage that utilizes the field time to collect samples. During the second half of the term, students analyze and synthesize the data, and present it in a publication-quality manuscript. Students taking graduate version complete additional assignments.
A. R. Babbin

12.377 The History of Earth’s Climate
Subject meets with 12.707
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units
Studies the climate history of the Earth, from the formation of the early atmosphere and ocean to the present. Evaluates geochemical, sedimentological, and paleontological evidence for changes in ocean circulation, global temperatures, and atmospheric carbon dioxide levels. Covers theories and models of Phanerozoic climate change. Provides a long-term history of the global carbon cycle. Students taking graduate version complete different assignments.
D. McGee

12.385 Science, Politics, and Environmental Policy
Subject meets with 11.373[J], 12.885[J]
Prereq: Permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-6 units
Examines the role of science in US and international environmental policymaking. Surveys the methods by which scientists learn about the natural world; the treatment of science by experts, advocates, the media, and the public and the way science is used in legislative, administrative and judicial decision making. Through lectures, group discussions, and written essays, students develop a critical understanding of the role of science in environmental policy. Potential case studies include fisheries management, ozone depletion, global warming, smog, and endangered species. Students taking the graduate version complete different assignments.
S. Solomon, J. Knox-Hayes

12.386[J] Environment and History
Same subject as 21H.185[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-S; CI-H
See description under subject 21H.185[J]. Enrollment limited.
H. Ritvo, S. Solomon

12.387[J] People and the Planet: Environmental Governance and Science
Same subject as 15.874[J], IDS.063[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-6 units
Introduces governance and science aspects of complex environmental problems and approaches to solutions. Introduces quantitative analyses and methodological tools to analyze environmental issues that have human and natural components. Demonstrates concepts through a series of in-depth case studies of environmental governance and science problems. Students develop writing, quantitative modeling, and analytical skills in assessing environmental systems problems and developing solutions. Through experiential activities, such as modeling and policy exercises, students engage with the challenges and possibilities of governance in complex, interacting systems, including biogeophysical processes and societal and stakeholder interactions.
N. Selin, S. Solomon, J. Sterman
12.390 Fluid Dynamics of the Atmosphere and Ocean
Subject meets with 12.800
Prereq: 12.003
U (Fall)
3-0-9 units
Introduction to fluid dynamics. Students acquire an understanding of some of the basic concepts of fluid dynamics that are needed as a foundation for advanced coursework in atmospheric science, physical oceanography, ocean engineering, climate science, etc. Emphasizes fluid fundamentals, with an atmosphere/ocean twist. Students taking graduate version complete additional assignments. A. Mahadevan, C. Cenedese

Planetary Science and Astronomy

12.400 The Solar System
Prereq: Physics I (GIR)
U (Spring)
Not offered regularly; consult department
3-0-9 units. REST
Introduction to the study of the solar system with emphasis on the latest spacecraft results. Subject covers basic principles rather than detailed mathematical and physical models. Topics include an overview of the solar system, planetary orbits, rings, planetary formation, meteorites, asteroids, comets, planetary surfaces and cratering, planetary interiors, planetary atmospheres, and life in the solar system. R. P. Binzel

12.402[J] Introduction to Astronomy
Same subject as 8.282[J]
Prereq: Physics I (GIR)
U (Spring)
3-0-6 units. REST
See description under subject 8.282[J]. A. Frebel

12.409 Hands-On Astronomy: Observing Stars and Planets
Prereq: None
U (Spring)
1-3-2 units
Background for, and techniques of, visual observation and electronic imaging of the Moon, planets, satellites, stars, and brighter deep-space objects. Weekly outdoor observing sessions using 8-inch diameter telescopes when weather permits. Indoor sessions introduce skills necessary for observation. Introduction to contemporary observational astronomy including astronomical computing, image and data processing, and how astronomers work. Student must maintain a careful and complete written log which is graded. Consumes an entire evening each week; 100% attendance at observing sessions required to pass. Enrollment limited; priority to first-year students. A. Bosh

12.410[J] Observational Techniques of Optical Astronomy
Same subject as 8.287[J]
Prereq: 8.282[J], 12.409, or other introductory astronomy course
U (Fall)
3-4-8 units. Institute LAB
Fundamental physical and optical principles used for astronomical measurements at visible wavelengths and practical methods of astronomical observations. Topics: astronomical coordinates, time, optics, telescopes, photon counting, signal-to-noise ratios, data analysis (including least-squares model fitting), limitations imposed by the Earth’s atmosphere on optical observations, CCD detectors, photometry, spectroscopy, astrometry, and time variability. Project at Wallace Astrophysical Observatory. Written and oral project reports. Limited to 18; preference to Course 8 and Course 12 majors and minors. R. Binzel, A. Bosh

12.411 Astronomy Field Camp
Prereq: 12.410[J] or 12.410[J]
U (IAP)
0-6-3 units
Can be repeated for credit.
Individual research projects in planetary science and astrophysics, involving supervised work at Lowell Observatory in Flagstaff, AZ. Projects may include observations made using Lowell’s telescope facilities. Project topics and objectives vary from year to year. Written and oral reports required. Limited to 6. A. Bosh
12.420 Essentials of Planetary Science
Subject meets with 12.601
Prereq: 12.002 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Advanced applications of physical and chemical principles to the study of the solar system. Topics include terrestrial and giant planets, meteorites, asteroids, comets, Kuiper belt objects, rings, impact craters, interiors, surfaces, atmospheres, geomagnetism, cosmochemistry, remote sensing, formation and evolution of the solar system.

J. de Wit

12.421 Physical Principles of Remote Sensing
Subject meets with 12.621
Prereq: Physics II (GIR)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units

Introduction to the physics of remote sensing with applications to the study of the Earth, Moon, planets and other solar system bodies, as well as to emerging fields, such as autonomous navigation. Includes the principles of optical, thermal, radar and lidar remote sensing. Covers fundamental properties of electromagnetic waves; principles of electromagnetic scattering from real and idealized materials, including various types of surfaces and vegetation; interaction of electromagnetic radiation with the atmosphere; and thermal and microwave emission from various media. Discusses past, present, and future remote sensing platforms along with the fundamentals of orbital mechanics and data processing tools and methods. Students taking graduate version complete different assignments.

B. Minchew

12.422 Planetary Atmospheres
Subject meets with 12.622
Prereq: 12.003 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units

Provides a basic understanding of the physics and chemistry of planetary atmospheres. Explores the formation and evolution of atmospheres, their structure and dynamics, and what is known about their chemical composition. Pays particular attention to their energy balance. Also presents the current state of understanding of exoplanet atmospheres. Students taking graduate version complete an additional research project.

J. de Wit

Same subject as 8.290[J]
Subject meets with 12.625
Prereq: 8.03 and 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-1-9 units. REST

Presents basic principles of planet atmospheres and interiors applied to the study of extrasolar planets. Focuses on fundamental physical processes related to observable extrasolar planet properties. Provides a quantitative overview of detection techniques. Introduction to the feasibility of the search for Earth-like planets, biosignatures and habitable conditions on extrasolar planets. Students taking graduate version complete additional assignments.

S. Seager

12.43[J] Space Systems Engineering
Same subject as 16.83[J]
Prereq: Permission of instructor
U (Fall)
3-3-6 units

See description under subject 16.83[J].

K. Cahoy

12.431[J] Space Systems Development
Same subject as 16.831[J]
Prereq: Permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
2-10-6 units. Institute LAB

See description under subject 16.831[J].

Staff

Independent Research Subjects

12.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Undergraduate research opportunities in Earth, Atmospheric, and Planetary Sciences.

Consult Department UROP Coordinator
12. URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Undergraduate research opportunities in Earth, Atmospheric, and Planetary Sciences. Consult Department UROP Coordinator.

12. IND Independent Study
Prereq: 12.TIP
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Independent reading, laboratory, or fieldwork in Earth, Atmospheric, and Planetary Sciences. To be arranged by student and an appropriate EAPS faculty member. A written report may be required at the discretion of the advisor. Units arranged should reflect the project requirements. Consult EAPS Education Office.

12. TIP Thesis Preparation
Prereq: None
U (Fall, Spring)
2-0-4 units

Definition of and early-stage work on the thesis project. Students develop a written research proposal and begin writing the supporting text of the thesis concurrent with conducting research for the thesis project. Supervision of the writing continues into the spring term which concludes with an oral presentation of the research results. J. Connor

12. THU Undergraduate Thesis
Prereq: 12.TIP
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a thesis; to be arranged by the student and an appropriate MIT faculty member. EAPS Faculty

Graduate Subjects

12.44 Practical Experience
Prereq: None
G (Summer)
Units arranged
Can be repeated for credit.

For Course 12 students participating in off-campus professional experiences related to their research. Before registering for this subject, students must have an offer from a company or organization, must identify an EAPS supervisor, and must receive prior approval from their advisor. Upon completion of the experience, student must submit a letter from the company or organization describing the what the student accomplished, along with a substantive final report from the student approved by the EAPS supervisor. Consult departmental academic office. EAPS Faculty

12.444 MatLab, Statistics, Regression, Signal Processing
Subject meets with 12.012
Prereq: 18.06
G (Fall)
3-0-9 units

Introduces the basic tools needed for data analysis and interpretation in the Geosciences, as well as other sciences. Composed of four modules, targeted at introducing students to the basic concepts and applications in each module. MatLab: Principles and practice in its uses, script and function modules, basic approaches to solving problems. Statistics: Correlation, means, dispersion, precision, accuracy, distributions, central limit theorem, skewness, probability, Chi-Square, Gaussian and other common distributions used in hypothesis testing. Regression: Random and grid search methods, basic least squares and algorithms applicable to regression, inversion and parameter estimation. Signal Processing: Analog and digital signals, Z-transform, Fourier series, fast Fourier transforms, spectral analysis leakage and bias, digital filtering. Students taking the graduate version complete different assignments. F. D. Morgan, T. A. Herring, S. Ravela
12.445 Communication in the Earth, Atmospheric, and Planetary Sciences
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-3 units
Concentrated instruction and practice in professional writing and presentation. Topics include review of various communication styles prevalent in the field; strategies for tailoring reports, technical papers, and presentations for specific audiences; and mechanics of organization and style. Weekly assignments in writing or speaking, with peer and instructor feedback. Limited to 6.
F. D. Morgan

12.446 Teaching Experience in EAPS
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Recognizes the educational value derived from satisfactory performance of assigned duties as a Teaching Assistant. Laboratory, field, recitation, or classroom teaching under supervision of a faculty member. Credit for this subject may not be used for any degree granted by Course 12. Total enrollment limited by availability of suitable teaching assignments.
EAPS Staff

12.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
Consult Department Headquarters

Geology and Geochemistry

12.450 Seminar in Geology and Geochemistry
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
2-0-4 units
Can be repeated for credit.
Seminar on topics of current interest in geology and geochemistry. Required background preparation for students taking pre-doctoral general examinations in these subjects.
Geology and Geochemistry Staff

12.451 Seminar in Regional Tectonics
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-6 units
Can be repeated for credit.
Applies techniques of tectonic synthesis to study the roles of particular orogenic belts in global plate tectonics. Treats different applications in different terms, so that the subject may be taken repeatedly to learn the range of orogenic responses to temporal and spatial variations of activity at plate boundaries.
B. C. Burchfiel, L. H. Royden

12.456 Seminar in Rock Mechanics
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
2-0-4 units
Can be repeated for credit.
Discussion of current research or advanced topics in continental tectonics, rock mechanics, or experimental structural geology.
EAPS Staff

12.458 Molecular Biogeochemistry
Subject meets with 12.158
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-6 units
Covers all aspects of molecular biosignatures, such as their pathways of lipid biosynthesis, the distribution patterns of lipid biosynthetic pathways with regard to phylogeny and physiology, isotopic contents, occurrence in modern organisms and environments, diagenetic pathways, analytical techniques and the occurrence of molecular fossils through the geological record. Students analyze in depth the recent literature on chemical fossils. Lectures provide background on the subject matter. Basic knowledge of organic chemistry required. Students taking graduate version complete additional assignments.
R. Summons

12.460-12.461 Current Research in Geology and Geochemistry
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Original investigations on problems in geology, petrology, mineralogy, geochemistry, or geobiology. 12.460 is letter-graded.
EAPS Staff
12.463 Geomorphology
Subject meets with 12.163
Prereq: (Calculus I (GIR), Physics I (GIR), and 12.001) or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-3-6 units

Quantitative examination of processes that shape Earth’s surface. Introduction to fluvial, hillslope, and glacial mechanics. Essentials of weathering, soil formation, runoff, erosion, slope stability, sediment transport, and river morphology. Landscape evolution in response to climatic and tectonic forcing. Application of terrestrial theory to planetary surfaces. Additional instruction in geographic information systems (GIS) and remote sensing analysis, field measurement techniques, and numerical modeling of surface processes. Students taking the graduate version complete different assignments.

T. Perron

12.465A Sedimentary Environments
Subject meets with 12.110A
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring; first half of term)
Acad Year 2020-2021: Not offered
2-1-3 units

Covers the basic concepts of sedimentation from the properties of individual grains to large-scale basin analysis. Lectures cover sediment textures and composition, fluid flow and sediment transport, and formation of sedimentary structures. Depositional models, for both modern and ancient environments are a major component and are studied in detail with an eye toward interpretation of depositional processes and reconstructing paleoenvironments from the rock record. Students taking graduate version complete additional assignments.

K. Bergmann

12.465B Sedimentology in the Field
Subject meets with 12.110B
Prereq: 12.456 or permission of instructor
Acad Year 2019-2020: G (Spring; second half of term)
Acad Year 2020-2021: Not offered
2-2-5 units
Can be repeated for credit.

Examines the fundamentals of sedimentary deposits and geological reasoning through first hand fieldwork. Students practice methods of modern geological field study off-campus during a required trip over spring break making field observations, measuring stratigraphic sections and making a sedimentological map. Relevant topics introduced are map and figure making in ArcGIS and Adobe Illustrator and sedimentary petrology. Culminates in an oral and written report built around data gathered in the field. Field sites and intervals of geologic time studied rotate annually and include Precambrian, Phanerozoic and Modern depositional environments. May be taken multiple times for credit. Students taking graduate version complete additional assignments.

K. Bergmann

12.467 Seminar in Geomorphology
Prereq: Permission of instructor
G (Spring)
2-0-4 units
Can be repeated for credit.

Discussion of current research or advanced topics in landscape evolution, surface hydrology, mechanics of sediment transport, basin analysis, or experimental geomorphology. Advanced instruction in process geomorphology.

EAPS Staff
12.470 Essentials of Geology  
Subject meets with 12.170  
Prereq: (Calculus II (GIR) and Physics II (GIR)) or permission of instructor  
G (Fall)  
Not offered regularly; consult department  
4-0-8 units  
Geology of planetary interiors and surfaces, including plate tectonics, and the Earth’s interior. Igneous, metamorphic, and sedimentary processes associated with tectonic settings and the typical rock suites created. Mineral and rock identification. Causes of compositional differences on many scales: mineral grains, rocks, regions of the Earth, different planets. Conditions required for melting and melting processes. Rock structure and field techniques. Earth history. Treatment of these topics includes discussions of the geochemical, petrologic, geochronological, experimental, or field techniques used to investigate them; the limitations of current geological techniques and geological controversies; and great geological expeditions, experiments, and studies from the past, their premises, and their results. Students taking graduate version complete additional assignments.  
EAPS Staff

12.471 Essentials of Geobiology  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-4-5 units  
Introduces basic concepts of microbial structure, growth, energetics, molecular biology, and biochemistry. Presents examples of microbial interactions with environments throughout Earth’s history as well as current topics in astrobiology. Includes lectures, discussions of literature, and a field trip. Lab focuses on student-designed projects that involve cultivation, modeling, or sample analyses. Intended for students whose background is not in biology, but who want to learn more about the contribution of microbes to geochemistry and planetary evolution.  
T. Bosak

12.473 Paleomagnetism and Planetary Magnetism  
Prereq: (12.002 and 18.03) or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
2-0-4 units  
Introduces the study of natural remanent magnetization and the generation of planetary magnetic fields. Topics include paleomagnetism, rock magnetism, geomagnetism, magnetostatigraphy, paleomagnetic measurement techniques, polar wander and continental drift, biomagnetism, dynamo theory, and the history and evolution of magnetic fields on the Earth and planets.  
B. P. Weiss

12.474 Origin and Evolution of the Earth’s Crust  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-6 units  
Broad overview of the origin and evolution of Earth’s crust and mantle with emphasis on the study of the Precambrian rock record. Topics include: processes of crustal growth, stabilization, and reactivation; evaluation of secular change; and use of radiogenic isotopes in geochronology and as tracers of crust forming processes.  
O. Jagoutz

12.475 Plate Tectonics and Continental Deformation  
Prereq: Permission of instructor  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-6 units  
First half covers basic elements of plate tectonics, including sea floor spreading, magnetic anomalies, and subduction zone. Second half covers implications of plate tectonics for continental processes, including continental rifting, continental collision, and mountain building. Emphasis will be on correlating plate tectonic and continental processes using specific examples from around the world.  
L. H. Royden
12.476 Radiogenic Isotope Geology
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-3-6 units
Applications of the variations in the relative abundance of radiogenic isotopes to problems of petrology, geochemistry, and tectonics. Topics: geochronology; isotopic evolution of Earth's crust and mantle; petrogenesis; and analytical techniques.
EAPS Staff

12.477 Astrobiology, Origins and Early Evolution of Life
Subject meets with 12.177
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Provides an understanding of major areas of research into the problem of the origin of life on the early Earth from an astrobiological perspective. Topics include the timing, setting and conditions for the origin of life on the Hadean Earth; roles of planetary and extra-planetary processes; defining life; prebiotic chemistry; origins of nucleic acids and peptides; evolution of cellularity, replication, metabolism, and translation; establishment of the genetic code; biogenesis vs. ecogenesis; the nature of the last common ancestor of life; conceptualizing the "tree of life;" and the early evolution of the ancestors of bacteria, archaeeal, and eukaryal lineages. Students taking graduate version complete an extra project.
G. Fournier

12.478 The Phylogenomic Planetary Record
Subject meets with 12.178
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Introduces the tools of sequence-based phylogenetic analysis and molecular evolution in the context of studying events in Earth's deep past that have been preserved by genomes. Topics include basic concepts of cladistics, phylogeny and sequence evolution, construction of phylogenetic trees of genes and microbial lineages, molecular clocks, dating, and ancestral sequence reconstruction. Special attention to the evolutionary history of microbial metabolisms and their relationship to global biogeochemical cycles across Earth's history. Students taking graduate version complete additional assignments.
G. Fournier

12.480 Thermodynamics for Geoscientists
Prereq: 3.046 or 5.60
G (Spring)
3-0-9 units
Principles of thermodynamics are used to infer the physical conditions of formation and modification of igneous and metamorphic rocks. Includes phase equilibria of homogeneous and heterogeneous systems and thermodynamic modelling of non-ideal crystalline solutions. Surveys the processes that lead to the formation of metamorphic and igneous rocks in the major tectonic environments in the Earth's crust and mantle.
T. L. Grove

12.481 Advanced Field Geology I
Prereq: 12.113
G (Fall)
Not offered regularly; consult department
2-2-2 units
Can be repeated for credit.
Introduction to the problems to be investigated in 12.482, as well as the regional setting and local geology of the field area. Various special techniques may be introduced and preparatory investigations may be conducted that are specific to the area to be studied in 12.482.
O. Jagoutz

12.482 Advanced Field Geology II
Prereq: 12.481
Acad Year 2019-2020: G (IAP)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.
In January, a geological and geomorphological study of a selected field area is conducted during a two-week excursion. Exercises include geological and geomorphological mapping on topographic and photographic base maps of a wide variety of bedrock and surficial rocks. Where feasible, geochemical and geophysical field measurements are correlated with geology. Meets with 12.115 when offered concurrently.
O. E. Jagoutz
12.486 Advanced Igneous Petrology
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-2-7 units
Can be repeated for credit.

Comprehensive overview of igneous rocks from the Earth, Moon, and meteorite parent bodies. Discusses the compositional diversity of igneous rocks and how it can be used to elucidate rock forming processes in the major tectonic provinces on modern Earth, including mid-ocean ridges, subduction zones, ocean islands, and inter-continental rift environments. Also covers magma generation processes in the terrestrial planets prior to 2.6 billion years ago. Laboratory exercises on selected suites of igneous rocks reinforce readings and classroom discussions. Uses evidence from related geo-science disciplines to develop an integrative approach to understanding processes that lead to the chemical differentiation of planetary bodies through time. Subject matter may be modified to reflect the interests of the group.

T. L. Grove

12.487A Field Geobiology I
Subject meets with 12.117A
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring; first half of term)
Acad Year 2020-2021: Not offered
2-1-3 units

Examines basic biological processes that operate in sediments. Lectures cover biological, physical and chemical processes that influence the formation and stabilization of sediments, including biomineralization, weathering, erosion, the formation of sedimentary structures and interactions with sediments, flow, and the cycles of nutrients. Lab covers analytical methods used to examine microbial processes, bioinformatic methods used to analyze microbial communities, and techniques used to analyze sediment grain sizes and chemistry. Readings and discussions provide preparation for the 12.487B field trip to a modern sedimentary environment. Enables students to interpret processes in modern sedimentary environments, reconstruct similar processes in the rock record, collect appropriate samples in the field, and analyze microbiological data. Students taking graduate version complete additional assignments.

T. Bosak

12.487B Field Geobiology II
Subject meets with 12.117B
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring; second half of term)
Acad Year 2020-2021: Not offered
2-2-5 units

Teaches fundamentals of field observations and reasoning in geobiology/sedimentology during a required trip to a modern sedimentary environment over spring break, followed by laboratory analyses of collected samples. Students make observations, develop hypotheses, collect samples required to test their hypotheses and interact with lecturers and students investigating the sedimentology of the site. Upon return to MIT, students work on field samples to characterize the sediments, use the preliminary data to develop an understanding of the field site, and write research reports. Students taking graduate version write proposals that present a research question based on the field observations and subsequent analyses. Meets with 12.110B and 12.465B when those subjects examine modern sedimentary environments.

T. Bosak

12.493[J] Microbial Genetics and Evolution
Same subject as 1.87[J], 7.493[J], 20.446[J]
Prereq: 7.03, 7.05, or permission of instructor
Acad Year 2019-2020: G (Fall)
4-0-8 units

See description under subject 7.493[J].
A. D. Grossman, O. Cordero

12.494 Geochemistry of Natural Waters
Subject meets with 12.104
Prereq: Calculus II (GIR)
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-2-7 units

Equips students with the fundamental skills to identify major controls on the chemistry of waters on the Earth. Students examine key concepts, theories and practical tools (e.g., pH, Eh, alkalinity, surface charge, speciation, and carbonate equilibrium) and apply them as tools to understand and make predictions for the biogeochemical cycles of the Earth systems. Graduate students complete additional assignments.

S. Ono
Geophysics

12.501 Essentials of Global Geophysics
Subject meets with 12.201
Prereq: Physics II (GIR) and 18.03
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
4-0-8 units

Overview of basic topics in solid-earth geophysics, such as the Earth’s rotation, gravity and magnetic field, seismology, and thermal structure. Formulation of physical principles presented in three one-hour lectures per week. Current applications discussed in an additional one-hour tutorial each week. Students taking graduate version complete different assignments.

R. van der Hilst

12.502 Flow, Deformation, and Fracture in Earth and Other Terrestrial Bodies (New)
Subject meets with 12.202
Prereq: Calculus II (GIR) and Physics I (GIR)
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-2-7 units

Covers fundamentals of deformation and fracture of solids and the flow of viscous fluids. Explores spatial scales from molecular to planetary, and time scales from fractions of a second to millions of years, to understand how and why natural materials on Earth and other terrestrial bodies respond to applied forces. Introduces anelasticity, granular mechanics, poroelasticity, rate-and-state friction, transport properties of Earth materials (Darcy’s law, Fick’s law), brittle-ductile transitions, creep of polycrystalline materials, stored energy and dissipation, and convection. Prepares students to gather, analyze and interpret data using existing theoretical models. Through a significant laboratory component, students obtain practical experience with experimental measurements and test their acquired theoretical knowledge. Students taking graduate version complete different assignments.

B. Minchew, M. Pec

12.503 Mechanics of Earth (New)
Subject meets with 12.203
Prereq: Calculus II (GIR) and Physics I (GIR)
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-2-7 units

Covers topics in the deformation and fracture of solids and the flow of viscous fluids. Explores spatial scales from molecular to planetary, and time scales from fractions of a second to millions of years, to understand how and why natural materials on Earth and other terrestrial bodies respond to applied forces. Introduces anelasticity, granular mechanics, poroelasticity, rate-and-state friction, transport properties of Earth materials (Darcy’s law, Fick’s law), brittle-ductile transitions, creep of polycrystalline materials, stored energy and dissipation, and convection. Prepares students to gather, analyze and interpret data using existing theoretical models. Through a significant laboratory component, students obtain practical experience with experimental measurements and test their acquired theoretical knowledge. Students taking graduate version complete different assignments.

B. Minchew, M. Pec

12.507 Essentials of Applied Geophysics
Subject meets with 12.214
Prereq: 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-3-6 units

Introduces the application of geophysical methods to all aspects of near-surface environmental and engineering geophysics, including the exploration for petroleum, water, and minerals. Topics include seismic, electrical, electromagnetic, ground penetrating radar, magnetics, gravity, rock physics and chemistry, borehole geophysics and the global positioning system (GPS). Uses a quantitative approach to emphasize basic principles and a physical/chemical understanding of each method. Discusses specific illustrative field examples. Lab work is mainly devoted to local field work and equipment preparation for the IAP Field Geophysics class. Students taking graduate version complete additional assignments.

F. D. Morgan, T. A. Herring, B. H. Hager
12.510 Introduction to Seismology
Prereq: 18.075 or 18.085
G (Spring)
3-1-8 units
A basic study in seismology and the utilization of seismic waves for the study of Earth's interior. Introduces techniques necessary for understanding of elastic wave propagation in stratified media and for calculation of synthetic seismograms (WKB and mode summation). Ray theory; interpretation of travel times (e.g., tomography); surface wave dispersion in layered media; Earth’s free oscillations; and seismicity, (earthquake locations, magnitude, moment, and source properties).
G. Prieto

12.511 Field Geophysics
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (IAP)
1-4-1 units
Covers practical methods of modern geophysics, including the global positioning system (GPS), gravity, and magnetics. Field work is conducted in western US and includes intensive 10-day field exercise. Focuses on measurement techniques and their interpretation. Introduces the science of gravity, magnetics, and the GPS. Measures crustal structure, fault motions, tectonic deformations, and the local gravity and magnetic fields. Students perform high-precision measurements and participate in data analysis. Emphasizes principles of geophysical data collection and the relevance of these data for tectonic faulting, crustal structure, and the dynamics of the earthquake cycle. Students taking graduate version complete additional assignments.
T. A. Herring, B. H. Hager, F. D. Morgan

12.512 Field Geophysics Analysis
Prereq: 12.511
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-0-4 units
Focuses on in-depth data analysis and development of skills needed to report results both in writing and orally. Students use data collected in 12.511 to develop written and oral reports of the results, with each student focusing on a different area. For example, students can develop the geophysical modeling or synthesis of the results into other studies in the area. The final written and oral reports are combined into a comprehensive report and presentation of the field camp and its results. Students taking graduate version complete additional assignments.
T. A. Herring, B. H. Hager, F. D. Morgan

12.515 Data and Models
Prereq: 18.075 or 18.085
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Surveys a number of methods of inverting data to obtain model parameter estimates. Topics include review of matrix theory and statistics, random and grid-search methods, linear and non-linear least squares, maximum-likelihood estimation, ridge regression, stochastic inversion, sequential estimation, singular value decomposition, solution of large systems, genetic and simulated annealing inversion, regularization, parameter error estimates, and solution uniqueness and resolution. Computer laboratory and algorithm development.
F. D. Morgan

12.521 Computational Geophysical Modeling
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Introduces theory, design, and practical methods of computational modeling in geodynamics and geophysical fluid dynamics. Covers the most effective and widely used numerical modeling approaches (e.g., boundary element, finite difference, finite element) and emphasizes problem-solving skills through illustrative examples of heat and mass transfer in the mantle and the ocean. Students acquire experience with various numerical methods through regularly assigned computational exercises and a term-long modeling project of each student’s choice.
J. Lin, O. Marchal, M. Behn

12.522 Geological Fluid Mechanics
Prereq: 8.03 and (18.075 or 18.085)
G (Fall)
Not offered regularly; consult department
3-0-9 units
Treats heat transfer and fluid mechanics in the Earth, low Reynolds number flows, convection instability, double diffusion, Non-Newtonian flows, flow in porous media, and the interaction of flows with accreting and deforming boundaries. Applications include: the flow under plates, postglacial rebound, diapirism, magma dynamics, and the mantle convection problem.
J. A. Whitehead (WHOI)
12.525 Mechanisms of Faulting and Earthquakes
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Explores the fundamental mechanics of faulting and earthquakes from four related perspectives: seismology, geodesy, geodynamics, and rheology. Topics to be covered include (1) the physical processes that control the rheology of faults, including friction and fracture, (2) how these rheological processes are manifest in faulting and earthquakes in the earth from a geodynamics perspective, and (3) how the mechanics of faulting and earthquakes are constrained by seismological and geodetic observations. Both continental and oceanic examples of faulting and earthquakes will be featured.

J. McGuire, G. Prieto

12.533 Rock Physics
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-3-6 units

Fundamentals of experimental and theoretical rock physics taught at an advanced level. Rocks viewed as complex composite media with behavior dependent both on the physical and chemical properties of the constituent phases, and on their geometries. Electrical, fluid transport, and seismic properties covered in detail. Other topics such as magnetic, mechanical, and thermal responses briefly discussed. Weekly laboratory.

F. D. Morgan

12.540 Principles of Global Positioning System
Prereq: Calculus II (GIR), Physics I (GIR), and 18.06
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-1-8 units

The principles and applications of the Global Positioning System (GPS) and other space geodetic systems, including very-long-baseline interferometry (VLBI) and satellite laser ranging (SLR). The nature and uses of the course acquisition (CA), the precise positioning (P) codes, and the differential carrier phase observable. Techniques for estimating geodetic and geophysical quantities from these data. Other topics include: atmospheric refraction modeling, effects of Selective Availability (SA), estimation techniques (including Kalman filtering). Statistical and spectral analysis of data.

T. A. Herring

12.552 Advanced Seismology: Theory and Applications of Seismic Imaging
Prereq: 12.510
G (Spring)
Not offered regularly; consult department
3-0-9 units

Introduces fundamental principles of seismic imaging used in both exploration and solid earth applications. Topics include ray theoretical approaches, scattering theory, and seismic waveform modeling. Through lectures, projects and student-led discussions of journal articles, the class covers the whole process of seismic imaging, from data preprocessing to model generation and geological interpretation of the results.

EAPS Faculty

12.550-12.561 Advanced Seminar in Exploration Geophysics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
2-0-4 units
Can be repeated for credit.

Advanced seminar focusing on areas of current interest in exploration geophysics and seismology. 12.550 is letter-graded.

Geophysics Staff

12.570 Topical Issues in Global Geophysics
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Series of formal lectures and seminars with the specific content varying by term to reflect current issues in research. Meets jointly with relevant Harvard course.

R. D. van der Hilst

12.571 Seminar in Geophysics
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Problems of current interest in geophysics; subject matter varying from term to term.

Geophysics Staff
12.580-12.581 Current Research in Geophysics  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in geophysics. 12.580 is letter-graded.

Geophysics Staff

12.586 Modeling Environmental Complexity  
Subject meets with 12.086  
Prereq: 18.03 or permission of instructor  
G (Fall)  
3-0-9 units

Introduction to mathematical and physical models of environmental processes. Emphasis on the development of macroscopic continuum or statistical descriptions of complex microscopic dynamics. Problems of interest include: random walks and statistical geometry of landscapes; percolation theory and transport in disordered media; fractals, scaling, and universality; ecological dynamics and the structure of ecosystems, food webs, and other natural networks; kinetics of biogeochemical cycles. Appropriate for advanced undergraduates. Beginning graduate students are encouraged to register for 12.586. Students taking the graduate version complete different assignments.

D. H. Rothman

Planetary Science

12.602 Asteroids and Small Bodies  
Prereq: Physics II (GIR) and 18.03  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units

Introduction to the study of asteroids and the ground-based and space-based techniques used to explore them. Topics include asteroid orbital properties, surface structure, physical properties, classifications, as well as their origin, thermal and collisional evolution, and interrelationships with meteorites and comets. Also covers the near-Earth asteroids, the probabilities and consequences of terrestrial collisions, and the possible utilization of asteroids as space resources.

R. P. Binzel

12.603 Solar System Dynamics  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units

Studies the dynamics of the solar system and its major subsystems, and the dynamics of exoplanets, with a modern emphasis on the qualitative structure of phase space. Topics may include rotational dynamics, spin-orbit coupling, Cassini states, and orbital dynamics, resonances, and Kozai oscillations, tidal evolution and tidal heating.

J. Wisdom

12.611 Advanced Planetary Observations  
Prereq: Permission of instructor  
G (IAP)  
0-6-3 units  
Can be repeated for credit.

Individual research projects in planetary science and astrophysics involving supervised work at Lowell Observatory in Flagstaff, AZ. Projects may include observations made using Lowell’s telescope facilities. Project topics and objectives vary from year to year. Written and oral reports required. Enrollment limited.

A. Bosh
Same subject as 6.946[J], 8.351[J]
Prereq: Physics I (GIR), 18.03, and permission of instructor
G (Fall)
3-3-6 units
J. Wisdom, G. J. Sussman

12.621 Physical Principles of Remote Sensing
Subject meets with 12.421
Prereq: Physics II (GIR)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Introduction to the physics of remote sensing with applications to the study of the Earth, Moon, planets and other solar system bodies, as well as to emerging fields, such as autonomous navigation. Includes the principles of optical, thermal, radar and lidar remote sensing. Covers fundamental properties of electromagnetic waves; principles of electromagnetic scattering from real and idealized materials, including various types of surfaces and vegetation; interaction of electromagnetic radiation with the atmosphere; and thermal and microwave emission from various media. Discusses past, present, and future remote sensing platforms along with the fundamentals of orbital mechanics and data processing tools and methods. Students taking graduate version complete different assignments.
B. Minchew

12.622 Planetary Atmospheres
Subject meets with 12.422
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Provides a basic understanding of the physics and chemistry of planetary atmospheres. Explores the formation and evolution of atmospheres, their structure and dynamics, and what is known about their chemical composition. Pays particular attention to their energy balance. Also presents the current state of understanding of exoplanet atmospheres. Students taking graduate version complete an additional research project.
J. de Wit

12.625 Extrasolar Planets: Physics and Detection Techniques
Subject meets with 8.290[J], 12.425[J]
Prereq: 8.03 and 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
In-depth study of current topics in exoplanets, such as exoplanet transits, radial velocity curves, current survey missions, the mass-radius relation, and super Earths. Class activities consist of reading the current literature, problem sets, and a term project. Students taking graduate version complete additional assignments.
S. Seager

12.650 Current Topics in Planetary Science
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.
In-depth discussion of current and classic literature on selected topics in planetary science. Topics vary from year to year.
J. Wisdom

12.652 Current Topics in Planetary Science
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
In-depth discussion of current and classic literature on selected topics in selected areas of asteroids and the Pluto-Charon system. Topics vary from year to year.
R. P. Binzel
12.690-12.691 Current Research in Planetary Science  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Original investigations, laboratory work, or fieldwork in planetary science. 12.690 is letter-graded.  
Planetary Science Staff

Geological, Geophysical, and Chemical Oceanography

12.701 Classic Papers in Physical Oceanography  
Prereq: None  
G (Spring)  
3-0-3 units  
Provides a historical perspective on fundamental topics in oceanography by considering individual works which, when pieced together, contribute to the more cohesive description of how the ocean works. In class discussions, students consider various aspects of the work in question, including motivation, approach, and implications for the broader context. They also synthesize information and make oral presentations. Develops basic analytical and critical skills in paper reading and writing.  
Y. Kwon (WHOI)

12.702 Elements of Modern Oceanography  
Subject meets with 12.372  
Prereq: None  
G (Fall)  
3-0-9 units  
Examines a series of crosscutting topics that exemplify current directions in interdisciplinary oceanography. Focuses on current themes in oceanography, their interdisciplinary nature, and the role of ocean sciences in society. Introduces core concepts across the disciplines of biological, physical, and chemical oceanography as well as marine geology. Emphasizes the interdisciplinary aspects of these core concepts, the kinds of approaches and modes of thinking common to all of the disciplines, and the technological developments underpinning current advances. Students taking graduate version complete different assignments.  
G. Lawson, A. Kirincich (WHOI)

12.703 Presenting Scientific Research  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-3 units  
Presenting scientific research geared toward a scientific audience. Each student gives one 30-minute talk, one AGU-style 15-minute talk, and one poster presentation. Students present their ongoing research and use the class as a forum to practice for upcoming talks in more formal settings. Abstracts are prepared for each presentation and discussed in class. Students provide comments, questions, encouragement, critiques, etc. on their peers' presentations.  
S. Nielsen, V. Le Roux (WHOI)

12.707 The History of Earth's Climate  
Subject meets with 12.377  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Studies the climate history of the Earth, from the formation of the early atmosphere and ocean to the present. Evaluates geochemical, sedimentological, and paleontological evidence for changes in ocean circulation, global temperatures, and atmospheric carbon dioxide levels. Covers theories and models of Phanerozoic climate change. Provides a long-term history of the global carbon cycle. Students taking graduate version complete different assignments.  
D. McGee

12.708 Topics in Paleoceanography  
Prereq: Permission of instructor  
G (Fall)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Seminar focusing on areas of current interest in paleoceanography and paleoclimatology. Includes discussion of current and classic literature. Topics vary from year to year.  
D. Oppo, O. Marchal (WHOI)
**12.710 Geological Oceanography**
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Provides a high level survey of a broad range of active science topics in Geological Oceanography. Presents background material that graduate students are expected to know in the disciplines of solid-earth geophysics, geochemistry, sedimentology and stratigraphy, coastal processes, and climate, including a representative set of canonical science papers, and builds on this material to give a sense of the current state of the science in these fields. Broad topics include the formation of the earth, petrogenesis, volcanism, plate tectonics, geodynamics, sedimentation in the oceans, coastal morphodynamics, paleo-oceanography, and climate. The interconnectedness of and feedbacks between processes discussed under these various topics is emphasized.

**WHOI Staff**

**12.712 Advanced Marine Seismology**
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units
Can be repeated for credit.

Focuses on synthetic seismograms, ocean bottom refraction seismology, and multi-channel reflection seismology as applied to studies of the ocean sediments, crust, and lithosphere. Topics include: the wave equations for elastic/anelastic, isotropic/anisotropic, homogeneous/heterogeneous and fluid/solid media; ray theory and WKBJ approximations; the Sommerfeld/Weyl integrals, asymptotic analysis, and Lamb’s problem for a fluid/solid interface; reflectivity and related methods; finite difference and finite element methods; and special topics of interest to the class. Extensive readings of geophysical and seismological literature.

*R. Stephen (WHOI)*

**12.714 Computational Data Analysis**
Prereq: 18.03
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

An introduction to the theory and practice of analyzing discrete data such as are normally encountered in geophysics and geology. Emphasizes statistical aspects of data interpretation and the nonparametric discrete-time approach to spectral analysis. Topics include: elements of probability and statistics, statistical inference, robust and nonparametric statistics, the method of least squares, univariate and multivariate spectral analysis, digital filters, and aspects of multidimensional data analysis.

*A. D. Chave, T. A. Herring*

**12.716 Essentials of Oceanic Petrology**
Prereq: 12.710 or permission of instructor
G (Spring)
3-2-4 units
Can be repeated for credit.

Qualitative interpretation and quantitative analysis of melting, melt transport, melt-rock reactions, igneous crustal accretion, metamorphism and hydrothermalism at oceanic spreading centers and subduction-related arcs applied to understanding the variations in the composition of the Earth’s (oceanic) mantle and crust and accretionary processes at mid-ocean ridges. Combines theoretical methods with field, petrographic, geochemical, and computational techniques. Topics vary from year to year.

*H. Dick, F. Klein (WHOI)*

**12.717 Coastal Geomorphology**
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Explores mechanisms behind the formation and reshaping of coastal environments. Focuses on a process-based understanding of both the fluid dynamic and sediment transport aspects of coastal landforms, and, especially, the importance of feedbacks between the two. Investigates coastal evolution at various scales - from ripples to coastline formation - with an emphasis on the behavior of coastal environments over integrated timescales of days and years to centuries and millennia. Students investigate the effect of storms, sea-level rise, and interactions with biological and anthropogenic influences. Covers a broad array of coastal environments, including beaches, barrier islands, spits, inlets, tidal flats, deltas, rocky coasts, arctic shores, and carbonate atolls.

*A. Ashton*

**12.718 Kinetics and Mass Transport**
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units

Offers a broad overview of various kinetic and transport processes in geology, including volume and grain boundary solid-state diffusion, defects in minerals, rates of mineral reaction and transformation, crystal nucleation and growth, advective transport in porous media and partially molten aggregates, and percolation theory. Emphasis on processes in crystalline rocks. Covers theoretical, phenomenological, and experimental constraints, with a consistent application to “real-world” settings and actual case histories.

*M. Behn and G. Gaetani (WHOI)*
EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES (COURSE 12)

12.721 Current Research in Marine Geology and Geophysics at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in marine geology and geophysics.

WHOI Staff

12.722 Current Research in Chemical Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in chemical oceanography.

WHOI Staff

12.723 Current Research in Biological Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in biological oceanography.

WHOI Staff

12.724 Current Research in Marine Geology and Geophysics at Woods Hole
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in marine geology and geophysics.

WHOI Staff

12.725 Current Research in Chemical Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Original investigations, laboratory work, or field work in chemical oceanography.

WHOI Staff

12.726 Current Research in Biological Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in biological oceanography.

WHOI Staff

12.730-12.731 Current Research in Marine Geology and Geophysics at MIT
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in marine geology and geophysics under the supervision of a faculty member in residence at MIT. For students in the MIT/WHOI Joint Program. 12.730 is letter-graded.

Marine Geology and Geophysics Staff

12.732 Current Research in Biological Oceanography at MIT
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in biological oceanography.

MIT Staff

12.733 Current Research in Biological Oceanography at MIT
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in biological oceanography.

MIT Staff
12.735-12.736 Current Research in Chemical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Original investigations, laboratory work, or fieldwork in chemical oceanography under the supervision of a faculty member in residence at MIT. For students in the MIT/WHOI Joint Program. 12.735 is letter-graded.

Chemical Oceanography Staff

12.739 Marine Microbiology and Biogeochemistry
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

Integrates the fields of microbiology and biogeochemistry, and is centered on elucidating the linkages between microorganisms and geochemical processes in the oceans. Divided into modules that first lay the theoretical framework to familiarize students of diverse backgrounds (biologists, chemists, physical oceanographers). Next, introduces specific and general linkages between the topics and the major tools and techniques that have advanced their integrated study. Concludes with a synthesis module examining the role of microorganisms in the biogeochemical cycles of diverse ocean biomes. A. Apprill, S. Sievert (WHOI)

12.740 Paleoceanography
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Studies the basic principles of techniques for reconstructing the history of ocean climate from marine sediment cores, corals, ice cores, and other paleoclimate archives. Examines this data in the light of proposed climate change mechanisms. Micropaleontological, isotopic, geochemical, and mineralogical changes are used to infer changes in seawater composition, atmospheric chemistry, and climate. Observations are interpreted as consequences of changes in ocean temperature, circulation, and chemistry, and are used to evaluate theories proposed to account for glacial/interglacial cycles. Focuses on the past two million years, but major processes and events from the past 100 million years are also included.

E. A. Boyle

12.741 Marine Bioinorganic Chemistry
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
2-0-7 units

Provides an overview of trace element biogeochemistry and marine bioinorganic chemistry. Topics include controls on oceanic trace metal distributions; co-evolution of biological metal requirements and metal availability during early Earth history; chemical speciation and its influence on microbial bioavailability; applications of metal isotopes; roles of metalloenzymes and metal proteins in biogeochemical cycles; and biogeochemical applications of metagenomics, metaproteomics, and bioinformatics.

M. Saito

12.742 Marine Chemistry
Prereq: Permission of instructor
G (Fall)

3-0-9 units

An introduction to chemical oceanography. Reservoir models and residence time. Major ion composition of seawater. Inputs to and outputs from the ocean via rivers, the atmosphere, and the sea floor. Biogeochemical cycling within the oceanic water column and sediments, emphasizing the roles played by the formation, transport, and alteration of oceanic particles and the effects that these processes have on seawater composition. Cycles of carbon, nitrogen, phosphorus, oxygen, and sulfur. Uptake of anthropogenic carbon dioxide by the ocean. Material presented through lectures and student-led presentation and discussion of recent papers.

B. Van Mooy, E. Kojawinski (WHOI)

12.743 Geochemistry of Marine Sediments
Prereq: Chemistry (GIR) and 5.60
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Focuses on processes that control the composition of sediments in coastal, shelf, and deep-sea environments and processes that define their roles in biogeochemical cycles. Topics include calculating chemical fluxes across the sediment-water interface; evaluating the sources and reactivity of carbonate, silicic, and detrital sediments; using pore water gradients to calculate diffusion, reaction, and flux rates; sediment dating; estimating accumulation rates; and using stable isotopes and natural-series radioisotopes. Covers evaluation of the links between sedimentary and water column processes; the effects of anthropogenic disturbances (e.g., eutrophication, acidification, warming) on sedimentary processes; and the role of sediments in global biogeochemical cycles. Introduces sampling techniques and mathematical modeling of sedimentary processes.

D. McCorkle, W. Martin, A. Wang, M. Long (WHOI)
**12.744 Marine Isotope Chemistry**  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  

Fundamentals of using isotopes to study processes and timescales for marine chemistry and geochemistry. Provides basic introduction to the nature, origins, and reasons for the distributions of isotopes in nature, then develops theory and approaches for radioactive dating methods. These are used to constrain the timing and nature of the geochemical evolution of the elements, solar system, earth, ocean, and atmosphere. Covers cosmogenic isotopes and their applications. Briefly discusses basics of mass spectrometry, followed by a closer inspection of the principles and applications of isotope fractionation. Introduces mass independent fractionation and clumped isotope methods. Explores applications of isotope methods to a number of water column processes, including particle scavenging, sedimentation, long term element budgets, redox processes, and air-sea exchange. Emphasizes quantitative methods and problem-solving. Includes problem sessions with development of problem solutions.  
*WHOI Staff*  

**12.746 Marine Organic Geochemistry**  
Prereq: Permission of instructor  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-6 units  

Provides an understanding of the distribution of organic carbon (OC) in marine sediments from a global and molecular-level perspective. Surveys the mineralization and preservation of OC in the water column and within anoxic and oxic marine sediments. Topics include: OC composition, reactivity and budgets within, and fluxes through, major reservoirs; microbial recycling pathways for OC; models for OC degradation and preservation; role of anoxia in OC burial; relationships between dissolved and particulate (sinking and suspended) OC; methods for characterization of sedimentary organic matter; application of biological markers as tools in oceanography. Both structural and isotopic aspects are covered.  
*D. Repeta (WHOI)*  

**12.747 Modeling, Data Analysis, and Numerical Techniques for Geochemistry**  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  

Emphasizes the basic skills needed for handling and assimilating data as well as the basic tool-set for numerical modeling. Uses MATLAB as its computation engine; begins with an introduction to MATLAB to ensure familiarity with software. Topics include: probability distributions, error propagation, least squares and regression techniques, principle component and factor analysis, objective mapping, Fourier and spectral analysis, numerical solutions to ODEs and PDEs, finite difference techniques, inverse models, and scientific visualization. 
*D. Nicholson (WHOI)*  

**12.749 Solid Earth Geochemistry**  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  

Integrates methods in mineralogy, petrology (both igneous and metamorphic), and trace element and isotope geochemistry to address scientific issues of the solid earth. Covers processes in the solar nebula, accretion, and early differentiation of the earth. Discusses topics in three representative geodynamic environments - mid-ocean ridges, subduction zones, and mantle plumes - with respect to physical framework and petrological/geochemical aspects.  
*N. Shimizu, S. Nielsen, G. Gaetani (WHOI)*  

**12.751-12.759 Seminar in Oceanography at Woods Hole**  
Prereq: Permission of instructor  
G (Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  

Topics in marine geology and geophysics, physical, dynamical, and chemical oceanography. Content varies from term to term. 12.754, 12.755, and 12.756 are letter-graded.  
*WHOI Staff*
12.760-12.761 Seminar in Marine Geology and Geophysics at MIT
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Topics in marine geology and geophysics taught at MIT. Content varies from term to term. 12.760 is letter-graded.

Marine Geology and Geophysics Staff

12.770-12.771 Seminar in Chemical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Topics in chemical oceanography taught at MIT. Content varies from term to term. 12.770 is letter-graded.

Chemical Oceanography Staff

12.777 Field Oceanography
Subject meets with 12.373
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-4-5 units

Provides an introduction to the biogeochemistry of the ocean, and the field techniques and methods used in its study. Emphasizes biogeochemistry and the interrelated nature of elemental cycling, but also examines physical transport and air-sea gas exchange. Covers multiple aspects related to field instrumentation and measurements, including nutrients, oxygen, the carbon system, temperature, and salinity. Presents microbial analyses, such as metagenomics. Includes an optional spring break field trip aboard a research vessel. Students work in groups to propose a project over the week-long voyage that utilizes the field time to collect samples. During the second half of the term, students analyze and synthesize the data, and present it in a publication-quality manuscript. Students taking graduate version complete additional assignments.

A. R. Babbin

Atmospheres, Oceans, and Climate

12.800 Fluid Dynamics of the Atmosphere and Ocean
Subject meets with 12.390
Prereq: 8.03 and 18.04
G (Fall)
3-0-9 units

Introduction to fluid dynamics. Students acquire an understanding of some of the basic concepts of fluid dynamics that are needed as a foundation for advanced coursework in atmospheric science, physical oceanography, ocean engineering, climate science, etc. Emphasizes fluid fundamentals, with an atmosphere/ocean twist. Students taking graduate version complete additional assignments.

A. Mahadevan, C. Cenedese

12.801 Large-scale Ocean Dynamics
Prereq: 12.800
G (Spring)
3-0-9 units

Applies fundamental principles of geophysical fluid dynamics to understand the general patterns of the ocean circulation and stratification. Includes the mid-latitude wind-driven circulation, the Southern Ocean circulation, and the global overturning circulation. Uses a combination of theory, numerical simulations, and observations to illustrate the concepts.

J. Yang (WHOI)

12.802 Waves, Instability and Turbulence at Small Scales
Prereq: 12.800 or permission of instructor
G (Spring)
3-0-9 units

Covers basic concepts of wave motion, flow instability, and turbulence in rotating and stratified fluids with emphasis on small scales. Presents wave properties, including the dispersion relation, phase and group velocities, and wave kinematics, and uses these concepts to study the dynamics of surface and internal gravity waves, Poincare waves, Kelvin waves, and topographic waves. Includes flow instability. Explores general concepts of linear instability in small-scale stratified shear flows (Rayleigh and Kelvin-Helmholtz instabilities); examines non-rotating stratified turbulence resulting from these instabilities. Also discusses wave-mean flow interaction, hydraulic control, the entrainment assumption, and the interpretation of microstructure observations.

G. Flierl, R. Ferrari
12.803 Advanced Geophysical Fluid Dynamics  
Prereq: 12.843  
G (Spring)  
2-0-7 units  
Further development of topics covered in 12.843, with a more mathematical treatment. Covers current topics of interest in rotating stratified flows of oceans and atmospheres.  
*G. Flierl, R. Ferrari*

12.805 Data Analysis in Physical Oceanography  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Directed at making scientifically-sensible inferences from physical oceanography data (both observations and models). Introduces linear inverse methods, including regression, singular value decomposition, objective mapping, and data assimilation. Connects these methods to time series analysis, including Fourier methods, spectra, coherence, and filtering. Focuses on working with data in a computer laboratory setting. Emphasizes how statistical information can be used to improve experimental design. Gives some attention to the instruments and algorithms used to acquire the data.  
*G. Gebbie, T. Farrar (WHOI)*

12.806[J] Atmospheric Physics and Chemistry  
Same subject as 10.571[J]  
Subject meets with 12.306  
Prereq: (18.075 and (5.60 or 5.61)) or permission of instructor  
G (Spring)  
3-0-9 units  
Introduction to the physics and chemistry of the atmosphere including experience with computer codes. Aerosols and theories of their formation, evolution, and removal. Gas and aerosol transport from urban to continental scales. Coupled models of radiation, transport, and chemistry. Solution of inverse problems to deduce emissions and removal rates. Emissions control technology and costs. Applications to air pollution and climate.  
*R. G. Prinn*

12.807[J] Atmospheric Chemistry  
Same subject as 1.84[J], 10.817[J]  
Prereq: 5.60  
G (Fall)  
3-0-9 units  
See description under subject 1.84[J].  
*J. H. Kroll*

12.808 Introduction to Observational Physical Oceanography  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Results and techniques of observations of the ocean in the context of its physical properties and dynamical constraints. Emphasis on large-scale steady circulation and the time-dependent processes that contribute to it. Includes the physical setting of the ocean, atmospheric forcing, application of conservation laws, description of wind-driven and thermohaline circulation, eddy processes, and interpretive techniques.  
*H. Seo, J. Toole (WHOI)*

12.809 Hydraulic Phenomena in Geophysical Fluid Flows  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-6 units  
Examination of the hydraulics of nonrotating flows (Long’s experiments, hydraulic control, upstream influence, nonlinear wave steepening, hydraulic jump and bores, application to severe downslope winds). Other topics may include: nonrotating stratified flows (two-layer hydraulics, virtual and approach controls, maximal and submaximal flow, application to the Strait of Gibraltar and the Bab al Mandab); and deep ocean straits and sills (steady theories for rotating channel flow, nonlinear Kelvin and frontal waves, rotating hydraulic jumps, geostrophic adjustment in a rotating channel, and applications to the Denmark Strait and other deep passages).  
*L. Pratt, K. Helfrich (WHOI)*

12.810 Dynamics of the Atmosphere  
Prereq: 12.800  
G (Spring)  
3-0-9 units  
Discusses the dynamics of the atmosphere, with emphasis on the large scale. Topics include internal gravity waves in the atmosphere; potential vorticity conservation and Rossby waves; baroclinic instability and extratropical storms; the tropical Hadley and Walker circulations and equatorial waves; and the general circulation, annular modes, and the response to climate change.  
*P. O’Gorman*
12.811 Tropical Meteorology
Prereq: 12.810; or Coreq: 12.843
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
A description of the large-scale circulation systems of the tropical atmosphere and analysis of the dynamics of such systems. Topics include: Radiative-convective equilibrium; the Hadley and Walker circulation; monsoons; tropical boundary layers; theory of the response of the tropical atmosphere to localized sea-surface temperature anomalies; intraseasonal oscillations; equatorial waves; El Niño/Southern Oscillation; easterly waves; and tropical cyclones.
K. A. Emanuel

12.812 The General Circulation of the Atmosphere and Climate Change
Prereq: 12.810 or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
2-0-7 units
Describes the general circulation of Earth's atmosphere and its maintenance. Second half of the course explores the response of the general circulation to climate change.
P. O'Gorman

Same subject as 1.842[J]
Subject meets with 12.338
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Focuses on understanding how aerosol particles form droplets or ice crystals during several atmospheric processes: determining Earth's radiative balance; heterogeneous chemistry and acid rain; understanding where, when and how much precipitation occurs; Provides tools for understanding the physics of aerosol and cloud element motion; the interaction of particles with water vapor, including phase changes and droplet and ice nucleation; the chemical composition of particles and the effect on cloud formation processes; and the effect of cloud processing on aerosol chemistry. Discusses relevant topics of contemporary interest, e.g., geoengineering and weather modification and volcanic effects. Students taking the graduate version complete different assignments.
D. Cziczo

12.815 Atmospheric Radiation and Convection
Subject meets with 12.315
Prereq: 12.800 or permission of instructor
G (Spring)
3-0-9 units
Introduction to the physics of atmospheric radiation, remote sensing, and convection, including use of computer codes. Radiative transfer equation including emission and scattering, spectroscopy, Mie theory, and numerical solutions. Physics of dry and moist convection, including moist thermodynamics. Radiative-convective equilibrium. Solution of inverse problems in remote sensing of atmospheric temperature and composition. Students taking graduate version complete additional assignments.
T. Cronin

12.817[J] Atmospheric Composition in the Changing Earth System
Same subject as 1.841[J]
Prereq: 1.84[J]
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 1.841[J].
C. Heald

12.818 Introduction to Atmospheric Data and Large-scale Dynamics
Subject meets with 12.318
Prereq: None. Coreq: 12.800
G (Fall)
3-3-6 units
Provides a general introduction to meteorological data and analysis techniques, and their use in the MIT Synoptic Laboratory to study the phenomenology and dynamics of large-scale atmospheric flow. Illustrates balance concepts as applied to the dynamics of frontal and synoptic scales, using real-time upper-air and surface station data and gridded analyzed fields. Uses advanced meteorological software packages to access, manipulate, and graphically display the data. Students taking graduate version complete different assignments.
L. Illari
12.820 Turbulence in the Ocean and Atmosphere
Prereq: 12.843
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Covers phenomena, theory and modeling of turbulence in the Earth’s oceans and atmosphere. The scope will range from centimeter- to planetary-scale motions. Includes homogeneous isotropic three- and two-dimensional turbulence, convection, stratified turbulence, quasi-geostrophic turbulence, baroclinic turbulence, and macroturbulence in the ocean and atmosphere.
R. Ferrari, G. Flierl

12.823 Modeling the Biology and Physics of the Ocean
Prereq: 18.075 or 18.085
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-6 units

G. Flierl, D. McGillicuddy

12.824 Stability Theory for Oceanic & Atmospheric Flows
Prereq: 12.802 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Basic theory of hydrodynamic instability with special application to flows of interest in oceanography and meteorology. Topics covered include general formulation of stability theory; concept of normal modes and linearization; fundamental stability theorems; baroclinic instability: Charney model, Eady model and the Phillips two-layer model; energy transformations; initial value theory and non-modal instability; barotropic instability for jets and shear layers; radiating instabilities; initial value problems applied to the concepts of convective, absolute and spatial instabilities; finite amplitude theory; stability of non-parallel flows.
G. Flierl

12.830 Topics in Waves and Instability
Prereq: 12.843
G (Fall)
Not offered regularly; consult department
3-0-9 units

A detailed presentation of selected advanced topics in waves and instability in the atmosphere. The precise selection varies from year to year. Topics have included wave-mean flow interaction, the quasi-biennial oscillation, sudden warmings, critical-level behavior, wave overreflection, nonlinear equilibration, wave breaking, tropical waves, and stationary waves.
EAPS Staff

12.834[J] Land-Atmosphere Interactions
Same subject as 1.713[J]
Prereq: Permission of instructor
G (Spring)
2-0-4 units

See description under subject 1.713[J].
D. Entekhabi

12.835 Experimental Atmospheric Chemistry
Subject meets with 12.335
Prereq: Permission of instructor
G (Fall)
2-4-6 units

Introduces the atmospheric chemistry involved in climate change, air pollution, and ozone depletion using a combination of interactive laboratory and field studies and simple computer models. Uses instruments for trace gas and aerosol measurements and methods for inferring fundamental information from these measurements. Students taking the graduate version complete different assignments.
R. Prinn, S. Ono, D. Cziczo
12.842 Climate Science
Subject meets with 12.301
Prereq: Chemistry (GIR), 18.03, or permission of instructor
G (Fall)
4.0-8 units

Introduction to climate studies, including beginnings of the solar system, time scales, and climate in human history; methods for detecting climate change, including proxies, ice cores, instrumental records, and time series analysis; physical and chemical processes in climate, including primordial atmosphere, ozone chemistry, carbon and oxygen cycles, and heat and water budgets; internal feedback mechanisms, including ice, aerosols, water vapor, clouds, and ocean circulation; climate forcing, including orbital variations, volcanism, plate tectonics, and solar variability; climate models and mechanisms of variability, including energy balance, coupled models, and global ocean and atmosphere models; and outstanding problems. Students taking the graduate version complete different assignments.
K. Emanuel, E. Boyle

12.843 Large-scale Atmosphere and Ocean Dynamics
Prereq: 12.801, 12.810, or permission of instructor
G (Fall)
2-4-9 units

Project-based with lectures covering the relevant theory. Students work in groups on four projects. Each of these comprises a numerical part, to illuminate and illustrate the theory, and a data part (drawn from laboratory tank experiments, atmospheric, or ocean observations), to illustrate the phenomena. Topics include: barotropic vorticity dynamics including inversion and evolution, geostrophic and higher order balance, baroclinic dynamics and the evolution of balanced flows, and stability with emphasis on the mutual interaction of disturbances. Projects include a verbal presentation and writeup covering both the numerical and geophysical parts plus additional derivations as needed.
G. Flierl, L. Illari

12.845(J) Sustainability Science and Engineering
Same subject as IDS.526(J)
Prereq: None
G (Fall)
3-0-6 units

See description under subject IDS.526(J).
N. E. Selin

12.846(J) Global Environmental Negotiations
Same subject as IDS.525(J)
Subject meets with 12.346(J), IDS.062(J)
Prereq: None
G (Fall)
Not offered regularly; consult department
2-0-4 units

See description under subject IDS.525(J).
N. Selin

12.848(J) Global Climate Change: Economics, Science, and Policy
Same subject as 15.023(J)
Subject meets with 12.348(J), 15.026(J)
Prereq: (Calculus II (GIR), 5.60, and (14.01 or 15.010)) or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units

See description under subject 15.023(J).
R. G. Prinn

12.849 Mechanisms and Models of the Global Carbon Cycle
Subject meets with 12.349
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Addresses changes in the ocean, terrestrial biosphere and rocks modulation of atmospheric carbon dioxide on timescales from months to millions of years. Includes feedbacks between carbon cycle and climate. Combines hands-on data analysis with the formulation of simple models rooted in basic physical, chemical and biological principles. Students create individual “toy” global carbon cycle models. Students taking graduate version complete different assignments.
M. Follows
12.850 Computational Ocean Modeling
Prereq: None
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Numerical modeling in oceanography and environmental fluid mechanics. Focuses on the building of computational models that describe processes such as transport (advection, diffusion), reaction (ecosystems), and boundary forcing, of relevance in the ocean. Models are developed in a hierarchical manner, starting from the simple (zero-dimensional in space), and incrementally advancing toward more complex, time-evolving systems in one-, two- (shallow water) and three-dimensions (Primitive equations). Students build their own models using the finite volume approach with an appreciation and understanding of the working of general circulation models
A. Mahadevan (WHOI), W. Zhang (WHOI)

12.853 Advanced geophysical fluid dynamics
Prereq: 12.843 or permission of instructor
G (Fall)
Not offered regularly; consult department
2-0-7 units
Follow-on to 12.843, with a more mathematical treatment and extension of material to current topics of interest involving rotating, stratified flows of oceans and atmospheres.
G. Flierl

12.860 Climate Variability and Diagnostics
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Explores climate variability and change, focusing on the atmosphere and ocean, while building experience applying diagnostic analyses to a range of modern observations and models. Provides practical insight, from regional to global scale, with applications to past and future climates. Emphasizes salient features of the mean climate system and modes of natural variability, as well as observed and projected manifestations of anthropogenic climate change. Students gain experience accessing, analyzing, and visualizing a wide range of gridded observational-based datasets, as well as output from global climate model simulations. Develops the tools necessary to apply climate diagnostic analysis to one’s own research, as well as the interdisciplinary edge to critically assess and interpret the observational and model results underpinning the Fifth Assessment Reports of the Intergovernmental Panel on Climate Change.
C. Uhmmenhofer

12.862 Coastal Physical Oceanography
Prereq: 12.800
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Introduction to the dynamics of flow over the continental shelf, nearshore, and estuaries, emphasizing both theory and observations. Content varies somewhat according to student and staff interests. Possible topics include fronts, buoyant plumes, surface and bottom boundary layers, wind-driven upwelling, coastal-trapped waves, internal waves, quasi-steady flows, high-latitude shelf processes, tides, and shelf-open ocean interactions.
R. Todd, D. Ralston (WHOI)

12.863 Advanced Topics in Coastal Physical Oceanography
Prereq: 12.862 or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
More specialized topics in the dynamics of flow over the continental shelf, including coastal-trapped waves, wind-driving, and mean flows. Emphasis on the relationship between theory and observations. Instrumentation and the application of statistical techniques also covered.
Woods Hole Staff

12.866 Theory of the General Circulation of the Ocean
Prereq: 12.800, 12.801, and 12.802
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
R. X. Huang (WHOI)
12.870 Air-Sea Interaction: Boundary Layers  
Prereq: Graduate-level fluid mechanics and a subject on waves or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Addresses the interaction of the atmosphere and ocean on temporal scales from seconds to days and spatial scales from centimeters to kilometers. Topics include the generation, propagation, and decay of surface waves; the processes by which mass, heat, momentum, and energy are transported vertically within the coupled atmospheric and oceanic boundary layers and across the air-sea interface; and the statistical tools, mathematical models, and observational methods that are used to quantify these processes.  
R. Todd, D. Ralston (WHOI)

12.885[J] Science, Politics, and Environmental Policy  
Same subject as 11.373[J]  
Subject meets with 12.385  
Prereq: Permission of instructor  
Acad Year 2019-2020: G (Fall)  
Acad Year 2020-2021: Not offered  
3-0-6 units  
Examines the role of science in US and international environmental policymaking. Surveys the methods by which scientists learn about the natural world; the treatment of science by experts, advocates, the media, and the public and the way science is used in legislative, administrative and judicial decision making. Through lectures, group discussions, and written essays, students develop a critical understanding of the role of science in environmental policy. Potential case studies include fisheries management, ozone depletion, global warming, smog, and endangered species. Students taking the graduate version complete different assignments.  
S. Solomon, J. Knox-Hayes

12.910 Communicating Ocean Science  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-6 units  
For students interested in improving their ability to teach science, the focus is on inquiry-based instructional methods and application to various audiences. Includes an opportunity to teach in a course at a local state university and in a supervised elementary school classroom. Class meets twice a week for 11 sessions, and episodically thereafter. The undergraduate lesson is arranged in consultation with Bridgewater State University faculty. Outreach in local school classrooms involves one session observing and three sessions teaching.  
L. Mullineaux (WHOI), A. Michel (WHOI)

12.950, 12.951 Seminar in Physical Oceanography at MIT  
Prereq: Permission of instructor  
G (Fall, Spring)  
Not offered regularly; consult department  
Units arranged [P/D/F]  
Can be repeated for credit.  
Topics in physical and dynamical oceanography. Content varying from term to term. 12.950 is letter-graded.  
Physical Oceanography Staff

12.960, 12.961 Current Research in Physical Oceanography at MIT  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Original investigations, laboratory work, or fieldwork in oceanography. 12.960 is letter-graded.  
Physical Oceanography Staff

12.970, 12.971 Current Research in Physical Oceanography at Woods Hole  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Original investigations, laboratory work, or field work on oceanographic problems. 12.970 is letter-graded.  
Woods Hole Staff

12.980, 12.981 Current Research in Atmospheric Science  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Original investigations on problems in atmospheric science. 12.980 is letter-graded.  
EAPS Staff

12.982, 12.983 Current Research in Climate Physics and Chemistry  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Original investigations, laboratory work, or fieldwork in problems related to climate. 12.982 is letter-graded  
PAOC faculty
12.5488, 12.5489 Special Seminar in Structural Geology
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject on an aspect of structural geology not normally covered in regularly scheduled subjects. 12.5488 is letter-graded.

12.5490, 12.5491 Special Seminar in Geology and Geochemistry
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject on an aspect of geology or geochemistry not normally covered in regularly scheduled subjects. 12.5490 is letter-graded.

12.5492, 12.5493 Special Seminar in Geobiology
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject on an aspect of geobiology not normally covered in regularly scheduled subjects. 12.5492 is letter-graded.

12.5590, 12.5591 Special Seminar in Geophysics
Prereq: Permission of instructor
Acad Year 2019-2020: G (IAP)
Acad Year 2020-2021: Not offered
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject on an aspect of geophysics not normally covered in regularly scheduled subjects. 12.5590 is letter-graded.

12.5592, 12.5593 Special Seminar in Earth, Atmospheric and Planetary Sciences
Prereq: Permission of instructor
Acad Year 2019-2020: G (IAP)
Acad Year 2020-2021: Not offered
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject on an aspect of the earth sciences, planetary sciences, or astronomy not normally covered in regularly scheduled subjects. 12.5592 is letter-graded.

12.5595 Special Seminar in Geophysics
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject on an aspect of geophysics not normally covered in regularly scheduled subjects. 12.5590 is letter-graded.

12.5597 Special Seminar in Earth, Atmospheric and Planetary Sciences
Prereq: Permission of instructor
G (Fall, IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject on an aspect of the earth sciences, planetary sciences, or astronomy not normally covered in regularly scheduled subjects. 12.5592 is letter-graded.

12.5680, 12.5681 Special Seminar in Planetary Science
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Organized lecture or laboratory subject on an aspect of planetary science not normally covered in regularly scheduled subjects. 12.5680 is letter-graded.

Consult EAPS Education Office
12.S990, 12.S991 Special Subject in Atmospheric Science
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Organized lecture or laboratory subject on an aspect of atmospheric science not normally covered in regularly scheduled subjects.
12.S990 is letter-graded.
*PAOC Staff*

12.S992, 12.S993 Special Subject in Climate Science
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Organized lecture or laboratory subject on an aspect of climate not normally covered in the regularly scheduled subjects. 12.S992 is letter-graded.
*PAOC Staff*
General Economics and Theory

14.00 Undergraduate Internship in Economics
Prereq: Permission of instructor
U (IAP, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For Course 14 students participating in off-campus internship experiences in economics. Before registering for this subject, students must have an employment offer from a company or organization and must identify a Course 14 supervisor. Upon completion of the internship, student must submit a letter from the employer describing the work accomplished, along with a substantive final report from the student approved by the MIT supervisor. Subject to departmental approval. Consult departmental undergraduate office. 
Consult D. Donaldson

14.000 Graduate Internship in Economics
Prereq: Permission of instructor
G (IAP, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For Course 14 students participating in off-campus internship experiences in economics. Before registering for this subject, students must have an employment offer from a company or organization and must identify a Course 14 supervisor. Upon completion of the internship, student must submit a letter from the employer describing the work accomplished, along with a substantive final report from the student approved by the MIT supervisor. Subject to departmental approval. Consult departmental graduate office. 
Consult R. Caballero

14.001 Data Economics and Development Policy Summer Internship
Prereq: Permission of department
G (Summer)
0-1-0 units

Provides students in the blended DEDP Master's program the opportunity to synthesize their coursework and professional experience in development economics and data analysis. In the context of a summer internship, students apply the knowledge gained in the program towards a project with a host organization, typically in the development sector. Students will be supported in finding a suitable opportunity or research project. All internship placements are subject to approval by the program director. Each student must write a capstone project report. Restricted to blended DEDP MASc students.
E. Duflo

14.003 Microeconomic Theory and Public Policy
Subject meets with 14.03
Prereq: 14.01 or permission of instructor
G (Fall, Spring)
4-0-8 units

Applies microeconomic theory to analysis of public policy. Builds from microeconomic model of consumer behavior; extends to operation of single and multiple markets and analysis of why markets sometimes fail. Empirical examples to evaluate theory, focusing on the casual effects of policy interventions on economic outcomes. Topics include minimum wages and employment, food stamps and consumer welfare, economics of risk and safety regulation, the value of education, and gains from international trade. Graduate students are expected to complete additional assignments.
D. Autor, N. Agarwal

14.009 Economics and Society's Toughest Problems (New)
Prereq: None
U (Fall)
1-0-2 units

Should we trade more with China? Why are some countries poor, and some countries rich? Why are the 1% getting richer? Should the US have universal health insurance? How can you fix failing schools? What should we do to prevent the next Great Recession? Economics shows you how to think about some of the toughest problems facing society -- and how to use data to get some answers. This exploratory course will feature a series of lectures by MIT's economics faculty, showing how their cutting-edge research can help you answer these questions and more. Subject can count toward the 9-unit discovery-focused credit limit for first year students.
B. Olken
14.01 Principles of Microeconomics
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-S

Introduces microeconomic concepts and analysis, supply and demand analysis, theories of the firm and individual behavior, competition and monopoly, and welfare economics. Applications to problems of current economic policy.
J. Gruber, S. Ellison

14.02 Principles of Macroeconomics
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-S

Provides an overview of macroeconomic issues including the determination of national income, economic growth, unemployment, inflation, interest rates, and exchange rates. Introduces basic macroeconomic models and illustrates key principles through applications to the experience of the US and other economies. Explores a range of current policy debates, such as the economic effects of monetary and fiscal policy, the causes and consequences of the 2008 global financial crisis, and the factors that influence long-term growth in living standards. Lectures are recorded and available for students with scheduling conflicts.
M. Beraja, R. Caballero

14.03 Microeconomic Theory and Public Policy
Subject meets with 14.003
Prereq: 14.01 or permission of instructor
U (Fall, Spring)
4-0-8 units. HASS-S

Applies microeconomic theory to analysis of public policy. Builds from microeconomic model of consumer behavior; extends to operation of single and multiple markets and analysis of why markets sometimes fail. Empirical examples to evaluate theory, focusing on the casual effects of policy interventions on economic outcomes. Topics include minimum wages and employment, food stamps and consumer welfare, economics of risk and safety regulation, the value of education, and gains from international trade.
T. Salz, N. Agarwal

14.04 Intermediate Microeconomic Theory
Prereq: Calculus II (GIR) and 14.01
U (Fall)
4-0-8 units. HASS-S

Analysis of consumer and producer decisions including analysis of competitive and monopolistic markets. Price-based partial and general equilibrium analysis. Introduction to game theory as a foundation for the strategic analysis of economic situations. Imperfect competition, dynamic games among firms. Failures of general equilibrium theory and their resolutions: externalities, public goods, incomplete information settings, signaling, screening, insurance, alternative market mechanisms, auctions, design of markets.
R. Townsend

14.05 Intermediate Macroeconomics
Prereq: 14.01 and (14.02 or permission of instructor)
U (Spring)
4-0-8 units. HASS-S

Uses the tools of macroeconomics to investigate various macroeconomic issues in depth. Topics range from economic growth and inequality in the long run to economic stability and financial crises in the short run. Surveys many economic models used today. Requires a substantial research paper on the economics of long-run economic growth.
A. Simsek

14.06 Advanced Macroeconomics
Prereq: 14.01 and 14.02
U (Spring)
4-0-8 units. HASS-S

Blends a thorough study of the theoretical foundations of modern macroeconomics with a review of useful mathematical tools, such as dynamic programming, optimal control, and dynamic systems. Develops comfort with formal macroeconomic reasoning and deepens understanding of key macroeconomic phenomena, such as business cycles. Goes on to study more specific topics, such as unemployment, financial crises, and the role of fiscal and monetary policy. Special attention to reviewing relevant facts and disentangling them from their popular interpretations. Uses insights and tools from game theory. Includes applications to recent and historical events.
G. M. Angeletos
14.07 Financial Markets and the Macroeconomy
Prereq: 14.01 and 14.02
U (Fall)
4-0-8 units. HASS-S
Analyzes the macroeconomic effects of financial markets, with emphasis on understanding financial crises. Surveys the benchmark theories of asset pricing, investment, and the capital structure. Topics include risk, arbitrage, financial market equilibrium, and market efficiency. Also introduces financial frictions, and analyzes the mechanisms by which frictions cause financial crises; focuses on asymmetric information, leverage, financial intermediation, belief disagreements, asset bubbles, fire sales, bank runs, interconnections, and complexity.
A. Simsek

14.08 Technical Topics in Economics
Prereq: 14.01
U (Fall, Spring)
4-0-8 units
Can be repeated for credit.
Considers technical issues of current research interest in economics.
Consult Department Headquarters

14.09 Reading Seminar in Economics
Prereq: 14.04 and 14.06
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Reading and discussion of particular topics in economics. Open to undergraduate students by arrangement with individual faculty members. Consult Department Headquarters.
D. Donaldson

14.10 Reading Seminar in Economics
Prereq: 14.04 and 14.06
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Reading and discussion of particular topics in economics. Open to undergraduate students by arrangement with individual faculty members. Consult Department Headquarters.
D. Donaldson

14.11 Topics in Economics
Prereq: 14.01
U (Fall)
Not offered regularly; consult department
4-0-8 units. HASS-S
Can be repeated for credit.
Considers issues of current research interest in economics.
Consult Department Headquarters

14.12 Economic Applications of Game Theory
Prereq: 14.01 and (6.041B or permission of instructor)
U (Fall)
4-0-8 units. HASS-S
Analysis of strategic behavior in multi-person economic settings. Introduction to solution concepts, such as rationalizability, backwards induction, Nash equilibrium, subgame-perfect equilibrium, and sequential equilibrium, with a strong emphasis on the assumptions behind these solution concepts. Issues of incomplete information, such as signaling and reputation formation. Applications drawn from microeconomics and political economy.
M. Yildiz

14.121 Microeconomic Theory I
Prereq: 14.04 and permission of instructor
G (Fall; first half of term)
3-0-3 units
Covers consumer and producer theory, markets and competition, general equilibrium and the welfare theorems; featuring applications, uncertainty, identification and restrictions models place on data. Enrollment limited; preference to PhD students.
P. Pathak

14.122 Microeconomic Theory II
Prereq: 14.121 and permission of instructor
G (Fall; second half of term)
3-0-3 units
Introduction to game theory. Topics include normal form and extensive form games, and games with incomplete information. Enrollment limited.
G. Ellison

14.123 Microeconomic Theory III
Prereq: 14.121, 14.122, and permission of instructor
G (Spring; first half of term)
3-0-3 units
Models of individual decision-making under certainty and uncertainty. Additional topics in game theory. Enrollment limited.
D. Fudenberg
14.124 Microeconomic Theory IV
Prereq: 14.123 or permission of instructor
G (Spring; second half of term)
3-0-3 units
Introduction to statistical decision theory, incentive contracting (moral hazard and adverse selection), mechanism design and incomplete contracting. Enrollment limited.
A. Wolitzky

14.125 Market Design
Prereq: 14.124
G (Spring)
4-0-8 units
Theory and practice of market design, building on ideas from microeconomics, game theory and mechanism design. Prominent case studies include auctions, labor markets, school choice, prediction markets, financial markets, and organ exchange clearinghouses.
P. Pathak

14.126 Game Theory
Prereq: 14.122
G (Spring)
3-0-9 units
Rigorous investigation of the evolutionary and epistemic foundations of solution concepts, such as rationalizability and Nash equilibrium. Covers classical topics, such as repeated games, bargaining, reputation, and supermodular games as well as new topics such as global games, heterogeneous priors, psychological games, and games without expected utility maximization. Applications provided when available.
D. Fudenberg, M. Yildiz

14.129 Advanced Contract Theory
Prereq: 14.121, 14.281, or permission of instructor
G (Spring; first half of term)
3-0-3 units
Recent developments in contract theory. Includes advanced models of moral hazard, adverse selection, mechanism design and incomplete contracts with applications to theory of the firm, organizational design, and financial structure.
Consult R. Townsend

14.13 Psychology and Economics
Subject meets with 14.131
Prereq: 14.01
U (Spring)
4-0-8 units. HASS-S
Introduces the theoretical and empirical literature of behavioral economics. Examines important and systematic departures from the standard models in economics by incorporating insights from psychology and other social sciences. Covers theory and evidence on time, risk, and social preferences; beliefs and learning; emotions; limited attention; and frames, defaults, and nudges. Studies applications to many different areas, such as credit card debt, procrastination, retirement savings, addiction, portfolio choice, poverty, labor supply, happiness, and government policy. Students participate in surveys and experiments in class, review evidence from lab experiments, examine how the results can be integrated into models, and test models using field and lab data. Students taking graduate version complete additional assignments.
F. Schilbach

14.130 Reading Economic Theory
Prereq: 14.121 and 14.451
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-0-10 units
Can be repeated for credit.
Class will read and discuss current research in economic theory with a focus on game theory, decision theory, and behavioral economics. Students will be expected to make one presentation and to read and post comments on every paper by the day before the paper is presented. Permission of the instructor required, and auditors are not allowed.
D. Fudenberg
14.131 Psychology and Economics
Subject meets with 14.13
Prereq: 14.01
G (Spring)
4-0-8 units
Introduces the theoretical and empirical literature of behavioral economics. Examines important and systematic departures from the standard models in economics by incorporating insights from psychology and other social sciences. Covers theory and evidence on time, risk, and social preferences; beliefs and learning; emotions; limited attention; and frames, defaults, and nudges. Studies applications to many different areas, such as credit card debt, procrastination, retirement savings, addiction, portfolio choice, poverty, labor supply, happiness, and government policy. Students participate in surveys and experiments in class, review evidence from lab experiments, examine how the results can be integrated into models, and test models using field and lab data. Students taking graduate version complete additional assignments.
F. Schilbach

14.137[J] Psychology and Economics
Same subject as 9.822[J]
Prereq: None
G (Spring)
4-0-8 units
Examines "psychology appreciation" for economics students. Aims to enhance knowledge and intuition about psychological processes in areas relevant to economics. Increases understanding of psychology as an experimental discipline, with its own distinct rules and style of argument. Topics include self-knowledge, cognitive dissonance, self-deception, emotions, social norms, self-control, learning, mental accounting, memory, individual and group behavior, and some personality and psycho-analytic models. Within each of these topics, we showcase effective and central experiments and discuss their role in the development of psychological theory. Term paper required.
D. Prelec

14.147 Topics in Game Theory
Prereq: 14.126
G (Fall)
4-0-8 units
Advanced subject on topics of current research interest.
D. Fudenberg

14.15[J] Networks
Same subject as 6.207[J]
Prereq: 6.041 or 14.30
U (Spring)
4-0-8 units. HASS-S
Highlights common principles that permeate the functioning of diverse technological, economic and social networks. Utilizes three sets of tools for analyzing networks--random graph models, optimization, and game theory--to study informational and learning cascades; economic and financial networks; social influence networks; formation of social groups; communication networks and the Internet; consensus and gossiping; spread and control of epidemics; control and use of energy networks; and biological networks.
A. Wolitzky

14.16 Strategy and Information
Prereq: 14.01 or permission of instructor
U (Spring)
4-0-8 units. HASS-S
Covers modern applications of game theory where incomplete information plays an important role. Applications include bargaining, auctions, global games, market design, information design, and network economics.
M. Yildiz

14.160 Behavioral Economics
Prereq: 14.122
G (Spring)
4-0-8 units
Covers recent theory and empirical evidence in behavioral economics. Topics include deviations from the neoclassical model in terms of (i) preferences (present bias, reference dependence, social preferences), (ii) beliefs (overconfidence, projection bias), and (iii) decision-making (cognition, attention, framing, persuasion), as well as (iv) market reactions to such deviations. Applications will cover a large range of fields, including labor and public economics, industrial organization, health economics, finance, and development economics.
A. Banerjee, F. Schilbach
14.18 Mathematical Economic Modeling
Prereq: 14.04, 14.12, 14.15[J], or 14.19
U (Spring)
4-0-8 units. HASS-S
Guides students through the process of developing and analyzing
formal economic models and effectively communicating their results.
Topics include decision theory, game theory, voting, and matching.
Instruction and practice in oral and written communication provided.
Prior coursework in microeconomic theory and/or proof-based
mathematics required.
Consult Department Headquarters

14.19 Market Design
Prereq: 14.01
U (Fall)
4-0-8 units. HASS-S
Covers the design and operation of organized markets, building on
ideas from microeconomic and game theory. Topics may include
mechanism design, auctions, matching markets, and other resource
allocation problems.
P. Pathak

14.191 Independent Research Paper
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-12-0 units
Can be repeated for credit.
Under supervision of a faculty member approved by Graduate
Registration Officer, student writes a substantial, probably
publishable research paper. Must be completed by the end
of a student’s second year to satisfy the departmental minor
requirement.
Staff

14.192 Advanced Research and Communication (New)
Prereq: 14.124, 14.382, and 14.454
G (Fall, IAP, Spring)
2-4-6 units
Can be repeated for credit.
Guides second-year Economics PhD students through the process of
conducting and communicating economic research. Students choose
topics for research projects, develop research strategies, carry out
analyses, and write and present research papers. Limited to second
year Economics PhD students.
Consult Department Headquarters

14.193 Advanced Seminar in Economics
Prereq: 14.121 and 14.451
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.
Reading and discussion of current topics in economics. Open
to advanced graduate students by arrangement with individual
members of the staff.
Consult Department headquarters

14.195 Reading Seminar in Economics
Prereq: 14.121
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Reading and discussion of current topics in economics. Open
to advanced graduate students by arrangement with individual
members of the staff.
Staff

14.197 Independent Research
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Under supervision of a faculty member approved by Graduate
Registration Officer, student conducts independent research.
Staff

14.198, 14.199 Teaching Introductory Economics
Prereq: None
G (Fall, Spring)
2-0-2 units
Can be repeated for credit.
Required of teaching assistants in introductory economics (14.01
and 14.02), under supervision of the faculty member in charge of the
subject.
Industrial Organization

14.20 Industrial Organization: Competitive Strategy and Public Policy
Subject meets with 14.200
Prereq: 14.01
U (Spring)
4-0-8 units. HASS-S

Analyzes the current debate over the rise of monopolies, the strategic behavior and performance of firms in imperfectly competitive markets, and the role of competition policy. Topics include monopoly power; pricing, product choice, and innovation decisions by firms in oligopoly markets; static and dynamic measurement of market performance; and incentives in organizations. Requires regular participation in class discussion and teamwork in a competitive strategy game. Students taking graduate version complete additional assignments.

N. Rose

14.200 Industrial Organization: Competitive Strategy and Public Policy (New)
Subject meets with 14.20
Prereq: 14.01
G (Spring)
4-0-8 units

Provides a rigorous, but not overly technical introduction to the economic theory of incentives and organization together with a varying set of applications. These include, among others, the optimal design of sales and CEO incentive schemes; the impact of incentives on risk taking and innovation; tournament design; the analysis of venture capital and other forms of financial incentive contracts; relational and behavioral aspects of incentive contracts; and various organizational design problems. Students taking graduate version complete additional assignments. Limited to 60.

R. Gibbons

14.26[J] Economics of Incentives: Theory and Applications
Same subject as 15.039[J]
Subject meets with 14.260
Prereq: 14.01
U (Spring)
4-0-8 units. HASS-S

Provides a rigorous, but not overly technical introduction to the economic theory of incentives and organization together with a varying set of applications. These include, among others, the optimal design of sales and CEO incentive schemes; the impact of incentives on risk taking and innovation; tournament design; the analysis of venture capital and other forms of financial incentive contracts; relational and behavioral aspects of incentive contracts; and various organizational design problems. Students taking graduate version complete additional assignments. Limited to 60.

R. Gibbons

14.260 Economics of Incentives: Theory and Applications (New)
Subject meets with 14.26[J], 15.039[J]
Prereq: None
G (Spring)
4-0-8 units

Provides a rigorous, but not overly technical introduction to the economic theory of incentives and organization together with a varying set of applications. These include, among others, the optimal design of sales and CEO incentive schemes; the impact of incentives on risk taking and innovation; tournament design; the analysis of venture capital and other forms of financial incentive contracts; relational and behavioral aspects of incentive contracts; and various organizational design problems. Students taking graduate version complete additional assignments. Limited to 60.

R. Gibbons

14.27 Economics and E-Commerce
Prereq: 14.01 and (6.041 or 14.30)
U (Fall)
4-0-8 units. HASS-S

Uses theoretical economic models and empirical evidence to help understand the growth and future of e-commerce. Economic models help frame class discussions of, among other topics, content provision, privacy, piracy, sales taxation, group purchasing, price search, and advertising on the internet. Empirical project and paper required.

S. Ellison
14.271 Industrial Organization I
Prereq: 14.04
G (Fall)
5-0-7 units
Covers theoretical and empirical work dealing with the structure, behavior, and performance of firms and markets and core issues in antitrust. Topics include: the organization of the firm, monopoly, price discrimination, oligopoly, and auctions. Theoretical and empirical work are integrated in each area.
N. Agarwal, G. Ellison

14.272 Industrial Organization II
Prereq: 14.271
G (Spring)
5-0-7 units
Continuation of 14.271, which focuses on government interventions in monopoly and oligopoly markets, and addresses both competition and regulatory policy. Topics include horizontal merger policy and demand estimation, vertical integration and vertical restraints, and the theory and practice of economic regulation. Applications include the political economy of regulation; the performance of economic regulation; deregulation in sectors, including electric power, transportation, and financial services; and pharmaceutical and environmental regulation in imperfectly competitive product markets.
N. Rose

14.273 Advanced Topics in Industrial Organization
Prereq: 14.271
G (Spring)
5-0-7 units
Empirical analysis of theoretically derived models of market behavior. Varied topics include demand estimation, differentiated products, production functions, analysis of market power, entry and exit, vertical relationships, auctions, matching markets, network externalities, dynamic oligopoly, moral hazard and adverse selection. Discussion will focus on methodological issues, including identification, estimation, counter-factual analysis and simulation techniques.
N. Agarwal, T. Salz

14.281 Contract Economics
Prereq: 14.124
G (Fall)
4-0-8 units
Covers theoretical research on contracts in static as well as dynamic settings. Emphasis is on canonical models in contracting (agency theory, mechanism design, incomplete contracting) illustrated by major areas of application (e.g. compensation, labor and capital markets, property rights, organizational design, corporate finance).
S. Morris

14.282 Introduction to Organizational Economics
Prereq: 14.124
G (Fall)
5-0-7 units
Begins with survey of contract theory for organizational economists, then introduces the main areas of the field, including the boundary of the firm; decision-making, employment, structures and processes in organizations; and organizations other than firms.
R. Gibbons, J. Van Reenen

14.283 Advanced Topics in Organizational Economics I
Prereq: 14.282
G (Spring; first half of term)
2-0-4 units
Builds on the work done in 14.282 to develop more in-depth analysis of topics in the field.
R. Gibbons

14.284 Advanced Topics in Organizational Economics II
Prereq: 14.282
G (Spring; second half of term)
2-0-4 units
Builds on the work done in 14.282 to develop more in-depth analysis of topics in the field.
J. Van Reenen
Statistics and Econometrics

14.30 Introduction to Statistical Methods in Economics
Subject meets with 14.300
Prereq: Calculus II (GIR)
U (Fall)
4-0-8 units. REST
Self-contained introduction to probability and statistics with applications in economics and the social sciences. Covers elements of probability theory, statistical estimation and inference, regression analysis, causal inference, and program evaluation. Couples methods with applications and with assignments involving data analysis. Uses basic calculus and matrix algebra. Students taking graduate version complete additional assignments. May not count toward HASS requirement.
A. Abadie

14.300 Introduction to Statistical Methods in Economics
Subject meets with 14.30
Prereq: Calculus II (GIR)
G (Fall)
4-0-8 units
Self-contained introduction to probability and statistics with applications in economics and the social sciences. Covers elements of probability theory, statistical estimation and inference, regression analysis, causal inference, and program evaluation. Couples methods with applications and with assignments involving data analysis. Uses basic calculus and matrix algebra. Students taking graduate version complete additional assignments.
A. Abadie, K. Evdokimov

14.310 Data Analysis for Social Scientists
Prereq: None
G (Spring)
Not offered regularly; consult department
4-0-8 units
Introduces methods for harnessing data to answer questions of cultural, social, economic, and policy interest. Presents essential notions of probability and statistics. Covers techniques in modern data analysis: regression and econometrics, prediction, design of experiment, randomized control trials (and A/B testing), machine learning, data visualization, analysis of network data, and geographic information systems. Projects include analysis of data with a written description and interpretation of results; may involve gathering of original data or use of existing data sets. Applications drawn from real-world examples and frontier research. Instruction in use of the statistical package R. Students taking graduate version complete additional assignments.
Consult E. Duflo

14.32 Econometric Data Science
Subject meets with 14.320
Prereq: 14.30
U (Fall, Spring)
4-4-4 units. Institute LAB
Introduces multiple regression methods for causal inference and descriptive analysis in economics and related disciplines. Extensions include instrumental variables methods, analysis of randomized experiments and quasi-experimental research designs, and regression with time series data. Develops the skills needed to conduct - and critique - empirical studies in economics and related fields. Students complete an empirical project with a written description and interpretation of results; this may involve original data collection or use of existing data sets. Applications drawn from real-world examples and frontier research. Familiarity with statistical programming languages is helpful. Students taking graduate version complete additional assignments.
A. Mikusheva, J. Angrist

14.320 Econometric Data Science
Subject meets with 14.32
Prereq: 14.300
G (Fall, Spring)
4-4-4 units
Introduces multiple regression methods for causal inference and descriptive analysis in economics and related disciplines. Extensions include instrumental variables methods, analysis of randomized experiments and quasi-experimental research designs, and regression with time series data. Develops the skills needed to conduct - and critique - empirical studies in economics and related fields. Students complete an empirical project with a written description and interpretation of results; this may involve original data collection or use of existing data sets. Applications drawn from real-world examples and frontier research. Familiarity with statistical programming languages is helpful. Students taking graduate version complete additional assignments.
A. Mikusheva, J. Angrist

14.33 Research and Communication in Economics: Topics, Methods, and Implementation
Prereq: 14.32 and (14.01 or 14.02)
U (Fall, Spring)
3-4-5 units. HASS-S
Exposes students to the process of conducting independent research in empirical economics and effectively communicating the results of the research. Emphasizes econometric analysis of an assigned economic question and culminates in each student choosing an original topic, performing appropriate analysis, and delivering oral and written project reports.
D. Donaldson, S. Jaeger
14.36 Advanced Econometrics  
Subject meets with 14.387  
Prereq: 14.32  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
4-0-8 units  
Emphasizes econometric theory, methods, and applications using regression, instrumental variables, differences-in-differences, regression discontinuity designs, machine learning and big data sets, and problems related to standard errors and statistical inference. Includes a project with a theoretical, written and data-analytic component. Familiarity with Stata or a similar statistical programming language recommended. Students taking graduate version complete additional assignments.  
J. Angrist, V. Chernozhukov

14.380 Statistical Method in Economics (New)  
Prereq: Calculus II (GIR) and permission of instructor  
G (Fall; first half of term)  
3-0-3 units  
Introduction to probability and statistics as background for advanced econometrics. Covers elements of probability theory, sampling theory, asymptotic approximations, hypothesis testing, and maximum-likelihood methods. Illustrations from economics and application of these concepts to economic problems. Limited to 40.  
A. Mikusheva

14.381 Applied Econometrics  
Prereq: 14.380 or permission of instructor  
G (Fall; second half of term)  
3-0-3 units  
Explains basic econometric ideas and methods through empirical applications, emphasizing cross-sectional causal inference. Topics may include randomized trials, regression, instrumental variables, differences-in-differences, regression discontinuity designs, and problems related to standard errors and statistical inference. Includes an empirical project.  
J. Angrist

14.382 Econometrics  
Prereq: 14.381 or permission of instructor  
G (Spring)  
5-0-7 units  
Covers key models as well as identification and estimation methods used in modern econometrics. Presents modern ways to set up problems and do better estimation and inference than the current empirical practice. Introduces generalized method of moments and the method of M-estimators in addition to more modern versions of these methods dealing with important issues, such as weak identification or biases arising in high dimensions. Also discusses the bootstrap and explores very high dimensional formulations, or “big data.” Students gain practical experience by applying the methods to real data sets. Enrollment limited.  
W. Newey

14.384 Time Series Analysis  
Prereq: 14.382 or permission of instructor  
G (Fall)  
5-0-7 units  
Studies theory and application of time series methods in econometrics, including spectral analysis, estimation with stationary and non-stationary processes, VARs, factor models, unit roots, cointegration, estimation of DSGE models, and Bayesian methods. Enrollment limited.  
A. Mikusheva

14.385 Nonlinear Econometric Analysis  
Prereq: 14.382 or permission of instructor  
G (Fall)  
5-0-7 units  
Studies micro-econometric models, including large sample theory for estimation and hypothesis testing, generalized method of moments, estimation of censored and truncated specifications, quantile regression, structural estimation, nonparametric and semiparametric estimation, panel data, bootstrapping, and simulation methods. Methods illustrated with economic applications. Enrollment limited.  
A. Abadie, W. Newey

14.386 New Econometric Methods  
Prereq: 14.382  
G (Spring)  
4-0-8 units  
Focuses on recent developments in econometrics, especially structural estimation. Topics include nonseparable models, models of imperfect competition, auction models, duration models, and nonlinear panel data. Results illustrated with economic applications.  
A. Abadie, W. Newey
14.387 Applied Econometrics
Subject meets with 14.36
Prereq: 14.382
Acad Year 2019–2020: Not offered
Acad Year 2020–2021: G (Spring)
4-0-8 units
Emphasizes econometric theory, methods, and applications using regression, instrumental variables, differences-in-differences, regression discontinuity designs, machine learning and big data sets, and problems related to standard errors and statistical inference. Includes a project with a theoretical, written and data-analytic component. Students taking graduate version complete additional assignments.
J. Angrist, V. Chernozhukov

14.391 Workshop in Economic Research
Prereq: 14.124 and 14.454
G (Fall)
2-0-10 units
Can be repeated for credit.
Develops research ability of students through intensive discussion of dissertation research as it proceeds, individual or group research projects, and critical appraisal of current reported research. Workshops divided into various fields, depending on interest and size.
Staff

14.392 Workshop in Economic Research
Prereq: 14.124 and 14.454
G (Spring)
2-0-10 units
Can be repeated for credit.
Develops research ability of students through intensive discussion of dissertation research as it proceeds, individual or group research projects, and critical appraisal of current reported research. Workshops divided into various fields, depending on interest and size.
Staff

14.399 Seminar in Data Economics and Development Policy
Prereq: Permission of instructor
G (Spring)
2-0-10 units
Group study of current topics in development policy and research. Includes student presentations and invited speakers. Restricted to blended DEDP MASc students.
E. Duflo

14.41 Public Finance and Public Policy
Subject meets with 14.410
Prereq: 14.01
U (Fall)
4-0-8 units. HASS-S
Explores the role of government in the economy, applying tools of basic microeconomics to answer important policy questions such as government response to global warming, school choice by K-12 students, Social Security versus private retirement savings accounts, government versus private health insurance, setting income tax rates for individuals and corporations. Students taking the graduate version complete additional assignments.
J. Gruber

14.410 Public Finance and Public Policy
Subject meets with 14.41
Prereq: 14.01
G (Fall)
4-0-8 units
Explores the role of government in the economy, applying tools of basic microeconomics to answer important policy questions such as government response to global warming, school choice by K-12 students, Social Security versus private retirement savings accounts, government versus private health insurance, setting income tax rates for individuals and corporations. Students taking the graduate version complete additional assignments.
J. Gruber

Same subject as 15.470[J]
Prereq: None
G (Fall)
4-0-8 units
See description under subject 15.470[J].
L. Kogan, L. Schmidt
14.42 Environmental Policy and Economics
Subject meets with 14.420
Prereq: 14.01
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-S

Investigates the proper role of government in the regulation of the environment. Presents tools necessary to estimate the costs and benefits of a variety of environmental policies. Focuses on both conceptual thinking and quantitative evaluation of environmental issues. Gives particular attention to climate change: defines the major concepts underlying the climate problem; examines the measurement of climate damages as well as the costs of mitigating them; and discusses the various policy options available to communities, countries, and international coalitions. Completion of 14.30 or equivalent statistics subject strongly recommended. Students taking graduate version complete additional assignments.

Consult Department Headquarters

14.420 Environmental Policy and Economics
Subject meets with 14.42
Prereq: 14.01
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
4-0-8 units

Investigates the proper role of government in the regulation of the environment. Presents tools necessary to estimate the costs and benefits of a variety of environmental policies. Focuses on both conceptual thinking and quantitative evaluation of environmental issues. Gives particular attention to climate change: defines the major concepts underlying the climate problem; examines the measurement of climate damages as well as the costs of mitigating them; and discusses the various policy options available to communities, countries, and international coalitions. Completion of 14.30 or equivalent statistics subject strongly recommended. Students taking graduate version complete additional assignments.

Consult Department Headquarters

Same subject as 15.037[J]
Prereq: 14.01 or 15.0111
U (Spring)
4-0-8 units. HASS-S
Credit cannot also be received for 14.444[J], 15.038[J]

Analyzes business and public policy issues in energy markets and in the environmental markets to which they are closely tied. Examines the economic determinants of industry structure and evolution of competition among firms in these industries. Investigates successful and unsuccessful strategies for entering new markets and competing in existing markets. Industries studied include oil, natural gas, coal, electricity, and transportation. Topics include climate change and environmental policy, the role of speculation in energy markets, the political economy of energy policies, and market power and antitrust. Two team-based simulation games, representing the world oil market and a deregulated electricity market, act to cement the concepts covered in lecture. Students taking graduate version complete additional assignments. Limited to 60.

C. Knittel

14.440[J] Advanced Corporate Finance
Same subject as 15.473[J]
Prereq: None
G (Spring)
3-0-9 units


D. Thesmar, A. Schoar

14.441[J] Corporate Finance
Same subject as 15.471[J]
Prereq: None
G (Spring)
3-0-9 units

See description under subject 15.471[J].

A. Schoar, D. Thesmar

Same subject as 15.472[J]
Prereq: None
G (Fall)
3-0-9 units


D. Greenwald
Same subject as 15.038[J]  
Prereq: 14.01 or 15.0111  
G (Spring)  
4-0-8 units  
Credit cannot also be received for 14.44[J], 15.037[J]

Theoretical and empirical perspectives on individual and industrial demand for energy, energy supply, energy markets, and public policies affecting energy markets. Discusses aspects of the oil, natural gas, electricity, and nuclear power sectors. Examines energy tax, price regulation, deregulation, energy efficiency and policies for controlling pollution and CO$_2$ emissions. Students taking the graduate version complete additional assignments. Limited to 60.  
C. Knittel

14.448[J] Current Topics in Finance  
Same subject as 15.474[J]  
Prereq: None  
G (Spring)  
3-0-9 units  
A. Malenko, C. Palmer, L. Schmidt, A. Verdelhan

Same subject as 15.475[J]  
Prereq: Permission of instructor  
G (Fall, Spring)  
3-0-3 units  
See description under subject 15.475[J]. Restricted to doctoral students.  
Staff

14.451 Dynamic Optimization Methods with Applications  
Prereq: 14.06 and permission of instructor  
G (Fall; first half of term)  
3-0-3 units  
Provides an introduction to dynamic optimization methods, including discrete-time dynamic programming in non-stochastic and stochastic environments, and continuous time methods including the Pontryagin maximum principle. Applications may include the Ramsey model, irreversible investment models, and consumption choices under uncertainty. Enrollment limited.  
A. Simsek

14.452 Economic Growth  
Prereq: 14.451 and permission of instructor  
G (Fall; second half of term)  
3-0-3 units  
Introduces the sources and modeling of economic growth and income differences across nations. Topics include an introduction to dynamic general equilibrium theory, the neoclassical growth model, overlapping generations, determinants of technological progress, endogenous growth models, measurement of technological progress, the role of human capital in economic growth, and growth in a global economy. Enrollment limited.  
D. Acemoglu

14.453 Economic Fluctuations  
Prereq: 14.452 and permission of instructor  
G (Spring; first half of term)  
3-0-3 units  
Investigation of why aggregate economic activity fluctuates, and the role of policy in affecting fluctuations. Topics include the link between monetary policy and output, the economic cost of aggregate fluctuations, the costs and benefits of price stability, and the role of central banks. Introduction to real business cycle and new Keynesian models. Enrollment limited.  
G. M. Angeletos

14.454 Economic Crises  
Prereq: 14.453 and permission of instructor  
G (Spring; second half of term)  
3-0-3 units  
Provides an overview of models of the business cycle caused by financial markets’ frictions and shocks. Topics include credit crunch, collateral shocks, bank runs, contagion, speculative bubbles, credit booms, leverage, safe asset shortages, capital flows and sudden stops. Enrollment limited.  
R. Caballero
14.46 Innovation Policy and the Economy
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-S; CI-H

Designed for students interested in how to best design innovation-related public policies. Addresses questions such as whether the patent system helps or hinders innovation, how the US National Institutes of Health (NIH) should allocate its funding across diseases, and whether the US would benefit from raising caps on the employment of skilled immigrants through the H-1B visa program. Presentations and writing assignments strengthen skills for effective communication.
H. Williams

14.461 Advanced Macroeconomics I
Prereq: 14.122 and 14.452
G (Fall)
5-0-7 units

Advanced subject in macroeconomics that seeks to bring students to the research frontier. Topics vary from year to year, covering a wide spectrum of classical and recent research. Topics may include business cycles, optimal monetary and tax policy, monetary economics, banking, and financial constraints on investment and incomplete markets.
M. Beraja, I. Werning

14.462 Advanced Macroeconomics II
Prereq: 14.461
G (Spring)
5-0-7 units

Topics vary from year to year. Often includes coordination failures; frictions in beliefs, such as rational inattention, higher-order uncertainty, certain forms of bounded rationality, heterogeneous beliefs, and ambiguity; implications for business cycles, asset markets, and policy; financial frictions and obstacles to trade; intermediation; liquidity; safe assets; global imbalances; financial crises; and speculation.
G. M. Angeletos, R. Townsend

Same subject as 11.167[J], 15.2191[J], 17.399[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Credit cannot also be received for 11.267[J], 15.219[J]

V. Karplus

14.471 Public Economics I
Prereq: 14.04
G (Spring)
4-0-8 units

Theory and evidence on government taxation policy. Topics include tax incidence; optimal tax theory; the effect of taxation on labor supply and savings; taxation and corporate behavior; and tax expenditure policy.
J. Poterba, I. Werning

14.472 Public Economics II
Prereq: 14.471
G (Fall)
3-0-9 units

Focuses on government expenditures and policies designed to correct market failures and/or redistribute resources. Key topics include theoretical and empirical analysis of insurance market failures, the optimal design of social insurance programs, and the design of redistributive programs.
A. Finkelstein

14.473 Public Policy in Health Economics
Prereq: 14.122
G (Spring)
Not offered regularly; consult department
4-0-8 units

Theory and evidence on the economics of the health care sector, with a particular emphasis on the economics of technological change and innovation.
Consult Department Headquarters

14.475 Environmental Economics
Prereq: None
G (Spring)
4-0-8 units

Discusses theory and evidence on environmental externalities and regulatory, tax, and other government responses to problems of market failure. Topics include cost-benefit analysis; measurement of the benefits of non-market goods; evaluation of the impacts of regulation; and international environmental issues, including the economics of climate change and trade and the environment.
C. Balboni
International, Interregional, and Urban Economics

14.54 International Trade
Prereq: 14.01 and 14.02
U (Fall)
4-0-8 units. HASS-S

Provides an introduction to theoretical and empirical topics in international trade. Offers a brief history of globalization. Introduces the theory of comparative advantage and discusses its implications for international specialization and wage inequality. Studies the determinants and consequences of trade policy, and analyzes the consequences of immigration and foreign direct investment.

A. Costinot

14.581 International Economics I
Prereq: 14.04
G (Fall)
5-0-7 units

Covers a variety of topics, both theoretical and empirical, in international trade, international macroeconomics, and economic geography. Focuses on general equilibrium analysis in neoclassical economies. Considers why countries and regions trade, and what goods they trade; impediments to trade, and why some countries deliberately erect policy to impede; and implications of openness for growth. Also tackles normative issues, such as whether trade openness is beneficial, whether there are winners and losers from trade and, if so, how they can possibly be identified.

A. Costinot, D. Donaldson

14.582 International Economics II
Prereq: 14.06
G (Spring)
5-0-7 units

Building on topics covered in 14.581, revisits a number of core questions in international trade, international macroeconomics, and economic geography in the presence of increasing returns, imperfect competition, and other distortions. Stresses their connection to both macro and micro (firm-level) data for questions related to trade policy, inequality, industrial policy, growth, and the location of economic activities. Focuses on both theoretical models, empirical findings, and the challenging task of putting those two together.

D. Atkin, A. Costinot

Labor Economics and Industrial Relations

14.64 Labor Economics and Public Policy
Prereq: 14.30 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-S

Provides an introduction to the labor market, how it functions, and the important role it plays in people’s lives. Topics include supply and demand, minimum wages, labor market effects of social insurance and welfare programs, the collective bargaining relationship, discrimination, human capital, and unemployment. Completion of or concurrent enrollment in 14.03 or 14.04 recommended.

Consult J. Angrist

14.661 Labor Economics I
Prereq: 14.04 and 14.32
G (Fall)
5-0-7 units

A systematic development of the theory of labor supply, labor demand, and human capital. Topics include wage and employment determination, turnover, search, immigration, unemployment, equalizing differences, and institutions in the labor market. Particular emphasis on the interaction between theoretical and empirical modeling.

D. Acemoglu, J. Angrist

14.662 Labor Economics II
Prereq: 14.04 and 14.32
G (Spring)
5-0-7 units

Theory and evidence on the determinants of earnings levels, inequality, intergenerational mobility, skill demands, and employment structure. Particular focus on the determinants of worker- and firm-level productivity; and the roles played by supply, demand, institutions, technology and trade in the evolving distribution of income.

D. Autor, S. Jager

Economic History

14.70[ ] Medieval Economic History in Comparative Perspective
Same subject as 21H.134[ ]
Prereq: None
U (Spring)
3-0-9 units. HASS-S; CI-H

See description under subject 21H.134[ ].

A. McCants
14.73 The Challenge of World Poverty
Prereq: None
U (Fall)
4-0-8 units. HASS-S; CI-H

Designed for students who are interested in the challenge posed by massive and persistent world poverty. Examines extreme poverty over time to see if it is no longer a threat, why some countries grow fast and others fall further behind, if growth or foreign aid help the poor, what we can do about corruption, if markets or NGOs should be left to deal with poverty, where to intervene, and how to deal with the disease burden and improve schools.
D. Atkin, E. Duflo, F. Schilbach

Economic Development

14.740 Foundations of Development Policy
Prereq: 14.01
G (Spring)
Not offered regularly; consult department
4-0-8 units

Explores the foundations of policy making in developing countries, with the goal of spelling out various policy options and quantifying the trade-offs between them. Topics include education, health, fertility, adoption of technological innovations, financial markets (credit, savings, and insurance), markets for land and labor, political factors, and international considerations (aid, trade, and multinational firms). Some basic familiarity with probability and/or statistics is useful for this class. Students taking graduate version complete additional assignments.
D. Atkins, D. Donaldson

14.75 Political Economy and Economic Development
Subject meets with 14.75
Prereq: 14.01
U (Spring)
4-0-8 units. HASS-S

Explores the relationship between political institutions and economic development, covering key theoretical issues as well as recent empirical evidence. Topics include corruption, voting, vote buying, the media, and war. Discusses not just what we know on these topics, but how we know it, covering how to craft a good empirical study or field experiment and how to discriminate between reliable and unreliable evidence. Some basic familiarity with probability and/or statistics is useful for this class. Students taking graduate version complete additional assignments.
A. Banerjee, B. Olken

14.750 Political Economy and Economic Development
Subject meets with 14.75
Prereq: 14.01
G (Spring)
4-0-8 units

Explores the relationship between political institutions and economic development, covering key theoretical issues as well as recent empirical evidence. Topics include corruption, voting, vote buying, the media, and war. Discusses not just what we know on these topics, but how we know it, covering how to craft a good empirical study or field experiment and how to discriminate between reliable and unreliable evidence. Some basic familiarity with probability and/or statistics is useful for this class. Students taking graduate version complete additional assignments.
A. Banerjee, B. Olken

14.76 Firms, Markets, Trade and Growth
Subject meets with 14.760
Prereq: 14.01
U (Spring)
4-0-8 units. HASS-S

Examines how industrial development and international trade have brought about rapid growth and large-scale reductions in poverty for some developing countries, while globalization has simply increased inequality and brought little growth for others. Also considers why, in yet other developing countries, firms remain small-scale and have not integrated with global supply chains. Draws on both theoretical models and empirical evidence to better understand the reasons for these very different experiences and implications for policy. Students taking graduate version complete additional assignments.
D. Atkin, D. Donaldson

14.760 Firms, Markets, Trade and Growth
Subject meets with 14.76
Prereq: 14.01
G (Spring)
4-0-8 units

Examines how industrial development and international trade have brought about rapid growth and large-scale reductions in poverty for some developing countries, while globalization has simply increased inequality and brought little growth for others. Also considers why, in yet other developing countries, firms remain small-scale and have not integrated with global supply chains. Draws on both theoretical models and empirical evidence to better understand the reasons for these very different experiences and implications for policy. Students taking graduate version complete additional assignments.
D. Atkin, D. Donaldson
14.770 Introduction to Collective Choice and Political Economy
Prereq: None
G (Fall)
4-0-8 units

Broad introduction to political economy. Covers topics from social choice theory to political agency models, including theories of voter turnout and comparison of political institutions.

D. Acemoglu, B. Olken

14.771 Development Economics: Microeconomic Issues
Prereq: 14.121 and 14.122
G (Fall)
5-0-7 units

A rigorous introduction to core micro-economic issues in economic development, focusing on both key theoretical contributions and empirical applications to understand both why some countries are poor and on how markets function differently in poor economies. Topics include human capital (education and health); labor markets; credit markets; land markets; firms; and the role of the public sector.

E. Duflo, B. Olken

14.772 Development Economics: Macroeconomics
Prereq: 14.121 and 14.451
G (Spring)
5-0-7 units

Dynamic models of growth and development emphasizing migration, modernization, risk and finance, and technological change; static and dynamic models of political economy; the dynamics of income distribution and institutional change; SME and larger firm structure in developing countries; development, transparency, and information systems; and functioning of financial markets and institutions in emerging markets, their design and regulation.

A. Banerjee, R. Townsend

14.773 Political Economy: Institutions and Development
Prereq: 14.121 and 14.451
G (Spring)
5-0-7 units

Economists and policymakers increasingly realize the importance of political institutions in shaping economic performance, especially in the context of understanding economic development. Work on the determinants of economic policies and institutions is in its infancy, but is growing rapidly. Subject provides an introduction to this area. Topics covered: the economic role of institutions; the effects of social conflict and class conflict on economic development; political economic determinants of macro policies; political development; theories of income distribution and distributional conflict; the efficiency effects of distributional conflict; the causes and consequences of corruption; the role of colonial history; and others. Both theoretical and empirical approaches discussed. Subject can be taken either as part of the Development Economics or the Positive Political Economy fields.

D. Acemoglu, A. Banerjee

14.781[J] Political Economy I: Theories of the State and the Economy
Same subject as 15.678[J], 17.100[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

See description under subject 17.100[J].

M. Piore, S. Berger

14.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research and writing of thesis; to be arranged by the student with supervising committee.

Staff

14.THU Thesis
Prereq: 14.33
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research and writing of thesis.

Staff
14.UR Undergraduate Research
Prereq: 14.02
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Participation in research with an individual faculty member or research group, independent research or study under the guidance of a faculty member. Admission by arrangement with individual faculty member.
Consult D. Donaldson

14.URG Undergraduate Research
Prereq: 14.02
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Participation in research with an individual faculty member or research group, independent research or study under the guidance of a faculty member. Admission by arrangement with individual faculty member.
Consult D. Donaldson
The Edgerton Center specializes in experiential learning and offers interactive subjects in electronics, high-speed photography, and video production. The center is also the home of D-Lab classes (see EC.700-EC.792).

**Seminars**

**EC.050 Re-create Experiments from History: Inform the Future from the Past**
Subject meets with EC.090  
Prereq: None  
U (Fall, IAP, Spring)  
1-3-2 units

Provides perspective for thinking about the future through the study of historical physical science and historically significant experiments. Designed to build awareness of the unexpected through both observation of the sky and lab activities that focus on light, electricity, and motion. Labs are complemented by museum and site visits; readings include accounts by Galileo, Archimedes, and other historical observers. Individual and team assignments provide opportunities to develop skills in observation, exploration, and evaluation. Students must keep an observing notebook and write a reflective paper; students taking the graduate version complete additional assignments.

*J. Bales, E. Cavicchi*

**EC.074 The Start-up Experience at MIT**
Prereq: None  
U (Fall)  
2-0-4 units

Explores some of the critical actions in starting up a technology-based business, including concept generation, searching prior art and patents, protecting intellectual property, founders agreements, forming and building teams, and work-life balance. Students review case studies and complete exercises that develop practicable knowledge in these areas. Each student keeps an "idea log book," which includes critical assessments of each case study, to be presented at the end of the term. First in a two-part series (seminars do not have to be taken sequentially; see EC.075 in fall term). Preference to undergraduates; open to graduate students with permission of advisor.

*J. Hadzima*

**EC.075 Starting Up New Technology-Based Business Enterprises at MIT**
Prereq: None  
U (Spring)  
2-0-4 units

Seminars participants define and study the development stages of new enterprises at MIT, from the exciting moment a new idea for a tech product or service is realized, through to selling, customer support, and the next new idea. Follows the history of successful MIT spin-off companies with attention to the people (and their ideas) behind the start-up. Students attend MIT technology and science start-up case presentations given by individuals and teams working from zero-stage, and by partners in going concerns of historical relevance to the Institute and the economy. Second in a two-part series (704 and 705 seminars do not have to be taken sequentially; see EC.075 in fall term).

*J. G. Hadzima*

**EC.090 Re-create Experiments from History: Inform the Future from the Past**
Subject meets with EC.050  
Prereq: None  
G (Fall, IAP, Spring)  
1-3-2 units

Provides perspective for thinking about the future through the study of historical physical science and historically significant experiments. Designed to build awareness of the unexpected through both observation of the sky and lab activities that focus on light, electricity, and motion. Labs are complemented by museum and site visits; readings include accounts by Galileo, Archimedes, and other historical observers. Individual and team assignments provide opportunities to develop skills in observation, exploration, and evaluation. Students must keep an observing notebook and write a reflective paper; students taking the graduate version complete additional assignments.

*J. Bales, E. Cavicchi*
Electronics and Programming

EC.110[J] Introduction to Digital Electronics
Same subject as 6.072[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
0-3-3 units

Design your own circuits for times when off-the-shelf solutions are not available. Seminar begins with assembly of a utility board. Weekly labs cover digital logic gates, memory elements, and finite-state machine design. Seminar concludes with a team-based design project. Preference given to freshmen. Maximum of 10 students per term, lottery at the first class session if oversubscribed.

J. Bales

EC.120[J] Electronics Project Laboratory
Same subject as 6.070[J]
Prereq: None
U (Fall, Spring)
1-2-3 units

See description under subject 6.070[J]. Enrollment may be limited.

J. Bales

Imaging and Visualization

EC.210 Visualization for Mathematics, Science, and Technology Education
Prereq: None
U (Spring)
3-2-7 units

Introduces principles and techniques for visual communication of educational concepts in mathematics, the natural sciences, and engineering. Students complete interactive assignments and class activities in visual arts media, such as photography, illustration, stop-motion and computer animation, and web graphics. A final project in a visual arts medium of the student’s choice must meet professional aesthetic standards for visualization; it must also be applicable for teaching and learning concepts in mathematics, science, or engineering in a formal or informal setting. Coursework requires use of production equipment (e.g., photo and video cameras) and software tools (Adobe Creative Suite, Final Cut Studio, and Maya) at the New Media Center. Limited to 18.

V. Ivanova

Media and Production

EC.305 Digital and Darkroom Imaging
Subject meets with EC.A305
Prereq: None
U (Fall)
2-0-4 units

Credit cannot also be received for EC.310

Students use both film and digital photography to develop a creative imaging project of their own choice. Develops skills in the use of image editing software to enhance, select, and combine images that the student has taken. Uses the darkroom to develop film for scanning and for chemical enlargement. Discusses topics such as the camera, composition, lighting, modes and formats, image compression, and halftone and dye sublimation printing. Students are expected to produce a duplicate set of black and white and/or color prints, along with a writeup and digital copy as the project output.

T. Mislick

EC.310 Creative Imaging
Prereq: None
U (Spring)
2-1-6 units. HASS-E
Credit cannot also be received for EC.305, EC.A305

Focuses on film and digital photography. Develops skill in the use of chemical darkrooms, scanners, digital printers and cameras to create striking still images capable of evoking strong emotional and intellectual responses from a viewer. Emphasizes the interplay between classical chemical and digital techniques and how they can be used to control the use of lighting, color, depth, and composition in an image. Students present their intermediate assignments to the class for critical discussion; at the end of the term, they submit a substantive project presenting their own creative images for critique and evaluation.

T. Mislick, J. K. Vandiver
D-Lab

EC.700 D-Lab: Field Study
Prereq: One D-Lab subject and permission of instructor
U (IAP)
Units arranged
Can be repeated for credit.
Provides the opportunity to gain direct fieldwork experience in a global context. Subject spans three-four weeks in which students continue work from a prior D-Lab subject. Students work directly with international community partners to find solutions to real world problems, focusing on one or more issues in education, design, or public service. Group presentations and written reflection required.
A. B. Smith, S. L. Hsu

EC.701[J] D-Lab: Development
Same subject as 11.025[J]
Subject meets with 11.472[J], EC.781[J]
Prereq: None
U (Fall)
3-2-7 units. HASS-S
Issues in international development, appropriate technology and project implementation addressed through lectures, case studies, guest speakers and laboratory exercises. Students form project teams to partner with community organizations in developing countries, and formulate plans for an optional IAP site visit. (Previous field sites include Ghana, Brazil, Honduras and India.) Recitation sections focus on specific project implementation, and include cultural, social, political, environmental and economic overviews of the target countries as well as an introduction to the local languages. Enrollment limited by lottery; must attend first class session.
S. L. Hsu, B. Sanyal

EC.702[J] Cross-Cultural Investigations: Technology and Development
Same subject as 21A.801[J], STS.071[J]
Subject meets with EC.792[J], 21A.839[J], STS.481[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
See description under subject 21A.801[J].
C. Walley

EC.711[J] Introduction to Energy in Global Development
Same subject as 2.651[J]
Subject meets with EC.791
Prereq: None
U (Spring)
3-2-7 units
Provides an overview of thermodynamics and heat transfer through an international development context to impart energy literacy and common sense applications. Students survey various alternative energy technologies and strategies for implementation in developing countries. Focuses on compact, robust, low-cost systems for generating electrical power and meeting household-level needs. Labs reinforce lecture material through deconstruction, system assembly, and sensor installation to track performance. Team projects involve activities, such as researching community needs, assessing the suitability of specific technologies, continuing the development of ongoing projects, and assessing the efficacy and impacts of existing projects. Optional summer fieldwork may be available. Students taking graduate version complete additional assignments. Enrollment limited by lottery; must attend first class session.
E. Verploegen

EC.712 Applications of Energy in Global Development
Subject meets with EC.782
Prereq: None
U (Fall)
4-0-8 units
Engages students in advancing the United Nations' Sustainable Development Goal 7, which seeks to ensure access to affordable, reliable, sustainable, and modern energy systems, through community-based approaches. Teams work on off-grid energy projects that focus on lighting, cooking, indoor heating, agricultural productivity, or other solutions to advance fieldwork with pre-selected community partners. Working at various stages along D-Lab's Off-Grid Energy Roadmap, teams consider needs assessment, technology and business model identification, and implementation strategies. Project work includes combinations of analysis, design, prototyping, and implementation. Optional January site visits may be available to test and implement projects. Students taking graduate version complete additional assignments. Limited to 20; preference to students who have taken EC.711[J].
E. Verploegen
EC.713 D-Lab Schools: Building Technology Laboratory
Same subject as 4.411[J]
Prereq: Calculus I (GIR) and Physics I (GIR)
U (Fall)
2-3-7 units. Institute LAB

See description under subject 4.411[J].
L. K. Norford

EC.715 D-Lab: Water, Sanitation and Hygiene
Subject meets with 11.474
Prereq: None
U (Fall)
3-0-9 units

Focuses on disseminating Water, Sanitation and Hygiene (WASH) or water/environment innovations in developing countries and underserved communities worldwide. Structured around field-based learning, case studies, lectures and videos in which teams propose an idea and are mentored through the process of bringing that innovation to fruition. Emphasizes core WASH and water/environment principles, culture-specific solutions, tools for start-ups, appropriate and sustainable technologies, behavior change, social marketing, building partnerships, and the theory and practice of innovation diffusion. Term project entails entering the IDEAS or other competition(s) while implementing a WASH innovation in a specific locale. Guest lectures on specific real-world WASH projects which have been disseminated by MIT faculty, students, alumni, and others. Students taking graduate version complete additional assignments. Limited to 30.
S. E. Murcott, S. L. Hsu

EC.717 D-Lab: Education and Learning
Subject meets with EC.787
Prereq: None
U (Spring)
2-2-5 units

Provides an overview of pedagogical theories and core teaching skills that allow students to craft their own K-12 curriculum using the design process. Working in groups and collaborating with an international partner, students use the design process to create a final project for a specific audience that emphasizes hands-on, inclusive, project-based learning. Suitable for students with varying levels of teaching experience. Local fieldwork and K-12 classroom visits are required throughout the semester and international fieldwork may be available to students in the summer. Students taking graduate version complete additional assignments. Limited to 10.
L. Nam, S. Hsu

EC.718 D-Lab: Gender and Development
Subject meets with EC.798
Prereq: None
U (Fall)
3-0-9 units

Explores gender roles, illuminates the power dynamics and root causes of inequality, and provides a framework for understanding gender dynamics. Develops skills to conduct a gender analysis and integrate gender-sensitive strategies into large- and small-scale development solutions. Prompts critical discussion about social, economic, and political conditions that shape gender in development. Begins with exploration of international development in the post-colonial era, using a gender lens, then provides students with the tools to integrate gender-sensitive strategies into international development work, with a particular focus on launching, building and scaling women's ventures. Opportunities may be available for international fieldwork over IAP. Students taking graduate version complete additional assignments. Limited to 12; must attend first class session.
E. McDonald, K. Mytty

EC.719 D-Lab: Water, Climate Change, and Health
Subject meets with EC.789
Prereq: None
U (Spring)
3-4-5 units

Addresses mitigation and adaptation to climate change as it pertains to water and health. Focuses on regions where water-borne illness, malnutrition, and vector-borne diseases - problems that will worsen with increasing temperatures and urban overcrowding - represent the top three causes of morbidity and mortality. Includes readings, workshops and films that address water, climate change and health challenges and explore solutions. Field trips include coastal watershed restoration, flood protection, carbon sequestration, and zero-carbon sites in the Boston area. Students complete a term project and/or teach a class, setting the stage for a life-long commitment to communicating climate science to a broad public. Students taking graduate version complete additional assignments.
S. Murcott, J. Simpson, V. Gupta
EC.720[J] D-Lab: Design
Same subject as 2.722[J]
Prereq: 2.670 or permission of instructor
U (Spring)
3-0-9 units
Addresses problems faced by underserved communities with a focus on design, experimentation, and prototyping processes. Particular attention placed on constraints faced when designing for developing countries. Multidisciplinary teams work on long-term projects in collaboration with community partners, field practitioners, and experts in relevant fields. Topics covered include design for affordability, manufacture, sustainability, and strategies for working effectively with community partners and customers. Students may continue projects begun in EC.701[J]. Enrollment limited by lottery; must attend first class session.
S. Grama, J. Arul

EC.724 D-Lab: Smallholder Agriculture
Subject meets with EC.784
Prereq: None
U (Spring)
3-0-6 units
Provides an overview of the scientific, social, and economic context of smallholder farmers in developing countries. Covers the scientific basis and environmental impacts of agriculture, the dynamics of smallholder farming, social and business systems, and the experience of farmers themselves. Lectures, guest experts, experiential activities, and semester projects with community partners contribute to learning objectives. Opportunities for summer fieldwork may be available. Students taking graduate version complete additional assignments. Limited to 15.
R. Nanes, G. Jones, S. Hsu

EC.726 D-Lab: Build-Its
Subject meets with EC.796
Prereq: None
U (Spring)
3-0-9 units
Engages students in the creation of “build-its,” hands-on pedagogical tools developed by D-Lab to teach workshop and design skills to a diverse audience around the world. Studies principles of experiential learning and successful examples of teaching in makerspaces and innovation centers. Students develop their own build-it, test and evaluate it with local students, and create instructions for its use. Optional travel opportunities exist over the summer to test the build-it at a D-Lab summit or training abroad. Opportunities for funded travel available. Students taking graduate version complete additional assignments. Opportunities for funded travel available. Limited to 16.
S. L. Hsu

EC.729[J] D-Lab: Design for Scale
Same subject as 2.729[J]
Subject meets with 2.789[J], EC.797[J]
Prereq: None. Coreq: 2.008; or permission of instructor
U (Fall)
3-2-7 units
Focuses on product development of technologies for people in less industrialized markets. Students work in interdisciplinary teams to develop previously established prototypes or technologies towards manufacturing-ready product designs. Topics are presented within the context of the developing world and include technology feasibility and scalability assessment; value chain analysis; product specification; design for affordability, manufacturability, usability, and desirability; and product testing and manufacturing at various scales. Lessons are experiential and case study-based; taught by instructors with field experience and by industry experts from product development consulting firms and the consumer electronics industry. Student taking graduate version complete additional oral and written assignments.
M. Yang

EC.731[J] Development Ventures
Same subject as 15.375[J], MAS.665[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject MAS.665[J].
J. Bonsen, A. Pentland, C. Breazeal

EC.733[J] D-Lab: Supply Chains
Same subject as 2.771J, 15.772[J]
Subject meets with 2.871
Prereq: None
U (Fall)
3-3-6 units
See description under subject 15.772[J].
S. C. Graves
EC.740 D-Lab: Inclusive Economies
Prereq: None
U (Spring)
2-0-7 units
Explores how innovations and market mechanisms can benefit humanity by rallying impact investments, engaging participants cooperatively, boosting equity and resilience, and broadening prosperity. Examines the ideas behind, and actions towards, multiple inclusive economic mechanisms and approaches. Students review and analyze the competing worldviews and historical pathways that led to the current dominant economic modalities, and both theoretical and empirical criticisms. Includes case studies developing alternative opportunities, modifications, and/or improvements to crafting circular economies and reinforcing local economies. Team projects focus on the facilitation of inclusive economy models in partnership with communities in Latin America or Africa. Optional project-focused travel may be available over IAP. Limited to 12.
E. McDonald, K. Mytty, J. Bonsen

EC.744 Technologies for Mental Health and Wellness (New)
Subject meets with EC.794
Prereq: None
U (Fall)
2-0-10 units
Provides an introduction to the field of computational psychiatry from the perspective of technology platforms that can be applied to mental health and wellness. Identifies current needs and challenges informed by clinical practice, and reviews emerging technologies, including chatbots, social robots, wearable sensors, virtual reality, mobile phones, and digital phenotyping. Discusses related topics of privacy and ethical use. Students complete weekly written assignments as well as three design exercises over the course of the semester. Students taking graduate version complete additional assignments.
R. Fletcher

EC.746[J] Design for Complex Environmental Issues: Building Solutions and Communicating Ideas
Same subject as 1.016[J], 2.00C[J]
Prereq: None
U (Spring)
3-1-5 units
Students work in small groups, under the guidance of researchers from MIT, to pursue specific aspects of the year’s Terrascope problem. Teams design and build prototypes, graphic displays and other tools to communicate their findings and display them in a Bazaar of ideas open to the MIT community. Some teams develop particular solutions, others work to provide deeper understanding of the issues, and others focus on ways to communicate these ideas with the general public. Students’ work is evaluated by independent experts. Offers students an opportunity to develop ideas from the fall semester and to work in labs across MIT. Limited to first-year students.
A. W. Epstein, S. L. Hsu

EC.750 Humanitarian Innovation: Design for Relief, Rebuilding, and Recovery
Subject meets with EC.785
Prereq: None
U (Spring)
4-0-8 units
Explores the role innovation can and does play in how humanitarian aid is provided, and how it can impact people, products, and processes. Provides a fundamental background in the history and practice of humanitarian aid. Considers the various ways that design can be used to enhance aid, such as product and system design for affected populations, co-creation with affected populations, and capacity building to promote design by refugees and the displaced. Case studies and projects examine protracted displacement as well as recovery and resettlement, including efforts in Colombia, Lebanon, Nepal, Sudan, and Uganda. Potential for students to travel over the summer to partner communities.
A. Smith, M. Thompson
EC.770 D-Lab: Independent Project  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.

Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and final report. Students work with international community partners to continue developing projects, focusing on one or more issues in education, design, or public service. Final presentations and written reflection required. May be repeated for credit for a maximum of 12 units.

S. L. Hsu

EC.780 D-Lab: Independent Project  
Prereq: None  
G (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.

Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and final report. Students work with international community partners to continue developing projects, focusing on one or more issues in education, design, or public service. Final presentations and written reflection required. May be repeated for credit for a maximum of 12 units.

S. L. Hsu

EC.781(J) D-Lab: Development  
Same subject as 11.472(J)  
Subject meets with 11.025(J), EC.701(J)  
Prereq: None  
G (Fall)  
3-2-7 units

Issues in international development, appropriate technology and project implementation addressed through lectures, case studies, guest speakers and laboratory exercises. Students form project teams to partner with community organizations in developing countries, and formulate plans for an optional IAP site visit. (Previous field sites include Ghana, Brazil, Honduras and India.) Recitation sections focus on specific project implementation, and include cultural, social, political, environmental and economic overviews of the target countries as well as an introduction to the local languages. Enrollment limited by lottery; must attend first class session.

S. L. Hsu, A. B. Smith, B. Sanyal

EC.782 Applications of Energy in Global Development  
Subject meets with EC.712  
Prereq: None  
G (Fall)  
4-0-8 units

Engages students in advancing the United Nations' Sustainable Development Goal 7, which seeks to ensure access to affordable, reliable, sustainable, and modern energy systems, through community-based approaches. Teams work on off-grid energy projects that focus on lighting, cooking, indoor heating, agricultural productivity, or other solutions to advance fieldwork with pre-selected community partners. Working at various stages along D-Lab's Off-Grid Energy Roadmap, teams consider needs assessment, technology and business model identification, and implementation strategies. Project work includes combinations of analysis, design, prototyping, and implementation. Optional January site visits may be available to test and implement projects. Students taking graduate version complete additional assignments. Limited to 20; preference to students who have taken EC.791.

E. Verploegen

EC.784 D-Lab: Smallholder Agriculture  
Subject meets with EC.724  
Prereq: None  
G (Spring)  
3-0-6 units

Provides an overview of the scientific, social, and economic context of smallholder farmers in developing countries. Covers the scientific basis and environmental impacts of agriculture, the dynamics of smallholder farming, social and business systems, and the experience of farmers themselves. Lectures, guest experts, experiential activities, and semester projects with community partners contribute to learning objectives. Opportunities for summer fieldwork may be available. Students taking graduate version complete additional assignments. Limited to 20.

R. Nanes, G. Jones, S. Hsu
EC.785 Humanitarian Innovation: Design for Relief, Rebuilding, and Recovery
Subject meets with EC.750
Prereq: None
G (Spring)
4-0-8 units
Explores the role innovation can and does play in how humanitarian aid is provided, and how it can impact people, products, and processes. Provides a fundamental background in the history and practice of humanitarian aid. Considers the various ways that design can be used to enhance aid, such as product and system design for affected populations, co-creation with affected populations, and capacity building to promote design by refugees and the displaced. Case studies and projects examine protracted displacement as well as recovery and resettlement, including efforts in Colombia, Lebanon, Nepal, Sudan, and Uganda. Potential for students to travel over the summer to partner communities.
A. Smith, M. Thompson

EC.787 D-Lab: Education and Learning
Subject meets with EC.717
Prereq: None
G (Spring)
2-2-5 units
Provides an overview of pedagogical theories and core teaching skills that allow students to craft their own K-12 curriculum using the design process. Working in groups and collaborating with an international partner, students use the design process to create a final project for a specific audience that emphasizes hands-on, inclusive, project-based learning. Suitable for students with varying levels of teaching experience. Local fieldwork and K-12 classroom visits are required throughout the semester and international fieldwork may be available to students in the summer. Students taking graduate version complete additional assignments. Limited to 10.
L. Nam, S. Hsu

EC.788 D-Lab: Field Research
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Combines hands-on methods for conducting field research with exploration of questions that continue to challenge practitioners, donors, policymakers and researchers in international development. Designed for students preparing to conduct field-based research for theses, product design project, or development ventures. Practices key research skills particularly applicable to conducting research involving people and communities in the context of development. Limited to 16.
E. Moreno

EC.789 D-Lab: Water, Climate Change, and Health
Subject meets with EC.719
Prereq: None
G (Spring)
3-4-5 units
Addresses mitigation and adaptation to climate change as it pertains to water and health. Focuses on regions where water-borne illness, malnutrition, and vector-borne diseases - problems that will worsen with increasing temperatures and urban overcrowding - represent the top three causes of morbidity and mortality. Includes readings, workshops and films that address water, climate change and health challenges and explore solutions. Field trips include coastal watershed restoration, flood protection, carbon sequestration, and zero-carbon sites in the Boston area. Students complete a term project and/or teach a class, setting the stage for a life-long commitment to communicating climate science to a broad public. Students taking graduate version complete additional assignments.
S. Murcott, J. Simpson, V. Gupta

EC.790 D-Lab: Field Study
Prereq: One D-Lab subject and permission of instructor
G (IAP)
Units arranged
Can be repeated for credit.
Provides the opportunity to gain direct fieldwork experience in a global context. Subject spans three-four weeks in which students continue work from a prior D-Lab subject. Students work directly with international community partners to find solutions to real world problems, focusing on one or more issues in education, design, or public service. Group presentations and written reflection required.
S. Hsu
EC.791 Introduction to Energy in Global Development
Subject meets with 2.651[J], EC.711[J]
Prereq: None
G (Spring)
3-2-7 units
Provides an overview of thermodynamics and heat transfer through an international development context to impart energy literacy and common sense applications. Students survey various alternative energy technologies and strategies for implementation in developing countries. Focuses on compact, robust, low-cost systems for generating electrical power and meeting household-level needs. Labs reinforce lecture material through deconstruction, system assembly, and sensor installation to track performance. Team projects involve activities, such as researching community needs, assessing the suitability of specific technologies, continuing the development of ongoing projects, and assessing the efficacy and impacts of existing projects. Optional summer fieldwork may be available. Students taking graduate version complete additional assignments. Enrollment limited by lottery; must attend first class session.
E. Verploegen

EC.792[J] Cross-Cultural Investigations: Technology and Development
Same subject as 21A.839[J], STS.481[J]
Subject meets with EC.702[J], 21A.801[J], STS.071[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units
See description under subject 21A.839[J].
C. Walley

EC.794 Technologies for Mental Health and Wellness (New)
Subject meets with EC.744
Prereq: None
G (Fall)
2-0-10 units
Provides an introduction to the field of computational psychiatry from the perspective of technology platforms that can be applied to mental health and wellness. Identifies current needs and challenges informed by clinical practice, and reviews emerging technologies, including chatbots, social robots, wearable sensors, virtual reality, mobile phones, and digital phenotyping. Discusses related topics of privacy and ethical use. Students complete weekly written assignments as well as three design exercises over the course of the semester. Students taking graduate version complete additional assignments.
R. Fletcher

EC.796 D-Lab: Build-Its
Subject meets with EC.726
Prereq: None
G (Spring)
3-0-9 units
Engages students in the creation of "build-its," hands-on pedagogical tools developed by D-Lab to teach workshop and design skills to a diverse audience around the world. Studies principles of experiential learning and successful examples of teaching in makerspaces and innovation centers. Students develop their own build-it, test and evaluate it with local students, and create instructions for its use. Optional travel opportunities exist over the summer to test the build-it at a D-Lab summit or training abroad. Students taking graduate version complete additional assignments. Limited to 16.
S. L. Hsu

EC.797[J] D-Lab: Design for Scale (New)
Same subject as 2.789[J]
Subject meets with 2.729[J], EC.729[J]
Prereq: None. Coreq: 2.008; or permission of instructor
G (Fall)
3-2-7 units
Focuses on product development of technologies for people in less industrialized markets. Students work in interdisciplinary teams to develop previously established prototypes or technologies towards manufacturing-ready product designs. Topics are presented within the context of the developing world and include technology feasibility and scalability assessment; value chain analysis; product specification; design for affordability, manufacturability, usability, and desirability; and product testing and manufacturing at various scales. Lessons are experiential and case study-based; taught by instructors with field experience and by industry experts from product development consulting firms and the consumer electronics industry. Student taking graduate version complete additional oral and written assignments.
M. Yang, H. Quintus-Bosz, S. Grama, K. Bergeron
EC.798 D-Lab: Gender and Development

Subject meets with EC.718
Prereq: None
G (Fall)
3.0-9 units

Explores gender roles, illuminates the power dynamics and root causes of inequality, and provides a framework for understanding gender dynamics. Develops skills to conduct a gender analysis and integrate gender-sensitive strategies into large- and small-scale development solutions. Prompts critical discussion about social, economic, and political conditions that shape gender in development. Begins with exploration of international development in the post-colonial era, using a gender lens, then provides students with the tools to integrate gender-sensitive strategies into international development work, with a particular focus on launching, building and scaling women's ventures. Opportunities may be available for international fieldwork over IAP. Students taking graduate version complete additional assignments. Limited to 12; must attend first class session.

E. McDonald, K. Mytty

Teaching, UROP, Independent Study

EC.900 Independent Study

Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and final report.

Staff

EC.901 Independent Study (New)

Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and final report.

Staff

EC.910 Edgerton Center Undergraduate Teaching

Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

An opportunity for undergraduates to participate in teaching and tutoring Center subjects and seminars. Students develop one-on-one teaching skills under the supervision of an Edgerton Center instructor.

Staff

EC.980 Edgerton Center Independent Study - Graduate

Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and final report.

Staff

EC.990 Edgerton Center Graduate Teaching

Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

An opportunity for graduate students to participate in teaching and tutoring Edgerton Center subjects and seminars. Permission of Edgerton Center staff required.

Staff

EC.UR Undergraduate Research

Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Undergraduate research opportunities in the Edgerton Center.

J. K. Vandiver

EC.URG Undergraduate Research

Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Undergraduate research opportunities in the Edgerton Center.

J. K. Vandiver
Special Subjects

EC.S00 Special Subject at the Edgerton Center
Prereq: None
U (IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.

Staff

EC.S01 Special Subject at the Edgerton Center
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.

Staff

EC.S02 Special Subject at the Edgerton Center
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.

Staff

EC.S03 Special Subject at the Edgerton Center
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.

Staff

EC.S04 Special Subject at the Edgerton Center
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.

Staff

EC.S05 Special Subject at the Edgerton Center
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.

Staff
EC.S06 Special Subject at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.
Staff

EC.S07 Special Subject at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.
Staff

EC.S08 Special Subject at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.
Staff

EC.S09 Special Subject at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.
Staff

EC.S10 Special Subject at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.
Staff

EC.S11 Special Subject at the Edgerton Center
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.
Staff
EC.S12 Special Subject at the Edgerton Center
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.
Staff

EC.S13 Special Subject at the Edgerton Center
Prereq: None
G (Fall)
Units arranged
Can be repeated for credit.

Seminar combining lectures and lab run by students and academic staff at the Edgerton Center. Students explore specialized electronics, robotics, or mechanical design and fabrication topics not offered in the regular curriculum; classes range from beginner level to more advanced. Some offerings may be taught in an intensive fashion (meeting for up to several times a week for four weeks). Up to three sequential seminars may be offered per semester, covering a different topic each time. Students can take one or all of the seminars.
Staff
6.0001 Introduction to Computer Science Programming in Python
Prereq: None
U (Fall, Spring; first half of term)
3-0-3 units

Introduction to computer science and programming for students with little or no programming experience. Students develop skills to program and use computational techniques to solve problems. Topics include the notion of computation, Python, simple algorithms and data structures, testing and debugging, and algorithmic complexity. Combination of 6.0001 and 6.0002 counts as REST subject. Final given in the seventh week of the term.
A. Bell, J. V. Guttag

6.0002 Introduction to Computational Thinking and Data Science
Prereq: 6.0001 or permission of instructor
U (Fall, Spring; second half of term)
3-0-3 units

Provides an introduction to using computation to understand real-world phenomena. Topics include plotting, stochastic programs, probability and statistics, random walks, Monte Carlo simulations, modeling data, optimization problems, and clustering. Combination of 6.0001 and 6.0002 counts as REST subject. Final given in the seventh week of the term.
A. Bell, J. V. Guttag

6.002 Circuits and Electronics
Prereq: Physics II (GIR); Coreq: 2.087 or 18.03
U (Fall, Spring)
3-2-7 units. REST

Fundamentals of linear systems and abstraction modeling through lumped electronic circuits. Linear networks involving independent and dependent sources, resistors, capacitors and inductors. Extensions to include nonlinear resistors, switches, transistors, operational amplifiers and transducers. Dynamics of first- and second-order networks; design in the time and frequency domains; signal and energy processing applications. Design exercises. Weekly laboratory with microcontroller and transducers.
J. H. Lang, T. Palacios, D. J. Perreault, J. Voldman

6.003 Signals and Systems
Prereq: Calculus I (GIR) and (6.0001 or 6.145)
U (Fall, Spring)
6-0-6 units. REST

Fundamentals of signal processing, focusing on the use of Fourier methods to analyze and process signals such as sounds and images. Topics include Fourier series, Fourier transforms, the Discrete Fourier Transform, sampling, convolution, deconvolution, filtering, noise reduction, and compression. Applications draw broadly from areas of contemporary interest with emphasis on both analysis and design.
D. M. Freeman, A. Hartz

6.004 Computation Structures
Prereq: Physics II (GIR) and 6.0001
U (Fall, Spring)
4-0-8 units. REST

Provides an introduction to the design of digital systems and computer architecture. Emphasizes expressing all hardware designs in a high-level hardware language and synthesizing the designs. Topics include combinational and sequential circuits, instruction set abstraction for programmable hardware, single-cycle and pipelined processor implementations, multi-level memory hierarchies, virtual memory, exceptions and I/O, and parallel systems.
Arvind, S. Z. Hanono Wachman, D. Sanchez

6.006 Introduction to Algorithms
Prereq: 6.042[J] and (6.0001 or Coreq: 6.009)
U (Fall, Spring)
4-0-8 units

Introduction to mathematical modeling of computational problems, as well as common algorithms, algorithmic paradigms, and data structures used to solve these problems. Emphasizes the relationship between algorithms and programming, and introduces basic performance measures and analysis techniques for these problems.
E. Demaine, S. Devadas
6.008 Introduction to Inference  
Prereq: Calculus II (GIR) or permission of instructor  
U (Fall)  
4-4-4 units. Institute LAB  
Introduces probabilistic modeling for problems of inference and machine learning from data, emphasizing analytical and computational aspects. Distributions, marginalization, conditioning, and structure, including graphical and neural network representations. Belief propagation, decision-making, classification, estimation, and prediction. Sampling methods and analysis. Introduces asymptotic analysis and information measures. Computational laboratory component explores the concepts introduced in class in the context of contemporary applications. Students design inference algorithms, investigate their behavior on real data, and discuss experimental results.  
P. Golland, G. W. Wornell

6.009 Fundamentals of Programming  
Prereq: 6.0001 or 6.145  
U (Fall, Spring)  
2-4-6 units. Institute LAB  
Introduces fundamental concepts of programming. Designed to develop skills in applying basic methods from programming languages to abstract problems. Topics include programming and Python basics, computational concepts, software engineering, algorithmic techniques, data types, and recursion. Lab component consists of software design, construction, and implementation of design.  
D. S. Boning, A. Chipala, S. Devadas, A. Hartz

6.01 Introduction to EECS via Robotics  
Prereq: 6.0001, 6.145, or permission of instructor  
U (Spring)  
2-4-6 units. Institute LAB  
An integrated introduction to electrical engineering and computer science, taught using substantial laboratory experiments with mobile robots. Key issues in the design of engineered artifacts operating in the natural world: measuring and modeling system behaviors; assessing errors in sensors and effectors; specifying tasks; designing solutions based on analytical and computational models; planning, executing, and evaluating experimental tests of performance; refining models and designs. Issues addressed in the context of computer programs, control systems, probabilistic inference problems, circuits and transducers, which all play important roles in achieving robust operation of a large variety of engineered systems.  
D. M. Freeman, A. Hartz, L. P. Kaelbling, T. Lozano-Perez

6.011 Signals, Systems and Inference  
Prereq: 6.003 and (6.008, 6.041, or 18.600)  
U (Spring)  
4-0-8 units  
Covers signals, systems and inference in communication, control and signal processing. Topics include input-output and state-space models of linear systems driven by deterministic and random signals; time- and transform-domain representations in discrete and continuous time; and group delay. State feedback and observers. Probabilistic models; stochastic processes, correlation functions, power spectra, spectral factorization. Least-mean square error estimation; Wiener filtering. Hypothesis testing; detection; matched filters.  
A. V. Oppenheim, G. C. Verghese

6.012 Nanoelectronics and Computing Systems  
Prereq: 6.002  
U (Fall, Spring)  
4-0-8 units  
Studies interaction between materials, semiconductor physics, electronic devices, and computing systems. Develops intuition of how transistors operate. Topics range from introductory semiconductor physics to modern state-of-the-art nano-scale devices. Considers how innovations in devices have driven historical progress in computing, and explores ideas for further improvements in devices and computing. Students apply material to understand how building improved computing systems requires knowledge of devices, and how making the correct device requires knowledge of computing systems. Includes a design project for practical application of concepts, and labs for experience building silicon transistors and devices.  
A. I. Akinwande, J. Kong, T. Palacios, M. Shulaker

6.013 Electromagnetics and Applications  
Prereq: Calculus II (GIR) and Physics II (GIR)  
U (Spring)  
3-5-4 units  
Analysis and design of modern applications that employ electromagnetic phenomena for signals and power transmission in RF, microwaves, optical and wireless communication systems. Fundamentals include dynamic solutions for Maxwell’s equations; electromagnetic power and energy, waves in media, metallic and dielectric waveguides, radiation, and diffraction; resonance; filters; and acoustic analogs. Labs activities range from building to testing of devices and systems (e.g., antenna arrays, radars, dielectric waveguides). Students work in teams on self-proposed maker-style design projects with a focus on fostering creativity, teamwork, and debugging skills. 6.002 and 6.003 are recommended but not required.  
L. Daniel, M. R. Watts
6.014 Electromagnetic Fields, Forces and Motion
Subject meets with 6.640
Prereq: Physics II (GIR) and 18.03
U (Fall)
3-0-9 units
J. L. Kirtley, Jr., J. H. Lang

6.02 Introduction to EECS via Communication Networks
Prereq: 6.0001
U (Fall)
4-4-4 units. Institute LAB
Studies key concepts, systems, and algorithms to reliably communicate data in settings ranging from the cellular phone network and the Internet to deep space. Weekly laboratory experiments explore these areas in depth. Topics presented in three modules - bits, signals, and packets - spanning the multiple layers of a communication system. Bits module includes information, entropy, data compression algorithms, and error correction with block and convolutional codes. Signals module includes modeling physical channels and noise, signal design, filtering and detection, modulation, and frequency-division multiplexing. Packets module includes switching and queuing principles, media access control, routing protocols, and data transport protocols.
K. LaCurts

6.021[J] Cellular Neurophysiology and Computing
Same subject as 2.791[J], 9.21[J], 20.370[J]
Prereq: Physics II (GIR), 18.021[J], 20.470[J], HST.541[J]
U (Fall)
5-2-5 units
Integrated overview of the biophysics of cells from prokaryotes to neurons, with a focus on mass transport and electrical signal generation across cell membrane. First third of course focuses on mass transport through membranes: diffusion, osmosis, chemically mediated, and active transport. Second third focuses on electrical properties of cells: ion transport to action potential generation and propagation in electrically excitable cells. Synaptic transmission. Electrical properties interpreted via kinetic and molecular properties of single voltage-gated ion channels. Final third focuses on biophysics of synaptic transmission and introduction to neural computing. Laboratory and computer exercises illustrate the concepts. Students taking graduate version complete different assignments. Preference to juniors and seniors.
J. Han, T. Heldt

6.022[J] Quantitative and Clinical Physiology
Same subject as 2.792[J], HST.542[J]
Prereq: Physics II (GIR), 18.03, or permission of instructor
U (Spring)
4-2-6 units
Application of the principles of energy and mass flow to major human organ systems. Anatomical, physiological and clinical features of the cardiovascular, respiratory and renal systems. Mechanisms of regulation and homeostasis. Systems, features and devices that are most illuminated by the methods of physical sciences and engineering models. Required laboratory work includes animal studies. Students taking graduate version complete additional assignments.
T. Heldt, R. G. Mark

6.023[J] Fields, Forces and Flows in Biological Systems
Same subject as 2.793[J], 20.330[J]
Prereq: Physics II (GIR) and (2.005, 6.021[J], or permission of instructor); Coreq: 20.309[J]
U (Spring)
4-0-8 units
See description under subject 20.330[J].
J. Han, S. Manalis
6.024[J] Molecular, Cellular, and Tissue Biomechanics
Same subject as 2.797[J], 3.053[J], 20.310[J]
Prereq: Biology (GIR), (2.370 or 20.110[J]), and (3.016B or 18.03)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units
See description under subject 20.310[J].
M. Bathe, A. Grodzinsky

6.025[J] Medical Device Design
Same subject as 2.750[J]
Subject meets with 2.75[J], 6.525[J], HST.552[J]
Prereq: 2.008, 6.101, 6.111, 6.115, 22.071, or permission of instructor
U (Fall)
3-0-9 units
See description under subject 2.750[J]. Enrollment limited.
A. H. Slocum, G. Hom, E. Roche, N. C. Hanumara

6.026[J] Biomedical Signal and Image Processing
Same subject as HST.482[J]
Subject meets with 6.555[J], 16.456[J], HST.582[J]
Prereq: (6.041 or permission of instructor) and (2.004, 6.003, 16.002, or 18.085)
U (Spring)
3-3-6 units
See description under subject HST.482[J].
J. Greenberg, E. Adalsteinsson, W. Wells

6.027[J] Biomolecular Feedback Systems
Same subject as 2.180[J]
Subject meets with 2.18[J], 6.557[J]
Prereq: Biology (GIR), 18.03, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units
See description under subject 2.180[J].
D. Del Vecchio

6.024[J] Molecular, Cellular, and Tissue Biomechanics
Same subject as 2.797[J], 3.053[J], 20.310[J]
Prereq: Biology (GIR), (2.370 or 20.110[J]), and (3.016B or 18.03)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units
See description under subject 20.310[J].
M. Bathe, A. Grodzinsky

6.03 Introduction to EECS via Medical Technology
Prereq: Calculus II (GIR) and Physics II (GIR)
U (Spring)
4-4-4 units. Institute LAB
Explores biomedical signals generated from electrocardiograms, glucose detectors or ultrasound images, and magnetic resonance images. Topics include physical characterization and modeling of systems in the time and frequency domains; analog and digital signals and noise; basic machine learning including decision trees, clustering, and classification; and introductory machine vision.
Labs designed to strengthen background in signal processing and machine learning. Students design and run structured experiments, and develop and test procedures through further experimentation.
C. M. Stultz, E. Adalsteinsson

6.031 Elements of Software Construction
Prereq: 6.009
U (Fall, Spring)
5-0-10 units
Introduces fundamental principles and techniques of software development: how to write software that is safe from bugs, easy to understand, and ready for change. Topics include specifications and invariants; testing, test-case generation, and coverage; abstract data types and representation independence; design patterns for object-oriented programming; concurrent programming, including message passing and shared memory concurrency, and defending against races and deadlock; and functional programming with immutable data and higher-order functions. Includes weekly programming exercises and larger group programming projects.
M. Goldman, R. C. Miller

6.033 Computer Systems Engineering
Prereq: 6.004 and 6.009
U (Spring)
5-1-6 units
Topics on the engineering of computer software and hardware systems: techniques for controlling complexity; strong modularity using client-server design, operating systems; performance, networks; naming; security and privacy; fault-tolerant systems, atomicity and coordination of concurrent activities, and recovery; impact of computer systems on society. Case studies of working systems and readings from the current literature provide comparisons and contrasts. Includes a single, semester-long design project. Students engage in extensive written communication exercises. Enrollment may be limited.
K. LaCurts
6.034 Artificial Intelligence
Subject meets with 6.844
Prereq: 6.0001
U (Fall)
4-3-5 units
Introduces representations, methods, and architectures used to build applications and to account for human intelligence from a computational point of view. Covers applications of rule chaining, constraint propagation, constrained search, inheritance, statistical inference, and other problem-solving paradigms. Also addresses applications of identification trees, neural nets, genetic algorithms, support-vector machines, boosting, and other learning paradigms. Considers what separates human intelligence from that of other animals. Students taking graduate version complete additional assignments.
P. H. Winston

6.035 Computer Language Engineering
Prereq: 6.004 and 6.031
U (Fall)
4-4-4 units
Analyzes issues associated with the implementation of higher-level programming languages. Fundamental concepts, functions, and structures of compilers. The interaction of theory and practice. Using tools in building software. Includes a multi-person project on compiler design and implementation.
M. C. Rinard

6.036 Introduction to Machine Learning
Prereq: Calculus II (GIR) and (6.0001 or 6.01)
U (Fall, Spring)
4-0-8 units
Credit cannot also be received for 6.862
Introduces principles, algorithms, and applications of machine learning from the point of view of modeling and prediction; formulation of learning problems; representation, over-fitting, generalization; clustering, classification, probabilistic modeling; and methods such as support vector machines, hidden Markov models, and neural networks. Students taking graduate version complete additional assignments. Meets with 6.862 when offered concurrently. Recommended prerequisites: 6.006 and 18.06. Enrollment may be limited.
R. Barzilay, T. Jaakkola, L. P. Kaelbling

6.037 Structure and Interpretation of Computer Programs
Prereq: None
U (IAP)
1-0-5 units
Studies the structure and interpretation of computer programs which transcend specific programming languages. Demonstrates thought patterns for computer science using Scheme. Includes weekly programming projects. Enrollment may be limited.
Staff

6.041 Introduction to Probability
Subject meets with 6.431
Prereq: Calculus II (GIR)
U (Fall, Spring)
4-0-8 units. REST
Credit cannot also be received for 15.079, 15.0791, 18.600
G. Bresler, P. Jaillet, J. N. Tsitsiklis

6.042[J] Mathematics for Computer Science
Same subject as 18.062[J]
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 units. REST
Elementary discrete mathematics for computer science and engineering. Emphasis on mathematical definitions and proofs as well as on applicable methods. Topics include formal logic notation, proof methods; induction, well-ordering; sets, relations; elementary graph theory; asymptotic notation and growth of functions; permutations and combinations, counting principles; discrete probability. Further selected topics include recursive definition and structural induction, state machines and invariants, integer congruences, recurrences, generating functions.
F. T. Leighton, Z. R. Abel, A. Moitra
6.045[J] Automata, Computability, and Complexity
Same subject as 18.400[J]
Prereq: 6.042[J]
U (Spring)
4-0-8 units

Mathematical introduction to questions concerning the definition of computation, and what problems can be solved by computers. Considers what problems can be efficiently solved by way of finite automata, circuits, Turing machines, and communication complexity. Provides complete, rigorous answers to the questions in some cases; others are major open problems. Builds skills in classifying computational problems in terms of their difficulty. Discusses other fundamental issues, including the Church-Turing Thesis, the P versus NP problem, and the power of randomness.

R. Williams, R. Rubinfeld

6.046[J] Design and Analysis of Algorithms
Same subject as 18.410[J]
Prereq: 6.006
U (Fall, Spring)
4-0-8 units

Techniques for the design and analysis of efficient algorithms, emphasizing methods useful in practice. Topics include sorting; search trees, heaps, and hashing; divide-and-conquer; dynamic programming; greedy algorithms; amortized analysis; graph algorithms; and shortest paths. Advanced topics may include network flow; computational geometry; number-theoretic algorithms; polynomial and matrix calculations; caching; and parallel computing.

E. Demaine, M. Goemans

6.047 Computational Biology: Genomes, Networks, Evolution
Subject meets with 6.878[J], HST.507[J]
Prereq: (Biology (GIR), 6.006, and 6.041B) or permission of instructor
U (Fall)
3-0-9 units

Covers the algorithmic and machine learning foundations of computational biology, combining theory with practice. Principles of algorithm design, influential problems and techniques, and analysis of large-scale biological datasets. Topics include (a) genomes: sequence analysis, gene finding, RNA folding, genome alignment and assembly, database search; (b) networks: gene expression analysis, regulatory motifs, biological network analysis; (c) evolution: comparative genomics, phylogenetics, genome duplication, genome rearrangements, evolutionary theory. These are coupled with fundamental algorithmic techniques including: dynamic programming, hashing, Gibbs sampling, expectation maximization, hidden Markov models, stochastic context-free grammars, graph clustering, dimensionality reduction, Bayesian networks.

M. Kellis

Same subject as 7.33[J]
Prereq: (6.0001 and 7.03) or permission of instructor
U (Spring)
3-0-9 units

See description under subject 7.33[J].

R. Berwick, D. Bartel

6.050[J] Information, Entropy, and Computation
Same subject as 2.110[J]
Prereq: Physics I (GIR)

Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-6 units

See description under subject 2.110[J].

S. Lloyd, P. Penfield, Jr.

6.057 Introduction to MATLAB
Prereq: None
U (IAP)
1-0-2 units

Accelerated introduction to MATLAB and its popular toolboxes. Lectures are interactive, with students conducting sample MATLAB problems in real time. Includes problem-based MATLAB assignments. Students must provide their own laptop and software. Enrollment limited.

Staff
6.058 Introduction to Signals and Systems, and Feedback Control
Prereq: Calculus II (GIR) or permission of instructor
U (IAP)
2·2·2 units
Introduces fundamental concepts for 6.003, including Fourier and Laplace transforms, convolution, sampling, filters, feedback control, stability, and Bode plots. Students engage in problem solving, using Mathematica and MATLAB software extensively to help visualize processing in the time frequency domains.
Staff

6.061 Introduction to Electric Power Systems
Subject meets with 6.690
Prereq: 6.002 and 6.013
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3·0·9 units
Electric circuit theory with application to power handling electric circuits. Modeling and behavior of electromechanical devices, including magnetic circuits, motors, and generators. Operational fundamentals of synchronous. Interconnection of generators and motors with electric power transmission and distribution circuits. Power generation, including alternative and sustainable sources. Incorporation of energy storage in power systems. Students taking graduate version complete additional assignments.
J. L. Kirtley, Jr.

6.070[J] Electronics Project Laboratory
Same subject as EC.120[J]
Prereq: None
U (Fall, Spring)
1·2·3 units
Intuition-based introduction to electronics, electronic components and test equipment such as oscilloscopes, meters (voltage, resistance inductance, capacitance, etc.), and signal generators. Emphasizes individual instruction and development of skills, such as soldering, assembly, and troubleshooting. Students design, build, and keep a small electronics project to put their new knowledge into practice. Intended for students with little or no previous background in electronics. Enrollment may be limited.
J. Bales

6.072[J] Introduction to Digital Electronics
Same subject as EC.110[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
0·3·3 units
See description under subject EC.110[J]. Maximum of 10 students per term, lottery at the first class session if oversubscribed.
J. Bales

6.073[J] Creating Video Games
Same subject as CMS.611[J]
Prereq: 6.01, CMS.301, or CMS.608
U (Spring)
3·3·6 units. HASS-A
See description under subject CMS.611[J]. Limited to 24.
P. Tan, S. Verrilli, R. Eberhardt, A. Grant

6.08 Introduction to EECS via Interconnected Embedded Systems
Prereq: 6.0001 or 6.145; Coreq: Physics II (GIR)
U (Spring)
1·5·6 units. Institute LAB
Introduction to embedded systems in the context of connected devices, wearables and the “Internet of Things” (IoT). Topics include microcontrollers, energy utilization, algorithmic efficiency, interfacing with sensors, networking, cryptography, and local versus distributed computation. Students design, make, and program an internet-connected wearable or handheld device. In final project, student teams design and demo their own cloud-connected IoT system. Enrollment limited; preference to first- and second-year students.
S. Mueller, J. D. Steinmeyer, J. Voldman

6.606 Special Subject in Electrical Engineering and Computer Science
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Basic undergraduate subjects not offered in the regular curriculum.
Consult Department
6.5063 Special Subject in Electrical Engineering and Computer Science
Prereq: None
U (Fall)
Units arranged
Can be repeated for credit.
Basic undergraduate subjects not offered in the regular curriculum.
Consult Department

6.5076-6.5084 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall)
Units arranged
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Consult Department

6.5085-6.5099 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Consult Department

Undergraduate Laboratory Subjects

6.100 Electrical Engineering and Computer Science Project
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual experimental work related to electrical engineering and computer science. Student must make arrangements with a project supervisor and file a proposal endorsed by the supervisor. Departmental approval required. Written report to be submitted upon completion of work.
Consult Department Undergraduate Office

6.101 Introductory Analog Electronics Laboratory
Prereq: 6.002
U (Spring)
2-9-1 units. Institute LAB
Introductory experimental laboratory explores the design, construction, and debugging of analog electronic circuits. Lectures and laboratory projects in the first half of the course investigate the performance characteristics of semiconductor devices (diodes, BJTs, and MOSFETs) and functional analog building blocks, including single-stage amplifiers, op amps, small audio amplifier, filters, converters, sensor circuits, and medical electronics (ECG, pulse-oximetry). Projects involve design, implementation, and presentation in an environment similar to that of industry engineering design teams. Instruction and practice in written and oral communication provided. Opportunity to simulate real-world problems and solutions that involve tradeoffs and the use of engineering judgment.
G. Hom

6.111 Introductory Digital Systems Laboratory
Prereq: 6.002, 6.08, or 16.004
U (Fall)
3-7-2 units. Institute LAB
Introduces digital systems with lectures and labs on logic, flip flops, FPGAs, counters, timing, synchronization, and finite-state machines. Includes overview of accelerometers, gyros, time of light and other modern sensors. Prepares students for the design and implementation of a final project of their choice: games, music, digital filters, wireless communications, video, or graphics. Extensive use of Verilog for describing and implementing digital logic designs.
G. P. Hom, J. Steinmeyer, A. P. Chandrakasan
6.115 Microcomputer Project Laboratory
Subject meets with 6.1151
Prereq: 6.002, 6.003, or 6.004
U (Spring)
3-6-3 units. Institute LAB

Introduces analysis and design of embedded systems. Microcontrollers provide adaptation, flexibility, and real-time control. Emphasizes construction of complete systems, including a five-axis robot arm, a fluorescent lamp ballast, a tomographic imaging station (e.g., a CAT scan), and a simple calculator. Presents a wide range of basic tools, including software and development tools, programmable system on chip, peripheral components such as A/D converters, communication schemes, signal processing techniques, closed-loop digital feedback control, interface and power electronics, and modeling of electromechanical systems. Includes a sequence of assigned projects, followed by a final project of the student's choice, emphasizing creativity and uniqueness. Provides instruction in written and oral communication. To satisfy the independent inquiry component of this subject, students expand the scope of their laboratory project.

S. B. Leeb

6.1151 Microcomputer Project Laboratory - Independent Inquiry
Subject meets with 6.115
Prereq: 6.002, 6.003, or 6.004
U (Spring)
3-9-3 units

Introduces analysis and design of embedded systems. Microcontrollers provide adaptation, flexibility, and real-time control. Emphasizes construction of complete systems, including a five-axis robot arm, a fluorescent lamp ballast, a tomographic imaging station (e.g., a CAT scan), and a simple calculator. Presents a wide range of basic tools, including software and development tools, programmable system on chip, peripheral components such as A/D converters, communication schemes, signal processing techniques, closed-loop digital feedback control, interface and power electronics, and modeling of electromechanical systems. Includes a sequence of assigned projects, followed by a final project of the student's choice, emphasizing creativity and uniqueness. Provides instruction in written and oral communication. Students taking independent inquiry version 6.1151 expand the scope of their laboratory project.

S. B. Leeb

6.117 Introduction to Electrical Engineering Lab Skills
Prereq: None
U (IAP)
1-3-2 units

Introduces basic electrical engineering concepts, components, and laboratory techniques. Covers analog integrated circuits, power supplies, and digital circuits. Lab exercises provide practical experience in constructing projects using multi-meters, oscilloscopes, logic analyzers, and other tools. Includes a project in which students build a circuit to display their own EKG. Enrollment limited.

G. P. Hom

6.123[J] Bioinstrumentation Project Lab
Same subject as 20.345[J]
Prereq: 20.309[J], (Biology (GIR) and (2.004 or 6.003)), or permission of instructor
U (Spring)
2-7-3 units

See description under subject 20.345[J]. Enrollment limited; preference to Course 20 majors and minors.

E. Boyden, M. Jonas, S. F. Nagle, P. So, S. Wasserman, M. F. Yanik

6.129[J] Biological Circuit Engineering Laboratory
Same subject as 20.129[J]
Prereq: Biology (GIR) and Calculus II (GIR)
U (Spring)
2-8-2 units. Institute LAB

Students assemble individual genes and regulatory elements into larger-scale circuits; they experimentally characterize these circuits in yeast cells using quantitative techniques, including flow cytometry, and model their results computationally. Emphasizes concepts and techniques to perform independent experimental and computational synthetic biology research. Discusses current literature and ongoing research in the field of synthetic biology. Instruction and practice in oral and written communication provided. Enrollment limited.

T. Lu, R. Weiss
6.131 Power Electronics Laboratory
Subject meets with 6.1311
Prereq: 6.002 or 6.003
U (Fall)
3-6-3 units. Institute LAB

Introduces the design and construction of power electronic circuits and motor drives. Laboratory exercises include the construction of drive circuitry for an electric go-cart, flash strobes, computer power supplies, three-phase inverters for AC motors, and resonant drives for lamp ballasts and induction heating. Basic electric machines introduced include DC, induction, and permanent magnet motors, with drive considerations. Provides instruction in written and oral communication. Students taking independent inquiry version 6.1311 expand the scope of their laboratory project.

S. B. Leeb

6.1311 Power Electronics Laboratory - Independent Inquiry
Subject meets with 6.131
Prereq: 6.002 or 6.003
U (Fall)
3-9-3 units

Introduces the design and construction of power electronic circuits and motor drives. Laboratory exercises include the construction of drive circuitry for an electric go-cart, flash strobes, computer power supplies, three-phase inverters for AC motors, and resonant drives for lamp ballasts and induction heating. Basic electric machines introduced include DC, induction, and permanent magnet motors, with drive considerations. Provides instruction in written and oral communication. To satisfy the independent inquiry component of this subject, students expand the scope of their laboratory project.

S. B. Leeb

6.145 Brief Introduction to Python
Prereq: None
U (IAP; partial term)
0-1-2 units

Three-week introduction to programming in Python for students with little or no prior experience, designed to be taken prior to 6.01 or 6.08. Provides instruction in the basics of programming in Python through online materials and in-class laboratory exercises.

A. Hartz

6.146 Mobile Autonomous Systems Laboratory: MASLAB
Prereq: None
U (IAP)
Not offered regularly; consult department
2-2-2 units
Can be repeated for credit.

Autonomous robotics contest emphasizing technical AI, vision, mapping and navigation from a robot-mounted camera. Few restrictions are placed on materials, sensors, and/or actuators enabling teams to build robots very creatively. Teams should have members with varying engineering, programming and mechanical backgrounds. Culminates with a robot competition at the end of IAP. Enrollment limited.

Staff

6.147 The Battlecode Programming Competition
Prereq: None
U (IAP)
2-0-4 units
Can be repeated for credit.

Artificial Intelligence programming contest in Java. Student teams program virtual robots to play Battlecode, a real-time strategy game. Competition culminates in a live BattleCode tournament. Assumes basic knowledge of programming.

Staff

6.148 Web Lab: A Web Programming Class and Competition
Prereq: None
U (IAP)
1-0-5 units
Can be repeated for credit.

Student teams design and build web applications. Lectures cover version control, HTML, CSS, and JavaScript. Prior experience unnecessary as instructors and industry professionals teach both basic and advanced material. Teams present their projects in competition for prizes awarded by a judging panel of industry experts.

Staff
6.150 Mobile Applications Competition
Prereq: Permission of instructor
U (IAP)
Not offered regularly; consult department
2-2-2 units
Can be repeated for credit.

Student teams design and build an Android application based on a given theme. Lectures and labs led by experienced students and leading industry experts, covering the basics of Android development, concepts and tools to help participants build great apps. Contest culminates with a public presentation in front of a judging panel comprised of professional developers and MIT faculty. Prizes awarded. Enrollment limited.

6.151 IOS Game Design and Development Competition
Prereq: None
U (IAP)
Not offered regularly; consult department
2-2-2 units

Introduction to iOS game design and development for students already familiar with object-oriented programming. Provides a set of basic tools (Objective-C and Cocos2D) and exposure to real-world issues in game design. Working in small teams, students complete a final project in which they create their own iPhone game. At the end of IAP, teams present their games in competition for prizes awarded by a judging panel of gaming experts.

Same subject as 3.155[J]
Prereq: Calculus II (GIR), Chemistry (GIR), Physics II (GIR), or permission of instructor
U (Fall)
3-4-5 units

Introduces the theory and technology of micro/nano fabrication. Includes lectures and laboratory sessions on processing techniques: wet and dry etching, chemical and physical deposition, lithography, thermal processes, packaging, and device and materials characterization. Homework uses process simulation tools to build intuition about higher order effects. Emphasizes interrelationships between material properties and processing, device structure, and the electrical, mechanical, optical, chemical or biological behavior of devices. Students fabricate solar cells, and a choice of MEMS cantilevers or microfluidic mixers. Students formulate their own device idea, either based on cantilevers or mixers, then implement and test their designs in the lab. Students engage in extensive written and oral communication exercises. Course provides background for research work related to micro/nano fabrication. Enrollment limited.

6.161 Modern Optics Project Laboratory
Subject meets with 6.637
Prereq: 6.003
U (Fall)
3-5-4 units. Institute LAB

Lectures, laboratory exercises and projects on optical signal generation, transmission, detection, storage, processing and display. Topics include polarization properties of light; reflection and refraction; coherence and interference; Fraunhofer and Fresnel diffraction; holography; Fourier optics; coherent and incoherent imaging and signal processing systems; optical properties of materials; lasers and LEDs; electro-optic and acousto-optic light modulators; photorefractive and liquid-crystal light modulation; display technologies; optical waveguides and fiber-optic communication systems; photodetectors. Students may use this subject to find an advanced undergraduate project. Students engage in extensive oral and written communication exercises.

Recommended prerequisite: 8.03.

C. Warde
6.163 Strobe Project Laboratory  
Prereq: Physics II (GiR) or permission of instructor  
U (Fall, Spring)  
2-8-2 units. Institute LAB  

Application of electronic flash sources to measurement and photography. First half covers fundamentals of photography and electronic flashes, including experiments on application of electronic flash to photography, stroboscopy, motion analysis, and high-speed videography. Students write four extensive lab reports. In the second half, students work in small groups to select, design, and execute independent projects in measurement or photography that apply learned techniques. Project planning and execution skills are discussed and developed over the term. Students engage in extensive written and oral communication exercises. Enrollment limited.  
J. K. Vandiver, J. W. Bales

6.169 Theory and Application of Circuits and Electronics  
Prereq: None. Coreq: 6.002  
U (Fall)  
Not offered regularly; consult department  
1-1-1 units  

Building on the framework of 6.002, provides a deeper understanding of the theory and applications of circuits and electronics.  
A. Agarwal, J. del Alamo, J. H. Lang, D. J. Perreault

6.170 Software Studio  
Prereq: 6.031 and 6.042[J]  
U (Fall)  
4-9-2 units  

Covers the design of software applications, with an emphasis on user experience. Provides instruction on how to craft robust and flexible implementations and how to shape the user experience through the design of interfaces and behavior. Topics include need finding, conceptual design, prototyping, data design and user interface design, as well as programming with JavaScript, a reactive front-end framework and a cloud data store. Students work in teams on term-long projects in which they construct applications of social value.  
D. N. Jackson, A. Satyanarayan

6.172 Performance Engineering of Software Systems  
Prereq: 6.004, 6.006, and 6.031  
U (Fall)  
3-12-3 units  

Project-based introduction to building efficient, high-performance and scalable software systems. Topics include performance analysis, algorithmic techniques for high performance, instruction-level optimizations, vectorization, cache and memory hierarchy optimization, and parallel programming.  
S. Amarasinghe, C. E. Leiserson

6.175 Constructive Computer Architecture  
Prereq: 6.004  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall)  
3-8-1 units  

Illustrates a constructive (as opposed to a descriptive) approach to computer architecture. Topics include combinational and pipelined arithmetic-logic units (ALU), in-order pipelined microarchitectures, branch prediction, blocking and unblocking caches, interrupts, virtual memory support, cache coherence and multicore architectures. Labs in a modern Hardware Design Language (HDL) illustrate various aspects of microprocessor design, culminating in a term project in which students present a multicore design running on an FPGA board.  
Arvind

6.176 Pokerbots Competition  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (IAP)  
1-0-5 units  
Can be repeated for credit.  

Build autonomous poker players and acquire the knowledge of the game of poker. Showcase decision making skills, apply concepts in mathematics, computer science and economics. Provides instruction in programming, game theory, probability and statistics and machine learning. Concludes with a final competition and prizes. Enrollment limited.  
Staff
6.178 Introduction to Software Engineering in Java  
Prereq: None  
U (IAP)  
1-1-4 units  
Covers the fundamentals of Java, helping students develop intuition about object-oriented programming. Focuses on developing working software that solves real problems. Designed for students with little or no programming experience. Concepts covered useful to 6.005. Enrollment limited.  
Staff

6.179 Introduction to C and C++  
Prereq: None  
U (IAP)  
3-3-0 units  
Fast-paced introduction to the C and C++ programming languages. Intended for those with experience in other languages who have never used C or C++. Students complete daily assignments, a small-scale individual project, and a mandatory online diagnostic test. Enrollment limited.  
Staff

6.182 Psychoacoustics Project Laboratory  
Prereq: None  
Acad Year 2019-2020: U (Spring)  
Acad Year 2020-2021: Not offered  
3-6-3 units. Institute LAB  
Introduces the methods used to measure human auditory abilities. Discusses auditory function, principles of psychoacoustic measurement, models for psychoacoustic performance, and experimental techniques. Project topics: absolute and differential auditory sensitivity, operating characteristics of human observers, span of auditory judgment, adaptive measurement procedures, and scaling sensory magnitudes. Knowledge of probability helpful. Students engage in extensive written and oral communication exercises.  
L. D. Braida

6.183 Special Laboratory Subject in Electrical Engineering and Computer Science  
Prereq: Permission of instructor  
U (Fall)  
Not offered regularly; consult department  
Units arranged [P/D/F]  
Can be repeated for credit.  
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.  
Consult Department

6.184 Special Laboratory Subject in Electrical Engineering and Computer Science  
Prereq: Permission of instructor  
U (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.  
Consult Department

6.185 Special Laboratory Subject in Electrical Engineering and Computer Science  
Prereq: Permission of instructor  
U (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.  
D. M. Freeman

6.186 Special Laboratory Subject in Electrical Engineering and Computer Science  
Prereq: Permission of instructor  
U (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.  
Consult Department

6.187 Special Laboratory Subject in Electrical Engineering and Computer Science  
Prereq: Permission of instructor  
U (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.  
Staff
6.5188 Special Laboratory Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
D. M. Freeman

6.5189 Special Laboratory Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
D. M. Freeman

6.5190 Special Laboratory Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
D. M. Freeman

6.5191 Special Laboratory Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Consult Department

6.5192 Special Laboratory Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Consult Department

6.5193-6.5198 Special Laboratory Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
Units arranged
Can be repeated for credit.
Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Consult Department

Senior Projects

6.UAP Undergraduate Advanced Project
Prereq: 6.UAT
U (Fall, IAP, Spring, Summer)
0-6-0 units
Can be repeated for credit.
Research project for those EECS students whose curriculum requires a senior project. To be arranged by the student and an appropriate MIT faculty member. Students who register for this subject must consult the department undergraduate office. Students engage in extensive written communications exercises.
Consult Department Undergraduate Office
6.UAR Seminar in Undergraduate Advanced Research
Prereq: 6.UR and permission of instructor
U (Fall, Spring)
2-0-4 units
Can be repeated for credit.

Instruction in effective undergraduate research, including choosing and developing a research topic, surveying previous work and publications, research topics in EECS, industry best practices, design for robustness, technical presentation, authorship and collaboration, and ethics. Students engage in extensive written and oral communication exercises, in the context of an approved advanced research project. A total of 12 units of credit is awarded for completion of the Fall and subsequent Spring term offerings. Application required; consult EECS SuperUROP website for more information.
A. P. Chandrakasan, D. M. Freeman, D. Katabi

6.UAT Oral Communication
Prereq: None
U (Fall, Spring)
3-0-6 units

Provides instruction in aspects of effective technical oral presentations and exposure to communication skills useful in a workplace setting. Students create, give and revise a number of presentations of varying length targeting a range of different audiences. Enrollment may be limited.
T. L. Eng

6.URS Undergraduate Research in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Year-long individual research project arranged with appropriate faculty member or approved supervisor. Forms and instructions for the proposal and final report are available in the EECS Undergraduate Office.
A. P. Chandrakasan, D. M. Freeman

Advanced Undergraduate Subjects and Graduate Subjects by Area

Systems Science and Control Engineering

6.207[J] Networks
Same subject as 14.15[J]
Prereq: 6.041 or 14.30
U (Spring)
4-0-8 units. HASS-S

See description under subject 14.15[J].
A. Wolitzky

6.215 Optimization Methods
Subject meets with 6.255[J], 15.093[J], IDS.200[J]
Prereq: 18.06
U (Fall)
4-0-8 units

Introduces the principal algorithms for linear, network, discrete, robust, nonlinear, and dynamic optimization. Emphasizes methodology and the underlying mathematical structures. Topics include the simplex method, network flow methods, branch and bound and cutting plane methods for discrete optimization, optimality conditions for nonlinear optimization, interior point methods for convex optimization, Newton’s method, heuristic methods, and dynamic programming and optimal control methods. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
D. Bertsimas, P. Parrilo

6.231 Dynamic Programming and Reinforcement Learning
Prereq: 18.600 or 6.041
G (Spring)
4-0-8 units

Dynamic programming as a unifying framework for sequential decision-making under uncertainty, Markov decision problems, and stochastic control. Perfect and imperfect state information models. Finite horizon and infinite horizon problems, including discounted and average cost formulations. Value and policy iteration. Suboptimal methods. Approximate dynamic programming for large-scale problems, and reinforcement learning. Applications and examples drawn from diverse domains. While an analysis prerequisite is not required, mathematical maturity is necessary.
J. N. Tsitsiklis
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Units</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.241[J]</td>
<td>Dynamic Systems and Control</td>
<td>Same subject as 16.338[J]; Prereq: 6.003 and 18.06</td>
<td>4-0-8</td>
<td>G (Spring)</td>
</tr>
<tr>
<td>6.245</td>
<td>Multivariable Control Systems</td>
<td>Prereq: 6.241[J] or 16.31</td>
<td>3-0-9</td>
<td>G (Fall)</td>
</tr>
<tr>
<td>6.246, 6.247</td>
<td>Advanced Topics in Control</td>
<td>Prereq: Permission of instructor</td>
<td>3-0-9</td>
<td>G (Fall)</td>
</tr>
<tr>
<td>6.248, 6.249</td>
<td>Advanced Topics in Numerical Methods</td>
<td>Prereq: Permission of instructor</td>
<td>3-0-9</td>
<td>G (Fall, Spring)</td>
</tr>
<tr>
<td>6.251[J]</td>
<td>Introduction to Mathematical Programming</td>
<td>Same subject as 15.081[J]; Prereq: 18.06</td>
<td>4-0-8</td>
<td>G (Fall)</td>
</tr>
</tbody>
</table>

6.241[J] Dynamic Systems and Control
Same subject as 16.338[J]
Prereq: 6.003 and 18.06
G (Spring)
4-0-8 units


M. A. Dahleh, A. Megretski

Same subject as IDS.136[J]
Prereq: 6.431 and 18.06
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

See description under subject IDS.136[J].
C. Uhler

6.245 Multivariable Control Systems
Prereq: 6.241[J] or 16.31
G (Fall)
Not offered regularly; consult department
3-0-9 units

Computer-aided design methodologies for synthesis of multivariable feedback control systems. Performance and robustness trade-offs. Model-based compensators; Q-parameterization; ill-posed optimization problems; dynamic augmentation; linear-quadratic optimization of controllers; H-infinity controller design; Mu-synthesis; model and compensator simplification; nonlinear effects. Computer-aided (MATLAB) design homework using models of physical processes.
A. Megretski

6.246, 6.247 Advanced Topics in Control
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Can be repeated for credit.

Advanced study of topics in control. Specific focus varies from year to year.
Consult Department

6.248, 6.249 Advanced Topics in Numerical Methods
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Advanced study of topics in numerical methods. Specific focus varies from year to year.
Consult Department

6.251[J] Introduction to Mathematical Programming
Same subject as 15.081[J]
Prereq: 18.06
G (Fall)
4-0-8 units

Introduction to linear optimization and its extensions emphasizing both methodology and the underlying mathematical structures and geometrical ideas. Covers classical theory of linear programming as well as some recent advances in the field. Topics: simplex method; duality theory; sensitivity analysis; network flow problems; decomposition; integer programming; interior point algorithms for linear programming; and introduction to combinatorial optimization and NP-completeness.
J. N. Tsitsiklis, D. Bertsimas
6.252[J] Nonlinear Optimization
Same subject as 15.084[J]
Prereq: 18.06 and (18.100A, 18.100B, or 18.100Q)
G (Spring)
4-0-8 units
R. M. Freund, P. Parrilo, G. Perakis

6.254 Game Theory with Engineering Applications
Prereq: 6.431
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
Introduction to fundamentals of game theory and mechanism design with motivations for each topic drawn from engineering applications (including distributed control of wireline/wireless communication networks, transportation networks, pricing). Emphasis on the foundations of the theory, mathematical tools, as well as modeling and the equilibrium notion in different environments. Topics include normal form games, supermodular games, dynamic games, repeated games, games with incomplete/imperfect information, mechanism design, cooperative game theory, and network games.
A. Ozdaglar

6.255[J] Optimization Methods
Same subject as 15.093[J], IDS.200[J]
Subject meets with 6.215
Prereq: 18.06
G (Fall)
4-0-8 units
See description under subject 15.093[J].
D. Bertsimas, P. Parrilo

6.256[J] Algebraic Techniques and Semidefinite Optimization
Same subject as 18.456[J]
Prereq: 6.251[J] or 15.093[J]
G (Spring)
3-0-9 units
Theory and computational techniques for optimization problems involving polynomial equations and inequalities with particular, emphasis on the connections with semidefinite optimization. Develops algebraic and numerical approaches of general applicability, with a view towards methods that simultaneously incorporate both elements, stressing convexity-based ideas, complexity results, and efficient implementations. Examples from several engineering areas, in particular systems and control applications. Topics include semidefinite programming, resultants/discriminants, hyperbolic polynomials, Groebner bases, quantifier elimination, and sum of squares.
P. Parrilo

6.260, 6.261 Advanced Topics in Communications
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Advanced study of topics in communications. Specific focus varies from year to year.
Consult Department

6.262 Discrete Stochastic Processes
Prereq: 6.431 or 18.204
G (Spring)
4-0-8 units
Review of probability and laws of large numbers; Poisson counting process and renewal processes; Markov chains (including Markov decision theory), branching processes, birth-death processes, and semi-Markov processes; continuous-time Markov chains and reversibility; random walks, martingales, and large deviations; applications from queueing, communication, control, and operations research.
R. G. Gallager, V. W. S. Chan
6.263[J] Data-Communication Networks
Same subject as 16.37[J]
Prereq: 6.041 or 18.204
G (Fall)
3-0-9 units
Provides an introduction to data networks with an analytic perspective, using wireless networks, satellite networks, optical networks, the internet and data centers as primary applications. Presents basic tools for modeling and performance analysis. Draws upon concepts from stochastic processes, queuing theory, and optimization.
E. Modiano

Same subject as 15.070[J]
Prereq: 6.431, 6.436[J], 18.100A, 18.100B, or 18.100Q
G (Spring)
3-0-9 units
See description under subject 15.070[J].
G. Bresler, D. Gamarnik, E. Mossel, Y. Polyanskiy

6.267 Heterogeneous Networks: Architecture, Transport, Protocols, and Management
Prereq: 6.041 or 6.042[J]
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
4-0-8 units
Introduction to modern heterogeneous networks and the provision of heterogeneous services. Architectural principles, analysis, algorithmic techniques, performance analysis, and existing designs are developed and applied to understand current problems in network design and architecture. Begins with basic principles of networking. Emphasizes development of mathematical and algorithmic tools; applies them to understanding network layer design from the performance and scalability viewpoint. Concludes with network management and control, including the architecture and performance analysis of interconnected heterogeneous networks. Provides background and insight to understand current network literature and to perform research on networks with the aid of network design projects.
V. W. S. Chan, R. G. Gallager

6.268 Network Science and Models
Prereq: 6.431 and 18.06
G (Spring)
3-0-9 units
Introduces the main mathematical models used to describe large networks and dynamical processes that evolve on networks. Static models of random graphs, preferential attachment, and other graph evolution models. Epidemic propagation, opinion dynamics, social learning, and inference in networks. Applications drawn from social, economic, natural, and infrastructure networks, as well as networked decision systems such as sensor networks.
P. Jaillet, J. N. Tsitsiklis

Electronics, Computers, and Systems

6.301 Solid-State Circuits
Subject meets with 6.321
Prereq: 6.002
U (Fall)
3-2-7 units
Fosters deep understanding and intuition that is crucial in innovating analog circuits and optimizing the whole system in bipolar junction transistor (BJT) and metal oxide semiconductor (MOS) technologies. Covers both theory and real-world applications of basic amplifier structures, operational amplifiers, temperature sensors, bandgap references, and translinear circuits. Provides practical experience through various lab exercises, including a broadband amplifier design and characterization. Students taking graduate version complete additional assignments.
H.-S. Lee, R. Han
6.302 Feedback System Design
Subject meets with 6.320
Prereq: Physics II (GIR) and (2.087 or 18.03)
U (Spring)
4-4-4 units

Learn-by-design introduction to modeling and control of discrete- and continuous-time systems, from classical analytical techniques to modern computational strategies. Topics include modeling (difference/differential equations, natural frequencies, transfer functions, frequency response, impedances); performance metrics (stability, tracking, disturbance rejection); classical design (root-locus, PID, lead-lag); state-space (ABCD matrices, pole placement, LQR, observers); and data-driven design (regression, identification, model-based control). Students apply concepts introduced in lectures and online assignments to design labs that include discussion-based checkoffs. In lab, students use circuits, sensors, actuators, and a microcontroller to design, build and test controllers for, e.g., propeller-actuated positioners, magnetic levitators, and two-wheel balancers. Students taking graduate version complete additional assignments.

J. K. White

6.320 Feedback System Design
Subject meets with 6.302
Prereq: Physics II (GIR) and (2.087 or 18.03)
G (Spring)
4-4-4 units

Learn-by-design introduction to modeling and control of discrete- and continuous-time systems, from classical analytical techniques to modern computational strategies. Topics include modeling (difference/differential equations, natural frequencies, transfer functions, frequency response, impedances); performance metrics (stability, tracking, disturbance rejection); classical design (root-locus, PID, lead-lag); state-space (ABCD matrices, pole placement, LQR, observers); and data-driven design (regression, identification, model-based control). Students apply concepts introduced in lectures and online assignments to design labs that include discussion-based checkoffs. In lab, students use circuits, sensors, actuators, and a microcontroller to design, build and test controllers for, e.g., propeller-actuated positioners, magnetic levitators, and two-wheel balancers. Students taking graduate version complete additional assignments.

J. K. White

6.321 Solid-State Circuits (New)
Subject meets with 6.301
Prereq: 6.002
G (Fall)
3-2-7 units

Fosters deep understanding and intuition that is crucial in innovating analog circuits and optimizing the whole system in bipolar junction transistor (BJT) and metal oxide semiconductor (MOS) technologies. Covers both theory and real-world applications of basic amplifier structures, operational amplifiers, temperature sensors, bandgap references, and translinear circuits. Provides practical experience through various lab exercises, including a broadband amplifier design and characterization. Students taking graduate version complete additional assignments.

H.-S. Lee, R. Han

6.332, 6.333 Advanced Topics in Circuits
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Can be repeated for credit.

Advanced study of topics in circuits. Specific focus varies from year to year. Consult department for details.

Consult Department

6.334 Power Electronics
Prereq: 6.012
G (Spring)
3-0-9 units

The application of electronics to energy conversion and control. Modeling, analysis, and control techniques. Design of power circuits including inverters, rectifiers, and dc-dc converters. Analysis and design of magnetic components and filters. Characteristics of power semiconductor devices. Numerous application examples, such as motion control systems, power supplies, and radio-frequency power amplifiers.

D. J. Perreault

Same subject as 18.336[J]
Prereq: 6.336[J], 16.920[J], 18.085, 18.335[J], or permission of instructor
G (Fall)
3-0-9 units

See description under subject 18.336[J].

K. Burns
ELECTRICAL ENGINEERING AND COMPUTER SCIENCE (COURSE 6)

6.336[J] Introduction to Numerical Simulation
Same subject as 2.096[J], 16.910[J]
Prereq: 18.03 or 18.06
G (Fall)
3-6-3 units
Introduction to computational techniques for modeling and simulation of a variety of large and complex engineering, science, and socio-economical systems. Prepares students for practical use and development of computational engineering in their own research and future work. Topics include mathematical formulations (e.g., automatic assembly of constitutive and conservation principles); linear system solvers (sparse and iterative); nonlinear solvers (Newton and homotopy); ordinary, time-periodic and partial differential equation solvers; and model order reduction. Students develop their own models and simulators for self-proposed applications, with an emphasis on creativity, teamwork, and communication. Prior basic linear algebra and programming (e.g., MATLAB or Python) helpful.
L. Daniel

6.337[J] Introduction to Numerical Methods
Same subject as 18.335[J]
Prereq: 18.06, 18.700, or 18.701
G (Spring)
3-0-9 units
See description under subject 18.335[J].
S. Johnson

6.338[J] Numerical Computing and Interactive Software
Same subject as 18.337[J]
Prereq: 18.06, 18.700, or 18.701
G (Fall)
3-0-9 units
See description under subject 18.337[J].
C. Rackauckas

Same subject as 2.097[J], 16.920[J]
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 units
See description under subject 16.920[J].
Q. Wang, S. Groth

6.341 Discrete-Time Signal Processing
Prereq: 6.011
G (Fall)
4-0-8 units
A. V. Oppenheim, J. Ward

6.344 Digital Image Processing
Prereq: 6.003 and 6.431
G (Spring)
3-0-9 units
J. S. Lim

6.345[J] Automatic Speech Recognition
Same subject as HST.728[J]
Prereq: 6.011 and 6.036
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-1-8 units
Introduces the rapidly developing fields of automatic speech recognition and spoken language processing. Topics include acoustic theory of speech production, acoustic-phonetics, signal representation, acoustic and language modeling, search, hidden Markov modeling, neural networks models, adaptation, and other related speech processing topics. Lecture material intersperses theory with practice. Includes problem sets, laboratory exercises, and opened-ended term project.
J. R. Glass, W. W. Zue
6.347, 6.348 Advanced Topics in Signals and Systems
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Advanced study of topics in signals and systems. Specific focus varies from year to year.
Consult Department

6.374 Analysis and Design of Digital Integrated Circuits
Prereq: 6.004 and 6.012
G (Fall)
3-3-6 units
Device and circuit level optimization of digital building blocks. MOS device models including Deep Sub-Micron effects. Circuit design styles for logic, arithmetic, and sequential blocks. Estimation and minimization of energy consumption. Interconnect models and parasitics, device sizing and logical effort, timing issues (clock skew and jitter), and active clock distribution techniques. Memory architectures, circuits (sense amplifiers), and devices. Testing of integrated circuits. Extensive custom and standard cell layout and simulation in design projects and software labs.
V. Sze, A. P. Chandrakasan

6.375 Complex Digital Systems Design
Prereq: 6.004
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
5-5-2 units
Introduction to the design and implementation of large-scale digital systems using hardware description languages and high-level synthesis tools in conjunction with standard commercial electronic design automation (EDA) tools. Emphasizes modular and robust designs, reusable modules, correctness by construction, architectural exploration, meeting area and timing constraints, and developing functional field-programmable gate array (FPGA) prototypes. Extensive use of CAD tools in weekly labs serve as preparation for a multi-person design project on multi-million gate FPGAs. Enrollment may be limited.
Arvind

Probabilistic Systems and Communication

6.419[J] Statistics, Computation and Applications
Same subject as IDS.012[J]
Subject meets with 6.439[J], IDS.131[J]
Prereq: (6.003, 6.002, 6.01, 18.03, or 18.06) and (6.008, 6.041, 14.30, 16.09, or 18.05) or permission of instructor
U (Fall)
3-1-8 units
See description under subject IDS.012[J]. Enrollment limited; priority to Statistics and Data Science minors, and to juniors and seniors.
S. Jegelka

6.431 Introduction to Probability
Subject meets with 6.041
Prereq: Calculus II (GIR)
G (Fall)
4-0-8 units
Credit cannot also be received for 15.079, 15.0791, 18.600
G. Bresler, P. Jaillet, J. N. Tsitsiklis

6.434[J] Statistics for Engineers and Scientists
Same subject as 16.391[J]
Prereq: Calculus II (GIR), 6.431, 18.06, or permission of instructor
G (Fall)
3-0-9 units
Rigorous introduction to fundamentals of statistics motivated by engineering applications. Topics include exponential families, order statistics, sufficient statistics, estimation theory, hypothesis testing, measures of performance, notions of optimality, analysis of variance (ANOVA), simple linear regression, and selected topics.
M. Win, J. N. Tsitsiklis
**6.435 Bayesian Modeling and Inference**  
Prereq: 6.436[J] and 6.867  
G (Spring)  
3-0-9 units  
Covers Bayesian modeling and inference at an advanced graduate level. Topics include de Finetti's theorem, decision theory, approximate inference (modern approaches and analysis of Monte Carlo, variational inference, etc.), hierarchical modeling, (continuous and discrete) nonparametric Bayesian approaches, sensitivity and robustness, and evaluation.  
T. Broderick

Same subject as 15.085[J]  
Prereq: Calculus II (GIR)  
G (Fall)  
4-0-8 units  
J. N. Tsitsiklis, D. Gamarnik

**6.437 Inference and Information**  
Prereq: 6.008, 6.041B, or 6.436[J]  
G (Spring)  
4-0-8 units  
Introduction to principles of Bayesian and non-Bayesian statistical inference. Hypothesis testing and parameter estimation, sufficient statistics; exponential families. EM algorithm. Log-loss inference criterion, entropy and model capacity. Kullback-Leibler distance and information geometry. Asymptotic analysis and large deviations theory. Model order estimation; nonparametric statistics. Computational issues and approximation techniques; Monte Carlo methods. Selected topics such as universal inference and learning, and universal features and neural networks.  
P. Golland, G. W. Wornell

**6.438 Algorithms for Inference**  
Prereq: 18.06 and (6.008, 6.041B, or 6.436[J])  
G (Fall)  
4-0-8 units  
Introduction to statistical inference with probabilistic graphical models. Directed and undirected graphical models, and factor graphs, over discrete and Gaussian distributions; hidden Markov models, linear dynamical systems. Sum-product and junction tree algorithms; forward-backward algorithm, Kalman filtering and smoothing. Min-sum and Viterbi algorithms. Variational methods, mean-field theory, and loopy belief propagation. Particle methods and filtering. Building graphical models from data, including parameter estimation and structure learning; Baum-Welch and Chow-Liu algorithms. Selected special topics.  
P. Golland, G. W. Wornell, D. Shah

**6.439[J] Statistics, Computation and Applications**  
Same subject as IDS.131[J]  
Subject meets with 6.419[J], IDS.012[J]  
Prereq: ((2.087, 6.0002, 6.01, 18.03, or 18.06) and (6.008, 6.041, 14.30, 16.09, or 18.05)) or permission of instructor  
G (Fall)  
3-1-8 units  
See description under subject IDS.131[J]. Limited enrollment; priority to Statistics and Data Science minors and to juniors and seniors.  
S. Jegelka

**6.440 Essential Coding Theory**  
Prereq: 6.006 and 6.045[J]  
G (Spring)  
3-0-9 units  
Introduces the theory of error-correcting codes. Focuses on the essential results in the area, taught from first principles. Special focus on results of asymptotic or algorithmic significance. Principal topics include construction and existence results for error-correcting codes; limitations on the combinatorial performance of error-correcting codes; decoding algorithms; and applications to other areas of mathematics and computer science.  
Staff
6.441 Information Theory
Prereq: 6.041B
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Mathematical definitions of information measures, convexity, continuity, and variational properties. Lossless source coding; variable-length and block compression; Slepian-Wolf theorem; ergodic sources and Shannon-McMillan theorem. Hypothesis testing, large deviations and I-projection. Fundamental limits of block coding for noisy channels: capacity, dispersion, finite blocklength bounds. Coding with feedback. Joint source-channel problem. Rate-distortion theory, vector quantizers. Advanced topics include Gelfand-Pinsker problem, multiple access channels, broadcast channels (depending on available time).
M. Medard, Y. Polyanskiy, L. Zheng

6.442 Optical Networks
Prereq: 6.041B or 6.042[J]
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Introduces the fundamental and practical aspects of optical network technology, architecture, design and analysis tools and techniques. The treatment of optical networks are from the architecture and system design points of view. Optical hardware technologies are introduced and characterized as fundamental network building blocks on which optical transmission systems and network architectures are based. Beyond the Physical Layer, the higher network layers (Media Access Control, Network and Transport Layers) are treated together as integral parts of network design. Performance metrics, analysis and optimization techniques are developed to help guide the creation of high performance complex optical networks.
V. W. S. Chan

6.443[J] Quantum Information Science
Same subject as 8.371[J], 18.436[J]
Prereq: 18.435[J]
G (Spring)
3-0-9 units
See description under subject 8.371[J].
I. Chuang, A. Harrow

6.450 Principles of Digital Communication
Prereq: 6.011
G (Fall)
3-0-9 units
Communication sources and channels; data compression; entropy and the AEP; Lempel-Ziv universal coding; scalar and vector quantization; L2 waveforms; signal space and its representation by sampling and other expansions; aliasing; the Nyquist criterion; PAM and QAM modulation; Gaussian noise and random processes; detection and optimal receivers; fading channels and wireless communication; introduction to communication system design. Prior coursework in basic probability and linear system theory recommended.
V. W. S. Chan

6.452 Principles of Wireless Communication
Prereq: 6.450
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Introduction to design, analysis, and fundamental limits of wireless transmission systems. Wireless channel and system models; fading and diversity; resource management and power control; multiple-antenna and MIMO systems; space-time codes and decoding algorithms; multiple-access techniques and multiuser detection; broadcast codes and precoding; cellular and ad-hoc network topologies; OFDM and ultrawideband systems; architectural issues.
G. W. Wornell, L. Zheng

6.453 Quantum Optical Communication
Prereq: 6.011 and 18.06
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Quantum optics: Dirac notation quantum mechanics; harmonic oscillator quantization; number states, coherent states, and squeezed states; radiation field quantization and quantum field propagation; P-representation and classical fields. Linear loss and linear amplification: commutator preservation and the Uncertainty Principle; beam splitters; phase-insensitive and phase-sensitive amplifiers. Quantum photodetection: direct detection, heterodyne detection, and homodyne detection. Second-order nonlinear optics: phasematched interactions; optical parametric amplifiers; generation of squeezed states, photon-twin beams, non-classical fourth-order interference, and polarization entanglement. Quantum systems theory: optimum binary detection; quantum precision measurements; quantum cryptography; and quantum teleportation.
J. H. Shapiro
6.454 Graduate Seminar in Area I  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
2-0-4 units  
Can be repeated for credit.

Student-run advanced graduate seminar with focus on topics in communications, control, signal processing, optimization. Participants give presentations outside of their own research to expose colleagues to topics not covered in the usual curriculum. Recent topics have included compressed sensing, MDL principle, communication complexity, linear programming decoding, biology in EECS, distributed hypothesis testing, algorithms for random satisfaction problems, and cryptography. Open to advanced students from all areas of EECS. Limited to 12.  
L. Zheng, D. Shah

6.456 Array Processing  
Prereq: 6.341 and (2.687 or (6.011 and 18.06))  
Acad Year 2019-2020: G (Fall)  
Acad Year 2020-2021: Not offered  
3-2-7 units  
Adaptive and non-adaptive processing of signals received at arrays of sensors. Deterministic beamforming, space-time random processes, optimal and adaptive algorithms, and the sensitivity of algorithm performance to modeling errors and limited data. Methods of improving the robustness of algorithms to modeling errors and limited data are derived. Advanced topics include an introduction to matched field processing and physics-based methods of estimating signal statistics. Homework exercises providing the opportunity to implement and analyze the performance of algorithms in processing data supplied during the course.  
E. Fischell

Bioelectrical Engineering

6.521[J] Cellular Neurophysiology and Computing  
Same subject as 2.794[J], 9.021[J], 20.470[J], HST.541[J]  
Subject meets with 2.791[J], 6.021[J], 9.21[J], 20.370[J]  
Prereq: (Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, or 20.110[J])) or permission of instructor  
G (Fall)  
5-2-5 units  
Integrated overview of the biophysics of cells from prokaryotes to neurons, with a focus on mass transport and electrical signal generation across cell membrane. First third of course focuses on mass transport through membranes: diffusion, osmosis, chemically mediated, and active transport. Second third focuses on electrical properties of cells: ion transport to action potential generation and propagation in electrically excitable cells. Synaptic transmission. Electrical properties interpreted via kinetic and molecular properties of single voltage-gated ion channels. Final third focuses on biophysics of synaptic transmission and introduction to neural computing. Laboratory and computer exercises illustrate the concepts. Students taking graduate version complete different assignments.  
J. Han, T. Heldt

Same subject as 2.796[J]  
Subject meets with 2.792[J], 6.022[J], HST.542[J]  
Prereq: 6.021[J] and (2.006 or 6.013)  
G (Spring)  
4-2-6 units  
Application of the principles of energy and mass flow to major human organ systems. Anatomical, physiological and clinical features of the cardiovascular, respiratory and renal systems. Mechanisms of regulation and homeostasis. Systems, features and devices that are most illuminated by the methods of physical sciences and engineering models. Required laboratory work includes animal studies. Students taking graduate version complete additional assignments.  
T. Heldt, R. G. Mark

6.524[J] Molecular, Cellular, and Tissue Biomechanics  
Same subject as 2.798[J], 3.971[J], 10.537[J], 20.410[J]  
Prereq: Biology (GIR) and (2.002, 2.006, 6.013, 10.301, or 10.302)  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  
See description under subject 20.410[J].  
R. D. Kamm, K. J. Van Vliet
6.525[J] Medical Device Design
Same subject as 2.75[J], HST.552[J]
Subject meets with 2.750[J], 6.025[J]
Prereq: 2.008, 6.101, 6.111, 6.115, 22.071, or permission of instructor
G (Fall)
3-0-9 units
See description under subject 2.75[J]. Enrollment limited.
A. H. Slocum, G. Hom, E. Roche, N. C. Hanumara

6.542[J] Laboratory on the Physiology, Acoustics, and Perception of Speech
Same subject as 24.966[J], HST.712[J]
Prereq: Permission of instructor
G (Spring)
2-2-8 units
Experimental investigations of speech processes. Topics include computer-aided waveform analysis and spectral analysis of speech; synthesis of speech; perception and discrimination of speech-like sounds; speech prosody; models of speech recognition; speech development; analysis of atypical speech; and others. Recommended prerequisite: 6.002, 18.03, or 24.900.
L. D. Braid, S. Shattuck-Hufnagel, J.-Y. Choi

6.544, 6.545 Advanced Topics in BioEECS
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Advanced study of topics in BioEECS. Specific focus varies from year to year. Consult department for details.
Consult Department

Same subject as HST.716[J]
Prereq: (6.003 and 6.041B or 6.431) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Studies information processing performance of the human auditory system in relation to current physiological knowledge. Examines mathematical models for the quantification of auditory-based behavior and the relation between behavior and peripheral physiology, reflecting the tono-topic organization and stochastic responses of the auditory system. Mathematical models of psychophysical relations, incorporating quantitative knowledge of physiological transformations by the peripheral auditory system.
L. D. Braid

6.555[J] Biomedical Signal and Image Processing
Same subject as 16.456[J], HST.582[J]
Subject meets with 6.026[J], HST.482[J]
Prereq: (6.041 and (2.004, 6.003, 16.002, or 18.085)) or permission of instructor
G (Spring)
3-3-6 units
See description under subject HST.582[J].
J. Greenberg, E. Adalsteinsson, W. Wells

6.556[J] Data Acquisition and Image Reconstruction in MRI
Same subject as HST.580[J]
Prereq: 6.011
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Applies analysis of signals and noise in linear systems, sampling, and Fourier properties to magnetic resonance (MR) imaging acquisition and reconstruction. Provides adequate foundation for MR physics to enable study of RF excitation design, efficient Fourier sampling, parallel encoding, reconstruction of non-uniformly sampled data, and the impact of hardware imperfections on reconstruction performance. Surveys active areas of MR research. Assignments include Matlab-based work with real data. Includes visit to a scan site for human MR studies.
E. Adalsteinsson

6.557[J] Biomolecular Feedback Systems
Same subject as 2.18[J]
Subject meets with 2.180[J], 6.027[J]
Prereq: Biology (GIR), 18.03, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
See description under subject 2.18[J].
D. Del Vecchio, R. Weiss

Same subject as 2.795[J], 10.539[J], 20.430[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject 20.430[J].
M. Bathe, A. J. Grodzinsky
6.580[J] Principles of Synthetic Biology
Same subject as 20.305[J]
Subject meets with 6.589[J], 20.405[J]
Prereq: None
U (Fall)
3-0-9 units
See description under subject 20.305[J].
R. Weiss

6.589[J] Principles of Synthetic Biology
Same subject as 20.405[J]
Subject meets with 6.580[J], 20.305[J]
Prereq: None
G (Fall)
3-0-9 units
See description under subject 20.405[J].
R. Weiss

Electrodynamics

6.602 Fundamentals of Photonics
Subject meets with 6.621
Prereq: 2.71, 6.013, or 8.07
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Covers the fundamentals of optics and the interaction of light and matter, leading to devices such as light emitting diodes, optical amplifiers, and lasers. Topics include classical ray, wave, beam, and Fourier optics; Maxwell’s electromagnetic waves; resonators; quantum theory of photons; light-matter interaction; laser amplification; lasers; and semiconductors optoelectronics. Students taking graduate version complete additional assignments.
D. R. Englund

6.621 Fundamentals of Photonics
Subject meets with 6.602
Prereq: 2.71, 6.013, or 8.07
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Covers the fundamentals of optics and the interaction of light and matter, leading to devices such as light emitting diodes, optical amplifiers, and lasers. Topics include classical ray, wave, beam, and Fourier optics; Maxwell’s electromagnetic waves; resonators; quantum theory of photons; light-matter interaction; laser amplification; lasers; and semiconductors optoelectronics. Students taking graduate version complete additional assignments.
D. R. Englund

6.630 Electromagnetics
Prereq: Physics II (GIR) and 6.003
G (Fall)
4-0-8 units
Explores electromagnetic phenomena in modern applications, including wireless and optical communications, circuits, computer interconnects and peripherals, microwave communications and radar, antennas, sensors, micro-electromechanical systems, and power generation and transmission. Fundamentals include quasistatic and dynamic solutions to Maxwell’s equations; waves, radiation, and diffraction; coupling to media and structures; guided and unguided waves; modal expansions; resonance; acoustic analogs; and forces, power, and energy.
M. R. Watts

6.631 Optics and Photonics
Prereq: 6.013 or 8.07
G (Fall)
3-0-9 units
J. G. Fujimoto

6.632 Electromagnetic Wave Theory
Prereq: 6.013, 6.630, or 8.07
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Solutions to Maxwell equations and physical interpretation. Topics include waves in media, equivalence principle, duality and complementarity, Huygens’ principle, Fresnel and Fraunhofer diffraction, radiation and dyadic Green’s functions, scattering, metamaterials, and plasmonics, mode theory, dielectric waveguides, and resonators. Examples deal with limiting cases of electromagnetic theory, multi-port elements, filters and antennas. Discusses current topics in microwave and photonic devices.
M. R. Watts
6.634[J] Nonlinear Optics  
Same subject as 8.431[J]  
Prereq: 6.013 or 8.07  
G (Spring)  
3-0-9 units  
J. G. Fujimoto

6.637 Optical Imaging Devices, and Systems  
Subject meets with 6.161  
Prereq: 6.003  
G (Fall)  
3-0-9 units  
Principles of operation and applications of optical imaging devices and systems (includes optical signal generation, transmission, detection, storage, processing and display). Topics include review of the basic properties of electromagnetic waves; coherence and interference; diffraction and holography; Fourier optics; coherent and incoherent imaging and signal processing systems; optical properties of materials; lasers and LEDs; electro-optic and acousto-optic light modulators; photorefractive and liquid-crystal light modulation; spatial light modulators and displays; near-eye and projection displays, holographic and other 3-D display schemes, photodetectors; 2-D and 3-D optical storage technologies; adaptive optical systems; role of optics in next-generation computers. Requires a research paper on a specific contemporary optical imaging topic. Recommended prerequisite: 8.03.  
C. Warde

6.640 Electromagnetic Fields, Forces and Motion  
Subject meets with 6.014  
Prereq: Physics II (GIR) and 18.03  
G (Fall)  
3-0-9 units  
J. L. Kirtley, Jr., J. H. Lang

6.644, 6.645 Advanced Topics in Applied Physics  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  
Can be repeated for credit.  
Advanced study of topics in applied physics. Specific focus varies from year to year. Consult department for details.  
Consult Department

6.685 Electric Machines  
Prereq: (6.061 or 6.690) or permission of instructor  
Acad Year 2019-2020: G (Fall)  
Acad Year 2020-2021: Not offered  
3-0-9 units  
J. L. Kirtley, Jr.
6.690 Introduction to Electric Power Systems
Subject meets with 6.061
Prereq: 6.002 and 6.013
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Electric circuit theory with application to power handling electric circuits. Modeling and behavior of electromechanical devices, including magnetic circuits, motors, and generators. Operational fundamentals of synchronous. Interconnection of generators and motors with electric power transmission and distribution circuits. Power generation, including alternative and sustainable sources. Incorporation of energy storage in power systems. Students taking graduate version complete additional assignments.

J. L. Kirtley, Jr.

6.695[J] Engineering, Economics and Regulation of the Electric Power Sector
Same subject as 15.032[J], IDS.505[J]
Subject meets with IDS.064
Prereq: 14.01, 22.081[J], IDS.060[J], or permission of instructor
G (Spring)
3-0-9 units

See description under subject IDS.505[J].

I. Perez-Arriaga

Solid-State Materials and Devices

6.701 Introduction to Nanoelectronics
Subject meets with 6.719
Prereq: 6.003
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4-0-8 units

Transistors at the nanoscale. Quantization, wavefunctions, and Schrodinger’s equation. Introduction to electronic properties of molecules, carbon nanotubes, and crystals. Energy band formation and the origin of metals, insulators and semiconductors. Ballistic transport, Ohm’s law, ballistic versus traditional MOSFETs, fundamental limits to computation.

M. A. Baldo

6.717[J] Design and Fabrication of Microelectromechanical Systems
Same subject as 2.374[J]
Subject meets with 2.372[J], 6.777[J]
Prereq: (Physics II (GIR) and (2.003[J] or 6.003)) or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units

Provides an introduction to microsystem design. Covers material properties, microfabrication technologies, structural behavior, sensing methods, electromechanical actuation, thermal actuation and control, multi-domain modeling, noise, and microsystem packaging. Applies microsystem modeling, and manufacturing principles to the design and analysis a variety of microscale sensors and actuators (e.g., optical MEMS, bioMEMS, and inertial sensors). Emphasizes modeling and simulation in the design process. Students taking the graduate version complete additional assignments.

Staff

6.719 Nanoelectronics
Subject meets with 6.701
Prereq: 6.003
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units

Meets with undergraduate subject 6.701, but requires the completion of additional/different homework assignments and or projects. See subject description under 6.701.

M. A. Baldo

6.720[J] Integrated Microelectronic Devices
Same subject as 3.43[J]
Prereq: 3.42 or 6.012
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units

Covers physics of microelectronic semiconductor devices for integrated circuit applications. Topics include semiconductor fundamentals, p-n junction, metal-oxide semiconductor structure, metal-semiconductor junction, MOS field-effect transistor, and bipolar junction transistor. Emphasizes physical understanding of device operation through energy band diagrams and short-channel MOSFET device design and modern device scaling. Familiarity with MATLAB recommended.

J. A. del Alamo, H. L. Tuller
6.728 Applied Quantum and Statistical Physics
Prereq: 6.003 and 18.06
G (Fall)
4-0-8 units
Elementary quantum mechanics and statistical physics. Introduces applied quantum physics. Emphasizes experimental basis for quantum mechanics. Applies Schrodinger's equation to the free particle, tunneling, the harmonic oscillator, and hydrogen atom. Variational methods. Elementary statistical physics; Fermi-Dirac, Bose-Einstein, and Boltzmann distribution functions. Simple models for metals, semiconductors, and devices such as electron microscopes, scanning tunneling microscope, thermonic emitters, atomic force microscope, and more.
P. L. Hagelstein

6.730 Physics for Solid-State Applications
Prereq: 6.013 and 6.728
G (Spring)
5-0-7 units
Classical and quantum models of electrons and lattice vibrations in solids, emphasizing physical models for elastic properties, electronic transport, and heat capacity. Crystal lattices, electronic energy band structures, phonon dispersion relations, effective mass theorem, semiclassical equations of motion, electron scattering and semiconductor optical properties. Band structure and transport properties of selected semiconductors. Connection of quantum theory of solids with quasi-Fermi levels and Boltzmann transport used in device modeling.
Q. Hu, R. Ram

6.731 Semiconductor Optoelectronics: Theory and Design
Prereq: 6.012 and 6.728
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Focuses on the physics of the interaction of photons with semiconductor materials. Uses the band theory of solids to calculate the absorption and gain of semiconductor media; and uses rate equation formalism to develop the concepts of laser threshold, population inversion, and modulation response. Presents theory and design for photodetectors, solar cells, modulators, amplifiers, and lasers. Introduces noise models for semiconductor devices, and applications of optoelectronic devices to fiber optic communications.
R. J. Ram

6.732 Physics of Solids
Prereq: 6.730 or 8.231
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
Continuation of 6.730 emphasizing applications-related physical issues in solids. Topics include: electronic structure and energy band diagrams of semiconductors, metals, and insulators; Fermi surfaces; dynamics of electrons under electric and magnetic fields; classical diffusive transport phenomena such as electrical and thermal conduction and thermoelectric phenomena; quantum transport in tunneling and ballistic devices; optical properties of metals, semiconductors, and insulators; impurities and excitons; photon-lattice interactions; Kramers-Kronig relations; optoelectronic devices based on interband and intersubband transitions; magnetic properties of solids; exchange energy and magnetic ordering; magneto-oscillatory phenomena; quantum Hall effect; superconducting phenomena and simple models.
Q. Hu

6.735, 6.736 Advanced Topics in Materials, Devices, and Nanotechnology
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Advanced study of topics in materials, devices, and nanotechnology. Specific focus varies from year to year.
Consult Department

6.774 Physics of Microfabrication: Front End Processing
Prereq: 6.152[J]
G (Fall)
Not offered regularly; consult department
3-0-9 units
Presents advanced physical models and practical aspects of front-end microfabrication processes, such as oxidation, diffusion, ion implantation, chemical vapor deposition, atomic layer deposition, etching, and epitaxy. Covers topics relevant to CMOS, bipolar, and optoelectronic device fabrication, including high k gate dielectrics, gate etching, implant-damage enhanced diffusion, advanced metrology, stress effects on oxidation, non-planar and nanowire device fabrication, SiGe and fabrication of process-induced strained Si. Exposure to CMOS process integration concepts, and impacts of processing on device characteristics. Students use modern process simulation tools.
J. L. Hoyt, L. R. Reif
6.775 CMOS Analog and Mixed-Signal Circuit Design
Prereq: 6.301
G (Spring)
3-0-9 units
A detailed exposition of the principles involved in designing and optimizing analog and mixed-signal circuits in CMOS technologies. Small-signal and large-signal models. Systemic methodology for device sizing and biasing. Basic circuit building blocks. Operational amplifier design. Large signal considerations. Principles of switched capacitor networks including switched-capacitor and continuous-time integrated filters. Basic and advanced A/D and D/A converters, delta-sigma modulators, RF and other signal processing circuits. Design projects on op amps and subsystems are a required part of the subject.
H. S. Lee, R. Han

6.776 High Speed Communication Circuits
Prereq: 6.301
G (Fall)
3-3-6 units
Principles and techniques of high-speed integrated circuits used in wireless/wireline data links and remote sensing. On-chip passive component design of inductors, capacitors, and antennas. Analysis of distributed effects, such as transmission line modeling, S-parameters, and Smith chart. Transceiver architectures and circuit blocks, which include low-noise amplifiers, mixers, voltage-controlled oscillators, power amplifiers, and frequency dividers. Involves IC/EM simulation and laboratory projects.
R. Han

6.777[J] Design and Fabrication of Microelectromechanical Systems
Same subject as 2.372[J]
Subject meets with 2.374[J], 6.717[J]
Prereq: (Physics II (GIR) and (2.003[J] or 6.003)) or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Provides an introduction to microsystem design. Covers material properties, microfabrication technologies, structural behavior, sensing methods, electromechanical actuation, thermal actuation and control, multi-domain modeling, noise, and microsystem packaging. Applies microsystem modeling, and manufacturing principles to the design and analysis a variety of microscale sensors and actuators (e.g., optical MEMS, bioMEMS, and inertial sensors). Emphasizes modeling and simulation in the design process. Students taking the graduate version complete additional assignments.
Staff

6.780[J] Control of Manufacturing Processes
Same subject as 2.830[J]
Prereq: 2.008, 6.041, or 6.152[J]
G (Fall)
3-0-9 units
See description under subject 2.830[J].
D. E. Hardt, D. S. Boning

6.781[J] Nanostructure Fabrication
Same subject as 2.391[J]
Prereq: (2.710, 6.152[J], or 6.161) or permission of instructor
G (Spring)
4-0-8 units
Describes current techniques used to analyze and fabricate nanometer-length-scale structures and devices. Emphasizes imaging and patterning of nanostructures, including fundamentals of optical, electron (scanning, transmission, and tunneling), and atomic-force microscopy; optical, electron, ion, and nanoimprint lithography, templated self-assembly, and resist technology. Surveys substrate characterization and preparation, facilities, and metrology requirements for nanolithography. Addresses nanodevice processing methods, such as liquid and plasma etching, lift-off, electroplating, and ion-implant. Discusses applications in nanoelectronics, nanomaterials, and nanophotonics.
K. K. Berggren

Computer Science

6.801 Machine Vision
Subject meets with 6.866
Prereq: 6.003 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Deriving a symbolic description of the environment from an image. Understanding physics of image formation. Image analysis as an inversion problem. Binary image processing and filtering of images as preprocessing steps. Recovering shape, lightness, orientation, and motion. Using constraints to reduce the ambiguity. Photometric stereo and extended Gaussian sphere. Applications to robotics; intelligent interaction of machines with their environment. Students taking the graduate version complete different assignments.
B. K. P. Horn
6.802[J] Computational Systems Biology: Deep Learning in the Life Sciences
Same subject as 20.390[J]
Subject meets with 6.874[J], 20.490, HST.506[J]
Prereq: (7.05 and (6.0002 or 6.01)) or permission of instructor
U (Spring)
3-0-9 units
Presents innovative approaches to computational problems in the life sciences, focusing on deep learning-based approaches with comparisons to conventional methods. Topics include protein-DNA interaction, chromatin accessibility, regulatory variant interpretation, medical image understanding, medical record understanding, therapeutic design, and experiment design (the choice and interpretation of interventions). Focuses on machine learning model selection, robustness, and interpretation. Teams complete a multidisciplinary final research project using TensorFlow or other framework. Provides a comprehensive introduction to each life sciences problem, but relies upon students understanding probabilistic problem formulations. Students taking graduate version complete additional assignments.
D. Gifford

6.803 The Human Intelligence Enterprise
Subject meets with 6.833
Prereq: 6.034 or permission of instructor
U (Spring)
3-0-9 units
Analyzes seminal work directed at the development of a computational understanding of human intelligence, such as work on learning, language, vision, event representation, commonsense reasoning, self reflection, story understanding, and analogy. Reviews visionary ideas of Turing, Minsky, and other influential thinkers. Examines the implications of work on brain scanning, developmental psychology, and cognitive psychology. Emphasis on discussion and analysis of original papers. Students taking graduate version complete additional assignments. Enrollment limited.
P. H. Winston

6.804[J] Computational Cognitive Science
Same subject as 9.66[J]
Subject meets with 9.660
Prereq: 6.008, 6.036, 6.041, 9.40, 18.05, or permission of instructor
U (Fall)
3-0-9 units
See description under subject 9.66[J].
J. Tenenbaum

Same subject as STS.085[J]
Subject meets with STS.487
Prereq: Permission of instructor
U (Fall)
3-0-9 units. HASS-S
Studies the growth of computer and communications technology and the new legal and ethical challenges that reflect tensions between individual rights and societal needs. Topics include computer crime; intellectual property restrictions on software; encryption, privacy, and national security; academic freedom and free speech. Students meet and question technologists, activists, law enforcement agents, journalists, and legal experts. Instruction and practice in oral and written communication provided. Students taking graduate version complete additional assignments. Enrollment limited.
H. Abelson, M. Fischer, D. Weitzner

6.806 Advanced Natural Language Processing
Subject meets with 6.864
Prereq: 6.046[J] or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Introduces the study of human language from a computational perspective, including syntactic, semantic and discourse processing models. Emphasizes machine learning methods and algorithms. Uses these methods and models in applications such as syntactic parsing, information extraction, statistical machine translation, dialogue systems, and summarization. Students taking graduate version complete additional assignments.
R. A. Barzilay

6.807 Computational Fabrication
Prereq: 6.837 or permission of instructor
U (Fall)
3-0-9 units
Introduces computational aspects of computer-aided design and manufacturing. Explores relevant methods in the context of additive manufacturing (e.g., 3D printing). Topics include computer graphics (geometry modeling, solid modeling, procedural modeling), physically-based simulation (kinematics, finite element method), 3D scanning/geometry processing, and an overview of 3D fabrication methods. Exposes students to the latest research in computational fabrication.
W. Matusik
Same subject as MAS.453[J]
Prereq: 6.033 or permission of instructor
U (Spring)
3-0-9 units
Focuses on "Internet of Things" (IoT) systems and technologies, sensing, computing, and communication. Explores fundamental design and implementation issues in the engineering of mobile and sensor computing systems. Topics include battery-free sensors, seeing through wall, robotic sensors, vital sign sensors (breathing, heartbeats, emotions), sensing in cars and autonomous vehicles, subsea IoT, sensor security, positioning technologies (including GPS and indoor WiFi), inertial sensing (accelerometers, gyroscopes, inertial measurement units, dead-reckoning), embedded and distributed system architectures, sensing with radio signals, sensing with microphones and cameras, wireless sensor networks, embedded and distributed system architectures, mobile libraries and APIs to sensors, and application case studies. Includes readings from research literature, as well as laboratory assignments and a significant term project.

H. Balakrishnan, S. Madden, F. Adib

6.809[J] Interactive Music Systems
Same subject as 21M.385[J]
Prereq: (6.009 and 21M.301) or permission of instructor
U (Fall, Spring)
3-0-9 units. HASS-A
See description under subject 21M.385[J]. Limited to 18.
E. Egozy, L. Kaelbling

6.810 Engineering Interactive Technologies
Prereq: 6.031, 6.08, 6.111, 6.115, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-3-6 units
Provides instruction in building cutting-edge interactive technologies, explains the underlying engineering concepts, and shows how those technologies evolved over time. Students use a studio format (i.e., extended periods of time) for constructing software and hardware prototypes. Topics include interactive technologies, such as multi-touch, augmented reality, haptics, wearables, and shape-changing interfaces. In a group project, students build their own interactive hardware/software prototypes and present them in a live demo at the end of term. Enrollment may be limited.
S. Mueller

6.811[J] Principles and Practice of Assistive Technology
Same subject as 2.78[J], HST.420[J]
Prereq: Permission of instructor
U (Fall)
2-4-6 units
Students work closely with people with disabilities to develop assistive and adaptive technologies that help them live more independently. Covers design methods and problem-solving strategies; human factors; human-machine interfaces; community perspectives; social and ethical aspects; and assistive technology for motor, cognitive, perceptual, and age-related impairments. Prior knowledge of one or more of the following areas useful: software; electronics; human-computer interaction; cognitive science; mechanical engineering; control; or MIT hobby shop, MIT PSC, or other relevant independent project experience.
R. C. Miller, J. E. Greenberg, J. J. Leonard

6.812 Hardware Architecture for Deep Learning (New)
Subject meets with 6.825
Prereq: 6.003 or 6.004
U (Spring)
3-3-6 units
Introduction to the design and implementation of hardware architectures for efficient processing of deep learning algorithms in AI systems. Topics include basics of deep learning, programmable platforms, accelerators, co-optimization of algorithms and hardware, training, support for complex networks, and applications of advanced technologies. Includes labs involving modeling and analysis of hardware architectures, building systems using popular deep learning tools and platforms (CPU, GPU, FPGA), and an open-ended design project. Students taking graduate version complete additional assignments.
V. Sze, J. Emer

6.814 Database Systems
Subject meets with 6.830
Prereq: (6.033 and (6.006 or 6.046[J])) or permission of instructor
U (Spring)
3-0-9 units
Topics related to the engineering and design of database systems, including data models; database and schema design; schema normalization and integrity constraints; query processing; query optimization and cost estimation; transactions; recovery; concurrency control; isolation and consistency; distributed, parallel and heterogeneous databases; adaptive databases; trigger systems; pub-sub systems; semi structured data and XML querying. Lecture and readings from original research papers. Semester-long project and paper. Students taking graduate version complete different assignments. Enrollment may be limited.
S. R. Madden
6.815 Digital and Computational Photography
Subject meets with 6.865
Prereq: Calculus II (GIR) and 6.009
U (Fall)
3-0-9 units
Presents fundamentals and applications of hardware and software
techniques used in digital and computational photography, with an
emphasis on software methods. Provides sufficient background to
implement solutions to photographic challenges and opportunities.
Topics include cameras and image formation, image processing
and image representations, high-dynamic-range imaging, human
visual perception and color, single view 3-D model reconstruction,
morphing, data-rich photography, super-resolution, and image-
based rendering. Students taking graduate version complete
additional assignments.
F. P. Durand

6.816 Multicore Programming
Subject meets with 6.836
Prereq: 6.006
U (Spring)
4-0-8 units
Introduces principles and core techniques for programming
multicore machines. Topics include locking, scalability, concurrent
data structures, multiprocessor scheduling, load balancing, and
state-of-the-art synchronization techniques, such as transactional
memory. Includes sequence of programming assignments on a
large multicore machine, culminating with the design of a highly
concurrent application. Students taking graduate version complete
additional assignments.
N. Shavit

6.817 (J) Principles of Autonomy and Decision Making (New)
Same subject as 16.410 (J)
Subject meets with 6.877 (J), 16.413 (J)
Prereq: 6.002 or 6.01
U (Fall)
4-0-8 units
See description under subject 16.410 (J).
B. C. Williams

6.819 Advances in Computer Vision
Subject meets with 6.869
Prereq: Calculus II (GIR) and 6.009
U (Fall)
3-0-9 units
Advanced topics in computer vision with a focus on the use of
machine learning techniques and applications in graphics and
human-computer interface. Covers image representations, texture
models, structure-from-motion algorithms, Bayesian techniques,
object and scene recognition, tracking, shape modeling, and image
databases. Applications may include face recognition, multimodal
interaction, interactive systems, cinematic special effects, and
photorealistic rendering. Covers topics complementary to 6.801.
Students taking graduate version complete additional assignments.
W. T. Freeman, A. Torralba

6.820 Foundations of Program Analysis
Prereq: 6.035
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Presents major principles and techniques for program analysis.
Includes formal semantics, type systems and type-based program
analysis, abstract interpretation and model checking and synthesis.
Emphasis on Haskell and Ocaml, but no prior experience in these
languages is assumed. Student assignments include implementing
techniques covered in class, including building simple verifiers.
A. Solar-Lezama

6.822 Formal Reasoning About Programs
Prereq: 6.031 and 6.042 (J)
G (Spring)
3-0-9 units
Surveys techniques for rigorous mathematical reasoning about
correctness of software, emphasizing commonalities across
approaches. Introduces interactive computer theorem proving
with the Coq proof assistant, which is used for all assignments,
providing immediate feedback on soundness of logical arguments.
Covers common program-proof techniques, including operational
semantics, model checking, abstract interpretation, type systems,
program logics, and their applications to functional, imperative, and
concurrent programs. Develops a common conceptual framework
based on invariants, abstraction, and modularity applied to state
and labeled transition systems.
A. Chlipala
6.823 Computer System Architecture
Prereq: 6.004
G (Spring)
4-0-8 units

Introduction to the principles underlying modern computer architecture. Emphasizes the relationship among technology, hardware organization, and programming systems in the evolution of computer architecture. Topics include pipelined, out-of-order, and speculative execution; caches, virtual memory and exception handling, superscalar, very long instruction word (VLIW), vector, and multithreaded processors; on-chip networks, memory models, synchronization, and cache coherence protocols for multiprocessors.

J. S. Emer, D. Sanchez

6.824 Distributed Computer Systems Engineering
Prereq: 6.033 and permission of instructor
G (Spring)
3-0-9 units


R. T. Morris, M. F. Kaashoek

6.825 Hardware Architecture for Deep Learning (New)
Subject meets with 6.812
Prereq: 6.003 or 6.004
G (Spring)
3-3-6 units

Introduction to the design and implementation of hardware architectures for efficient processing of deep learning algorithms in AI systems. Topics include basics of deep learning, programmable platforms, accelerators, co-optimization of algorithms and hardware, training, support for complex networks, and applications of advanced technologies. Includes labs involving modeling and analysis of hardware architectures, building systems using popular deep learning tools and platforms (CPU, GPU, FPGA), and an open-ended design project. Students taking graduate version complete additional assignments.

V. Sze, J. Emer

6.826 Principles of Computer Systems
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Introduction to the basic principles of computer systems with emphasis on the use of rigorous techniques as an aid to understanding and building modern computing systems. Particular attention paid to concurrent and distributed systems. Topics include: specification and verification, concurrent algorithms, synchronization, naming, Networking, replication techniques (including distributed cache management), and principles and algorithms for achieving reliability.

M. F. Kaashoek, B. Lampson, N. B. Zeldovich

6.828 Operating System Engineering
Prereq: 6.031 and 6.033
G (Fall)
3-6-3 units

Fundamental design and implementation issues in the engineering of operating systems. Lectures based on the study of a symmetric multiprocessor version of UNIX version 6 and research papers. Topics include virtual memory; file system; threads; context switches; kernels; interrupts; system calls; interprocess communication; coordination, and interaction between software and hardware. Individual laboratory assignments accumulate in the construction of a minimal operating system (for an x86-based personal computer) that implements the basic operating system abstractions and a shell. Knowledge of programming in the C language is a prerequisite.

M. F. Kaashoek

6.829 Computer Networks
Prereq: 6.033 or permission of instructor
G (Fall)
4-0-8 units

Topics on the engineering and analysis of network protocols and architecture, including architectural principles for designing heterogeneous networks; transport protocols; Internet routing; router design; congestion control and network resource management; wireless networks; network security; naming; overlay and peer-to-peer networks. Readings from original research papers. Semester-long project and paper.

H. Balakrishnan, D. Katabi
6.830 Database Systems
Subject meets with 6.814
Prereq: (6.033 and (6.006 or 6.046[J])) or permission of instructor
G (Spring)
3.0-9 units

Topics related to the engineering and design of database systems, including data models; database and schema design; schema normalization and integrity constraints; query processing; query optimization and cost estimation; transactions; recovery; concurrency control; isolation and consistency; distributed, parallel and heterogeneous databases; adaptive databases; trigger systems; pub-sub systems; semi structured data and XML querying. Lecture and readings from original research papers. Semester-long project and paper. Students taking graduate version complete different assignments. Enrollment may be limited.
S. R. Madden

6.832 Underactuated Robotics
Prereq: 2.12, 2.165[J], 6.141[J], or permission of instructor
G (Spring)
3.0-9 units

Covers nonlinear dynamics and control of underactuated mechanical systems, with an emphasis on computational methods. Topics include the nonlinear dynamics of robotic manipulators, applied optimal and robust control and motion planning. Discussions include examples from biology and applications to legged locomotion, compliant manipulation, underwater robots, and flying machines.
R. Tedrake

6.833 The Human Intelligence Enterprise
Subject meets with 6.803
Prereq: 6.034
G (Spring)
3.0-9 units

Analyzes seminal work directed at the development of a computational understanding of human intelligence, such as work on learning, language, vision, event representation, commonsense reasoning, self reflection, story understanding, and analogy. Reviews visionary ideas of Turing, Minsky, and other influential thinkers. Examines the implications of work on brain scanning, developmental psychology, and cognitive psychology. Emphasis on discussion and analysis of original papers. Requires the completion of additional exercises and a substantial term project. Enrollment limited.
P. H. Winston

6.834[J] Cognitive Robotics
Same subject as 16.412[J]
Prereq: (6.034 or 16.413[J]) and (6.042[J]), 16.09, or 6.041
G (Spring)
3.0-9 units

See description under subject 16.412[J]. Enrollment may be limited.
B. C. Williams

6.835 Intelligent Multimodal User Interfaces
Prereq: 6.031, 6.034, or permission of instructor
G (Spring)
3.0-9 units

Implementation and evaluation of intelligent multi-modal user interfaces, taught from a combination of hands-on exercises and papers from the original literature. Topics include basic technologies for handling speech, vision, pen-based interaction, and other modalities, as well as various techniques for combining modalities. Substantial readings and a term project, where students build a program that illustrates one or more of the themes of the course.
R. Davis

6.836 Multicore Programming
Subject meets with 6.816
Prereq: 6.006
G (Spring)
4.0-8 units

Introduces principles and core techniques for programming multicore machines. Topics include locking, scalability, concurrent data structures, multiprocessor scheduling, load balancing, and state-of-the-art synchronization techniques, such as transactional memory. Includes sequence of programming assignments on a large multicore machine, culminating with the design of a highly concurrent application. Students taking graduate version complete additional assignments.
N. Shavit

6.837 Computer Graphics
Prereq: (Calculus II (GiR) and 6.031) or permission of instructor
U (Fall)
3.0-9 units

Introduction to computer graphics algorithms, software and hardware. Topics include ray tracing, the graphics pipeline, transformations, texture mapping, shadows, sampling, global illumination, splines, animation and color.
F. P. Durand, W. Matusik, J. Solomon
6.838 Shape Analysis
Prereq: Calculus II (GIR), 18.06, and (6.837 or 6.869)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Introduces mathematical, algorithmic, and statistical tools needed to analyze geometric data and to apply geometric techniques to data analysis, with applications to fields such as computer graphics, machine learning, computer vision, medical imaging, and architecture. Potential topics include applied introduction to differential geometry, discrete notions of curvature, metric embedding, geometric PDE via the finite element method (FEM) and discrete exterior calculus (DEC),; computational spectral geometry and relationship to graph-based learning, correspondence and mapping, level set method, descriptor, shape collections, optimal transport, and vector field design.
J. Solomon

6.839 Advanced Computer Graphics
Prereq: 6.031, 6.837, 18.06, or permission of instructor
G (Fall)
3-0-9 units

A graduate level course investigates computational problems in rendering, animation, and geometric modeling. The course draws on advanced techniques from computational geometry, applied mathematics, statistics, scientific computing and other. Substantial programming experience required.
W. Matusik

Same subject as 18.4041[J]
Subject meets with 18.404
Prereq: 6.042[J] or 18.200
G (Fall)
4-0-8 units

See description under subject 18.4041[J].
M. Sipser

6.841[J] Advanced Complexity Theory
Same subject as 18.405[J]
Prereq: 18.404
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

See description under subject 18.405[J].
R. Williams

6.842 Randomness and Computation
Prereq: 6.046[J] and 18.4041[J]
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

The power and sources of randomness in computation. Connections and applications to computational complexity, computational learning theory, cryptography and combinatorics. Topics include: probabilistic proofs, uniform generation and approximate counting, Fourier analysis of Boolean functions, computational learning theory, expander graphs, pseudorandom generators, derandomization.
R. Rubinfeld

6.844 Artificial Intelligence (New)
Subject meets with 6.034
Prereq: 6.0001
G (Fall)
4-3-5 units

Introduces representations, methods, and architectures used to build applications and to account for human intelligence from a computational point of view. Covers applications of rule chaining, constraint propagation, constrained search, inheritance, statistical inference, and other problem-solving paradigms. Also addresses applications of identification trees, neural nets, genetic algorithms, support-vector machines, boosting, and other learning paradigms. Considers what separates human intelligence from that of other animals. Students taking graduate version complete additional assignments.
P. H. Winston

6.845 Quantum Complexity Theory
Prereq: 6.045[J], 18.4041[J], and 18.435[J]
G (Fall)
Not offered regularly; consult department
3-0-9 units

Introduction to quantum computational complexity theory, the study of the fundamental capabilities and limitations of quantum computers. Topics include complexity classes, lower bounds, communication complexity, proofs and advice, and interactive proof systems in the quantum world; classical simulation of quantum circuits. The objective is to bring students to the research frontier.
Staff
6.846 Parallel Computing
Prereq: 6.004 or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Introduction to parallel and multicore computer architecture and programming. Topics include the design and implementation of multicore processors; networking, video, continuum, particle and graph applications for multicores; communication and synchronization algorithms and mechanisms; locality in parallel computations; computational models, including shared memory, streams, message passing, and data parallel; multicore mechanisms for synchronization, cache coherence, and multithreading. Performance evaluation of multicores; compilation and runtime systems for parallel computing. Substantial project required.
A. Agarwal

6.849 Geometric Folding Algorithms: Linkages, Origami, Polyhedra
Prereq: 6.046[J] or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Covers discrete geometry and algorithms underlying the reconfiguration of foldable structures, with applications to robotics, manufacturing, and biology. Linkages made from onedimensional rods connected by hinges: constructing polynomial curves, characterizing rigidity, characterizing unfoldable versus locked, protein folding. Folding two-dimensional paper (origami): characterizing flat foldability, algorithmic origami design, one-cut magic trick. Unfolding and folding three-dimensional polyhedra: edge unfolding, vertex unfolding, gluings, Alexandrov's Theorem, hinged dissections.
E. D. Demaine

6.850 Geometric Computing
Prereq: 6.046[J]
G (Spring)
3-0-9 units

P. Indyk

6.851 Advanced Data Structures
Prereq: 6.046[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

More advanced and powerful data structures for answering several queries on the same data. Such structures are crucial in particular for designing efficient algorithms. Dictionaries; hashing; search trees. Self-adjusting data structures; linear search; splay trees; dynamic optimality. Integer data structures; word RAM. Predecessor problem; van Emde Boas priority queues; y-fast trees; fusion trees. Lower bounds; cell-probe model; round elimination. Dynamic graphs; link-cut trees; dynamic connectivity. Strings; text indexing; suffix arrays; suffix trees. Static data structures; compact arrays; rank and select. Succinct data structures; tree encodings; implicit data structures. External-memory and cache-oblivious data structures; B-trees; buffer trees; tree layout; ordered-file maintenance. Temporal data structures; persistence; retroactivity.
E. D. Demaine

6.852[J] Distributed Algorithms
Same subject as 18.437[J]
Prereq: 6.046[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Design and analysis of concurrent algorithms, emphasizing those suitable for use in distributed networks. Process synchronization, allocation of computational resources, distributed consensus, distributed graph algorithms, election of a leader in a network, distributed termination, deadlock detection, concurrency control, communication, and clock synchronization. Special consideration given to issues of efficiency and fault tolerance. Formal models and proof methods for distributed computation.
N. A. Lynch
6.853 Topics in Algorithmic Game Theory  
Prereq: 6.006 or 6.046[J]  
G (Spring)  
3-0-9 units  
Prresents research topics at the interface of computer science and game theory, with an emphasis on algorithms and computational complexity. Explores the types of game-theoretic tools that are applicable to computer systems, the loss in system performance due to the conflicts of interest of users and administrators, and the design of systems whose performance is robust with respect to conflicts of interest inside the system. Algorithmic focus is on algorithms for equilibria, the complexity of equilibria and fixed points, algorithmic tools in mechanism design, learning in games, and the price of anarchy.  
K. Daskalakis

Same subject as 18.415[J]  
Prereq: 6.046[J] and (6.042[J], 18.600, or 6.041)  
G (Fall)  
5-0-7 units  
First-year graduate subject in algorithms. Emphasizes fundamental algorithms and advanced methods of algorithmic design, analysis, and implementation. Surveys a variety of computational models and the algorithms for them. Data structures, network flows, linear programming, computational geometry, approximation algorithms, online algorithms, parallel algorithms, external memory, streaming algorithms.  
A. Moitra, D. R. Karger

6.856[J] Randomized Algorithms  
Same subject as 18.416[J]  
Prereq: (6.041 or 6.042[J]) and (6.046[J] or 6.854[J])  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
5-0-7 units  
Studies how randomization can be used to make algorithms simpler and more efficient via random sampling, random selection of witnesses, symmetry breaking, and Markov chains. Models of randomized computation. Data structures: hash tables, and skip lists. Graph algorithms: minimum spanning trees, shortest paths, and minimum cuts. Geometric algorithms: convex hulls, linear programming in fixed or arbitrary dimension. Approximate counting; parallel algorithms; online algorithms; derandomization techniques; and tools for probabilistic analysis of algorithms.  
D. R. Karger

6.857 Network and Computer Security  
Prereq: 6.033 and 6.042[J]  
G (Spring)  
4-0-8 units  
Emphasis on applied cryptography and may include: basic notion of systems security, cryptographic hash functions, symmetric cryptography (one-time pad, stream ciphers, block ciphers), cryptanalysis, secret-sharing, authentication codes, public-key cryptography (encryption, digital signatures), public-key attacks, elliptic curve cryptography; pairing functions, fully homomorphic encryption, differential privacy, bitcoin, viruses, electronic voting. Assignments include a group final project. Topics may vary year to year.  
R. L. Rivest, Y. Kalai

6.858 Computer Systems Security  
Prereq: 6.031 and 6.033  
G (Spring)  
3-6-3 units  
Design and implementation of secure computer systems. Lectures cover attacks that compromise security as well as techniques for achieving security, based on recent research papers. Topics include operating system security, privilege separation, capabilities, language-based security, cryptographic network protocols, trusted hardware, and security in web applications and mobile phones. Labs involve implementing and compromising a web application that sandboxes arbitrary code, and a group final project.  
N. B. Zeldovich

6.860[J] Statistical Learning Theory and Applications  
Same subject as 9.520[J]  
Prereq: 6.041, 6.867, 18.06, or permission of instructor  
G (Fall)  
3-0-9 units  
See description under subject 9.520[J].  
T. Poggio, L. Rosasco

6.861[J] Aspects of a Computational Theory of Intelligence  
Same subject as 9.523[J]  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  
See description under subject 9.523[J].  
T. Poggio, S. Ullman
6.862 Applied Machine Learning
Prereq: Permission of instructor
G (Fall, Spring)
4-0-8 units
Credit cannot also be received for 6.036
Introduces principles, algorithms, and applications of machine learning from the point of view of modeling and prediction; formulation of learning problems; representation, over-fitting, generalization; classification, regression, reinforcement learning; and methods such as linear classifiers, feed-forward, convolutional, and recurrent networks. Students taking graduate version complete different assignments. Meets with 6.036 when offered concurrently. Recommended prerequisites: 18.06 and 6.006. Enrollment limited; no listeners.
R. Barzilay, T. Jaakkola, L. Kaelbling

6.863[J] Natural Language and the Computer Representation of Knowledge
Same subject as 9.611[J]
Prereq: 6.034
G (Spring)
3-3-6 units
Explores the relationship between the computer representation and acquisition of knowledge and the structure of human language, its acquisition, and hypotheses about its differentiating uniqueness. Emphasizes development of analytical skills necessary to judge the computational implications of grammatical formalisms and their role in connecting human intelligence to computational intelligence. Uses concrete examples to illustrate particular computational issues in this area.
R. C. Berwick

6.864 Advanced Natural Language Processing
Subject meets with 6.806
Prereq: 6.046[J] or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Introduces the study of human language from a computational perspective, including syntactic, semantic and discourse processing models. Emphasizes machine learning methods and algorithms. Uses these methods and models in applications such as syntactic parsing, information extraction, statistical machine translation, dialogue systems, and summarization. Students taking graduate version complete additional assignments.
R. A. Barzilay

6.865 Advanced Computational Photography
Subject meets with 6.815
Prereq: Calculus II (GIR) and 6.031
G (Fall)
3-0-9 units
Presents fundamentals and applications of hardware and software techniques used in digital and computational photography, with an emphasis on software methods. Provides sufficient background to implement solutions to photographic challenges and opportunities. Topics include cameras and image formation, image processing and image representations, high-dynamic-range imaging, human visual perception and color, single view 3-D model reconstruction, morphing, data-rich photography, super-resolution, and image-based rendering. Students taking graduate version complete additional assignments.
F. P. Durand

6.866 Machine Vision
Subject meets with 6.801
Prereq: 6.003 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Intensive introduction to the process of generating a symbolic description of the environment from an image. Students expected to attend the 6.801 lectures as well as occasional seminar meetings on special topics. Material presented in 6.801 is supplemented by reading from the literature. Students required to implement a project on a topic of their choice from the material covered.
B. K. P. Horn

6.867 Machine Learning
Prereq: 18.06 and (6.041B or 18.600)
G (Fall)
3-0-9 units
Principles, techniques, and algorithms in machine learning from the point of view of statistical inference; representation, generalization, and model selection; and methods such as linear/additive models, active learning, boosting, support vector machines, non-parametric Bayesian methods, hidden Markov models, Bayesian networks, and convolutional and recurrent neural networks. Recommended prerequisite: 6.036 or other previous experience in machine learning.
T. Jaakkola, L. P. Kaelbling
6.869 Advances in Computer Vision
Subject meets with 6.819
Prereq: 18.06 and (6.041B or 6.042J)
G (Fall)
3-0-9 units
Advanced topics in computer vision with a focus on the use of machine learning techniques and applications in graphics and human-computer interface. Covers image representations, texture models, structure-from-motion algorithms, Bayesian techniques, object and scene recognition, tracking, shape modeling, and image databases. Applications may include face recognition, multimodal interaction, interactive systems, cinematic special effects, and photorealistic rendering. Covers topics complementary to 6.866. Students taking graduate version complete additional assignments.

W. T. Freeman, A. Torralba

6.870 Advanced Topics in Computer Vision
Prereq: 6.801, 6.869, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.

Seminar exploring advanced research topics in the field of computer vision; focus varies with lecturer. Typically structured around discussion of assigned research papers and presentations by students. Example research areas explored in this seminar include learning in vision, computational imaging techniques, multimodal human-computer interaction, biomedical imaging, representation and estimation methods used in modern computer vision.

W. T. Freeman, B. K. P. Horn, A. Torralba

Same subject as HST.956J]
Prereq: 6.034, 6.036, 6.438, 6.806, 6.867, or 9.520J]
G (Spring)
4-0-8 units

See description under subject HST.956J]. Limited to 55.

D. Sontag, P. Szolovits

6.872J] Biomedical Computing
Same subject as HST.950J]
Prereq: 6.034, 6.036, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Analyzes computational needs of clinical medicine, reviews systems and approaches that have been used to support those needs, and the relationship between clinical data and gene and protein measurements to support precision medicine. Topics include the nature of clinical data, architecture and design of healthcare information systems, privacy and security issues, medical expert systems, predictive models and machine learning from big data in healthcare, and an introduction to bioinformatics. Case studies and guest lectures describe contemporary institutions, systems, and research projects. Term project using large clinical and genomic data sets integrates classroom topics.

G. Alterovitz, P. Szolovits

6.874J] Computational Systems Biology: Deep Learning in the Life Sciences
Same subject as HST.506J]
Subject meets with 6.802J], 20.390J], 20.490
Prereq: Biology (GIR) and (18.600 or 6.041)
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Presents innovative approaches to computational problems in the life sciences, focusing on deep learning-based approaches with comparisons to conventional methods. Topics include protein-DNA interaction, chromatin accessibility, regulatory variant interpretation, medical image understanding, medical record understanding, therapeutic design, and experiment design (the choice and interpretation of interventions). Focuses on machine learning model selection, robustness, and interpretation. Teams complete a multidisciplinary final research project using TensorFlow or other framework. Provides a comprehensive introduction to each life sciences problem, but relies upon students understanding probabilistic problem formulations. Students taking graduate version complete additional assignments.

D. K. Gifford
6.875[J] Cryptography and Cryptanalysis
Same subject as 18.425[J]
Prereq: 6.046[J]
G (Fall)
3-0-9 units

A rigorous introduction to modern cryptography. Emphasis on the fundamental cryptographic primitives of public-key encryption, digital signatures, pseudo-random number generation, and basic protocols and their computational complexity requirements.
S. Goldwasser, S. Micali, V. Vaikuntanathan

6.876 Advanced Topics in Cryptography
Prereq: 6.875[J]
G (Fall)
3-0-9 units
Can be repeated for credit.

In-depth exploration of recent results in cryptography.
S. Goldwasser, S. Micali, V. Vaikuntanathan

Same subject as 16.413[J]
Subject meets with 6.817[J], 16.410[J]
Prereq: 6.0002, 6.01, or permission of instructor
G (Fall)
3-0-9 units

See description under subject 16.413[J].
B. C. Williams

Same subject as HST.507[J]
Subject meets with 6.047
Prereq: (Biology (GIR), 6.006, and 6.041) or permission of instructor
G (Fall)
4-0-8 units

See description for 6.047. Additionally examines recent publications in the areas covered, with research-style assignments. A more substantial final project is expected, which can lead to a thesis and publication.
M. Kellis

6.881 Advanced Topics in Artificial Intelligence
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Can be repeated for credit.

Advanced study of topics in artificial intelligence. Specific focus varies from year to year. Consult department for details.
Consult Department

6.882 Advanced Topics in Artificial Intelligence
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.

Advanced study of topics in artificial intelligence. Specific focus varies from year to year. Consult department for details.
Consult Department

6.883 Advanced Topics in Artificial Intelligence
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.

Advanced study of topics in artificial intelligence. Specific focus varies from year to year. Consult department for details.
Consult Department

6.884 Advanced Topics in Artificial Intelligence
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Can be repeated for credit.

Advanced study of topics in artificial intelligence. Specific focus varies from year to year. Consult department for details.
Consult Department

6.885-6.888 Advanced Topics in Computer Systems
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.

Advanced study of topics in computer systems. Specific focus varies from year to year. Consult department for details.
Consult Department

6.889-6.893 Advanced Topics in Theoretical Computer Science
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Advanced study of topics in theoretical computer science. Specific focus varies from year to year. Consult department for details.
Consult Department
6.894-6.896 Advanced Topics in Graphics and Human-Computer Interfaces
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Advanced study of topics in graphics and human-computer interfaces. Specific focus varies from year to year. Consult department for details.
Consult Department

6.897 Advanced Topics in Computer Graphics
Prereq: 6.837
G (Spring)
Not offered regularly; consult department
3-0-9 units
In-depth study of an active research topic in computer graphics. Topics change each term. Readings from the literature, student presentations, short assignments, and a programming project.
J. Solomon

6.901[J] Engineering Innovation: Moving Ideas to Impact
Same subject as 15.359[J]
Prereq: None
U (Fall)
3-3-6 units
See description under subject 15.359[J].
V. Bulovic, F. Murray

6.902 Engineering Innovation and Design
Engineering School-Wide Elective Subject.
Offered under: 2.723, 6.902, 16.662
Prereq: None
U (Fall, Spring)
2-1-3 units
Project-based seminar in innovative design thinking develops students’ ability to conceive, implement, and evaluate successful projects in any engineering discipline. Lectures focus on the iterative design process and techniques to enhance creative analysis. Students use this process to design and implement robust voice recognition applications using a simple web-based system. They also give presentations and receive feedback to sharpen their communication skills for high emotional and intellectual impact. Guest lectures illustrate multidisciplinary approaches to design thinking.
B. Kotelly

Prereq: None
U (Spring)
2-0-4 units
Intensive introduction to the law, focusing on intellectual property, patents, copyrights, trademarks, and trade secrets. Covers the process of drafting and filing patent applications, enforcement of patents in the courts, licensing IP rights, the differences between US and international IP laws and enforcement mechanisms, and what rights an inventor does and does not obtain. Highlights current legal issues and trends relating to information technology, biogenetic materials, and business methods. Readings include judicial opinions and statutory material, and class participation includes patent drafting assignments, patentability opinions and courtroom presentation. No listeners.
S. M. Bauer

6.904 Ethics for Engineers
Engineering School-Wide Elective Subject.
Offered under: 1.082, 2.900, 6.904, 10.01, 16.676, 22.014
Subject meets with 6.9041, 20.005
Prereq: None
U (Fall, Spring)
2-0-10 units
Explores the ethical principles by which an engineer ought to be guided. Integrates foundational texts in ethics with case studies illustrating ethical problems arising in the practice of engineering. Readings from classic sources including Aristotle, Kant, Machiavelli, Hobbes, Locke, Rousseau, Franklin and Tocqueville. Case studies include articles and films that address engineering disasters, safety, ethical codes, biotechnology, the internet and AI, and the ultimate scope and aims of engineering. To satisfy the independent inquiry component of this subject, students expand the scope of their term project. Students taking 20.005 focus their term project on a problem in biological engineering in which there are intertwined ethical and technical issues.
B. L. Trout
6.905 Large-scale Symbolic Systems
Subject meets with 6.945
Prereq: 6.034 or permission of instructor
U (Spring)
3-0-9 units

Concepts and techniques for the design and implementation of large software systems that can be adapted to uses not anticipated by the designer. Applications include compilers, computer-algebra systems, deductive systems, and some artificial intelligence applications. Covers means for decoupling goals from strategy, mechanisms for implementing additive data-directed invocation, work with partially-specified entities, and how to manage multiple viewpoints. Topics include combinators, generic operations, pattern matching, pattern-directed invocation, rule systems, backtracking, dependencies, indeterminacy, memoization, constraint propagation, and incremental refinement. Students taking graduate version complete additional assignments.

6.906 StartMIT: Workshop for Entrepreneurs and Innovators
Subject meets with 6.936
Prereq: None
U (IAP)
4-0-2 units

Designed for students who are interested in entrepreneurship and want to explore the potential commercialization of their research project. Introduces practices for building a successful company, such as idea creation and validation, defining a value proposition, building a team, marketing, customer traction, and possible funding models. Students taking graduate version complete different assignments.

A. Chandrakasan, C. Chase, B. Aulet

6.907[J] Entrepreneurship in Engineering
Same subject as 2.913[J]
Subject meets with 6.933
Prereq: None
U (Spring)
4-0-8 units

Immerses students in the experience of an engineer who founds a start-up company. Examines leadership, innovation, and creativity through the lens of an entrepreneur. Suitable for students interested in transforming an idea into a business or other realization for wide-scale societal impact. Covers critical aspects of validating ideas and assessing personal attributes needed to activate and lead a growing organization. Teams explore the basics of new venture creation and experimentation. Emphasizes personal skills and practical experiences. Students taking graduate version will complete additional assignments. No listeners.

C. Chase

6.910 Independent Study in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for independent study at the undergraduate level under regular supervision by a faculty member. Study plans require prior approval.

Consult Department Undergraduate Office

6.911 Engineering Leadership Lab
Engineering School-Wide Elective Subject.
Offered under: 6.911, 16.650
Subject meets with 6.913[J], 16.667[J]
Prereq: None. Coreq: 6.912; or permission of instructor
U (Fall, Spring)
0-2-1 units
Can be repeated for credit.

Exposes students to leadership frameworks, models and cases within an engineering context, in an interactive, practice-based environment. Hones leadership, teamwork and communication skills. Students participate in guided reflections on individual and team successes, and discover opportunities for improvement in controlled settings. Activities include design-implement activities, role-plays, simulations, small group discussions, and performance and peer assessments by and of other students. Content throughout the term is frequently student-driven. First year Gordon Engineering Leadership Program (GEL) students register for 6.911. Second year GEL Program students register for 6.913. Preference to students enrolled in the Bernard M. Gordon-MIT Engineering Leadership Program.

L. McGonagle, J. Feiler
6.912 Engineering Leadership
Engineering School-Wide Elective Subject.
Offered under: 6.912, 16.651
Prereq: None. Coreq: 6.911; or permission of instructor
U (Fall, Spring)
1-0-2 units
Can be repeated for credit.
Exposes students to the models and methods of engineering leadership within the contexts of conceiving, designing, implementing and operating products, processes and systems. Introduces the Capabilities of Effective Engineering Leaders, and models and theories related to the capabilities. Discusses the appropriate times and reasons to use particular models to deliver engineering success. Includes occasional guest speakers or panel discussions. May be repeated for credit once with permission of instructor. Preference to first-year students in the Gordon Engineering Leadership Program.
J. Magarian, J. Schindall, L. McGonagle

6.913 Engineering Leadership Lab
Engineering School-Wide Elective Subject.
Offered under: 6.913, 16.667
Subject meets with 6.911[J], 16.650[J]
Prereq: 6.902, 6.911, 6.912, or permission of instructor
U (Fall, Spring)
0-2-4 units
Can be repeated for credit.
Exposes students to leadership frameworks, models and cases within an engineering context, in an interactive, practice-based environment. Hones leadership, teamwork and communication skills. Students lead and participate in guided reflections on individual and team successes, and discover opportunities for improvement in controlled settings. Activities include leading and supporting design-implement activities, role-plays, simulations, small group discussions, and performance and peer assessments by and of other students. Content throughout the term is frequently student-driven. First year Gordon Engineering Leadership Program (GEL) students register for 6.911. Second year GEL Program students register for 6.913. Preference to students enrolled in the second year of the Gordon-MIT Engineering Leadership Program.
L. McGonagle, J. Feiler

6.914 Project Engineering
Engineering School-Wide Elective Subject.
Offered under: 6.914, 16.669
Prereq: (6.902 and (6.911 or 6.912)) or permission of instructor
U (IAP)
1-2-1 units
Students attend a four-day off-site workshop where an introduction to basic principles, methods, and tools for project management in a realistic context are covered. In teams, students create a plan for a project of their choice in one of several areas, including aircraft modification, factory automation, enterprise software, flood prevention engineering, solar farm engineering, among others. Develops skills applicable to the management of complex development projects. Topics include cost-benefit analysis, resource and cost estimation, and project control and delivery, which are practiced during an experimental, team-based activity. Case studies highlight projects in both hardware/construction and software. Preference to students in the Bernard M. Gordon-MIT Engineering Leadership Program.
O. de Weck, J. Feiler, L. McGonagle, R. Rahaman

6.914[J] Leading Innovation in Teams
Same subject as 16.671[J]
Prereq: None
U (Spring)
3-0-6 units
Empowers future innovators in engineering and technology with a foundation of leadership and teamwork skills. Grounded in research but practical in focus, equips students with leadership competencies such as building self-awareness, motivating and developing others, influencing without authority, managing conflict, and communicating effectively. Teamwork skills include how to convene, launch, and develop various types of teams, including project teams. Reviews recent advances in implementing innovations and building personal capacity for lifelong learning as a leading innovator. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.
D. Nino, J. Schindall
6.920 Practical Internship Experience
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 units
Can be repeated for credit.

For Course 6 students participating in curriculum-related off-campus internship experiences in electrical engineering or computer science. Before enrolling, students must have an employment offer from a company or organization and must find an EECS supervisor. Upon completion of the internship the student must submit a letter from the employer evaluating the work accomplished, a substantive final report from the student, approved by the MIT supervisor. Subject to departmental approval. Consult Department Undergraduate Office for details on procedures and restrictions.

6.921 6-A Internship
Prereq: None
U (Fall, Spring, Summer)
0-12-0 units

Provides academic credit for the first assignment of 6-A undergraduate students at companies affiliated with the department’s 6-A internship program. Limited to students participating in the 6-A internship program.
T. Palacios

6.922 Advanced 6-A Internship
Prereq: 6.921
U (Fall, Spring, Summer)
0-12-0 units

Provides academic credit for the second assignment of 6-A undergraduate students at companies affiliated with the department’s 6-A internship program. Limited to students participating in the 6-A internship program.
T. Palacios

6.928[J] Leading Creative Teams
Same subject as 15.674[J], 16.990[J]
Prereq: None
G (Fall, Spring)
3-0-6 units

Prepares students to lead teams charged with developing creative solutions in engineering and technical environments. Grounded in research but practical in focus, equips students with leadership competencies such as building self-awareness, motivating and developing others, creative problem solving, influencing without authority, managing conflict, and communicating effectively. Teamwork skills include how to convene, launch, and develop various types of teams, including project teams. Learning methods emphasize personalized and professional skill development.
D. Nino, J. Schindall

6.929[J] Energy Technology and Policy: From Principles to Practice
Same subject as 5.00[J], 10.579[J], 22.813[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-6 units

Develops analytical skills to lead a successful technology implementation with an integrated approach that combines technical, economical and social perspectives. Considers corporate and government viewpoints as well as international aspects, such as nuclear weapons proliferation and global climate issues. Discusses technologies such as oil and gas, nuclear, solar, and energy efficiency. Limited to 100.
J. Deutch

6.930 Management in Engineering
Engineering School-Wide Elective Subject.
Offered under: 2.96, 6.930, 10.806, 16.653
Prereq: None
U (Fall)
3-1-8 units

See description under subject 2.96. Restricted to juniors and seniors.
H. S. Marcus, J.-H. Chun
6.933 Entrepreneurship in Engineering
Subject meets with 2.913[J], 6.907[J]
Prereq: None
G (Spring)
4-0-8 units
Immerses students in the experience of an engineer who founds a start-up company. Examines leadership, innovation, and creativity through the lens of an entrepreneur. Suitable for students interested in transforming an idea into a business or other realization for wide-scale societal impact. Covers critical aspects of validating ideas and assessing personal attributes needed to activate and lead a growing organization. Teams explore the basics of new venture creation and experimentation. Emphasizes personal skills and practical experiences. Students taking graduate version will complete additional assignments. No listeners.
C. Chase

6.934[J] Engineering, Economics and Regulation for Energy Access in Developing Countries
Same subject as 15.017[J]
Prereq: None
G (Spring)
3-0-9 units
See description under subject 15.017[J].
I. Perez-Arriaga, R. Stoner

Same subject as 15.481[J]
Prereq: 15.401, 15.414, or 15.415
G (Spring)
4-0-5 units
See description under subject 15.481[J].
A. Lo

6.936 StartMIT: Workshop for Entrepreneurs and Innovators
Subject meets with 6.906
Prereq: None
G (IAP)
4-0-2 units
Designed for students who are interested in entrepreneurship and want to explore the potential commercialization of their research project. Introduces practices for building a successful company, such as idea creation and validation, defining a value proposition, building a team, marketing, customer traction, and possible funding models. Students taking graduate version complete different assignments.
A. Chandrakasan

6.941 Statistics for Research Projects: Statistical Modeling and Experiment Design
Prereq: None
G (IAP)
Not offered regularly; consult department
2-2-2 units
Practical introduction to data analysis, statistical modeling, and experimental design, intended to provide essential skills for conducting research. Covers basic techniques such as hypothesis-testing and regression models for both traditional experiments and newer paradigms such as evaluating simulations. Assignments reinforce techniques through analyzing sample datasets and reading case studies. Students with research projects will be encouraged to share their experiences and project-specific questions.
Staff

6.943[J] How to Make (Almost) Anything
Same subject as 4.140[J], MAS.863[J]
Prereq: Permission of instructor
G (Fall)
3-9-6 units
See description under subject MAS.863[J].
N. Gershenfeld, J. DiFrancesco, J. Lavallee, G. Darcey

6.945 Large-scale Symbolic Systems
Subject meets with 6.905
Prereq: 6.034 or permission of instructor
G (Spring)
3-0-9 units
Concepts and techniques for the design and implementation of large software systems that can be adapted to uses not anticipated by the designer. Applications include compilers, computer-algebra systems, deductive systems, and some artificial intelligence applications. Covers means for decoupling goals from strategy, mechanisms for implementing additive data-directed invocation, work with partially-specified entities, and how to manage multiple viewpoints. Topics include combinators, generic operations, pattern matching, pattern-directed invocation, rule systems, backtracking, dependencies, indeterminacy, memoization, constraint propagation, and incremental refinement. Students taking graduate version complete additional assignments.
G. J. Sussman
Same subject as 8.351[J], 12.620[J]
Prereq: Physics I (GIR), 18.03, and permission of instructor
G (Fall)
3-3-6 units
See description under subject 12.620[J].
J. Wisdom, G. J. Sussman

6.951 Graduate 6-A Internship
Prereq: 6.921 or 6.922
G (Fall, Spring, Summer)
0-12-0 units
Provides academic credit for a graduate assignment of graduate 6-A students at companies affiliated with the department’s 6-A internship program. Limited to graduate students participating in the 6-A internship program.
T. Palacios

6.952 Graduate 6-A Internship
Prereq: 6.951
G (Fall, Spring, Summer)
0-12-0 units
Provides academic credit for graduate students who require an additional term at the company to complete the graduate assignment of the department’s 6-A internship program. This academic credit is for registration purposes only and cannot be used toward fulfilling the requirements of any degree program. Limited to graduate students participating in the 6-A internship program.
T. Palacios

6.960 Introductory Research in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Enrollment restricted to first-year graduate students in Electrical Engineering and Computer Science who are doing introductory research leading to an SM, EE, ECS, PhD, or ScD thesis. Opportunity to become involved in graduate research, under guidance of a staff member, on a problem of mutual interest to student and supervisor. Individual programs subject to approval of professor in charge.
L. A. Kolodziejski

6.961 Introduction to Research in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-0-0 units
Seminar on topics related to research leading to an SM, EE, ECS, PhD, or ScD thesis. Limited to first-year regular graduate students in EECS with a fellowship or teaching assistantship.
L. A. Kolodziejki

6.962 Independent Study in Electrical Engineering and Computer Science
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Opportunity for independent study under regular supervision by a faculty member. Projects require prior approval.
L. A. Kolodziejki

6.980 Teaching Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
For qualified students interested in gaining teaching experience. Classroom, tutorial, or laboratory teaching under the supervision of a faculty member. Enrollment limited by availability of suitable teaching assignments.
H. S. Lee, R. C. Miller

6.981 Teaching Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
For Teaching Assistants in Electrical Engineering and Computer Science, in cases where teaching assignment is approved for academic credit by the department.
H. S. Lee, R. C. Miller
6.991 Research in Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For EECS MEng students who are Research Assistants in Electrical Engineering and Computer Science, in cases where the assigned research is approved for academic credit by the department. Hours arranged with research supervisor.
Consult Department Undergraduate Office

6.994 Professional Perspective I
Prereq: None
G (Fall, IAP, Spring, Summer)
0-0-1 units
Can be repeated for credit.

Required for Course 6 students in the doctoral program to gain professional perspective in research experiences, academic experiences, and internships in electrical engineering and computer science. Professional perspective options include: internships (with industry, government or academia), industrial colloquia or seminars, research collaboration with industry or government, and professional development for entry into academia or entrepreneurial engagement. For an internship experience, an offer of employment from a company or organization is required prior to enrollment; employers must document work accomplished. A written report is required upon completion of a minimum of 4 weeks of off-campus experiences. Proposals subject to departmental approval.
Consult Department Graduate Office

6.995 Professional Perspective II
Prereq: 6.994
G (Fall, IAP, Spring, Summer)
0-0-1 units
Can be repeated for credit.

Required for Course 6 students in the doctoral program to gain professional perspective in research experiences, academic experiences, and internships in electrical engineering and computer science. Professional perspective options include: internships (with industry, government or academia), industrial colloquia or seminars, research collaboration with industry or government, and professional development for entry into academia or entrepreneurial engagement. For an internship experience, an offer of employment from a company or organization is required prior to enrollment; employers must document work accomplished. A written report is required upon completion of a minimum of 4 weeks of off-campus experiences. Proposals subject to departmental approval.
Consult Department Graduate Office

6.997 Professional Perspective Internship
Prereq: None
G (Fall, IAP, Spring, Summer)
0-1-0 units

Required for Course 6 students in the MEng program to gain professional perspective in research experiences or internships in electrical engineering or computer science. Before enrolling, students must have an offer of employment from a company or organization. Employers must document the work accomplished. Written report required upon completion of a minimum of four weeks of off-campus experience. Proposals subject to departmental approval. For international students who begin the MEng program in the same summer as the proposed experience, internship may not begin earlier than the first day of the Summer Session.
Consult Department Undergraduate Office

6.998 Practical Experience in EECS
Prereq: None
G (Fall, IAP, Spring, Summer)
0-1-0 units
Can be repeated for credit.

For Course 6 students in the MEng program who seek practical off-campus research experiences or internships in electrical engineering or computer science. Before enrolling, students must have an offer of employment from a company or organization and secure a supervisor within EECS. Employers must document the work accomplished. Proposals subject to departmental approval. For students who begin the MEng program in the summer only, the experience or internship cannot exceed 20 hours per week and must begin no earlier than the first day of the Summer Session, but may end as late as the last business day before the Fall Term.
Consult Department Undergraduate Office

6.999 Practical Experience in EECS
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]

For Course 6 students in the SM/PhD track who seek practical off-campus research experiences or internships in electrical engineering or computer science. Before enrolling, students must have a firm employment offer from a company or organization and secure a research supervisor within EECS. Employers required to document the work accomplished. Research proposals subject to departmental approval; consult departmental Graduate Office.
L. A. Kolodziejski
6.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE,
16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units
See description under subject 2.EPE.
Staff

6.EPW UPOP Engineering Practice Workshop
Engineering School-Wide Elective Subject.
Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW,
20.EPW, 22.EPW
Prereq: None
U (Fall, IAP)
1-0-0 units
See description under subject 2.EPW. Enrollment limited.
Staff

6.S897-6.S899 Special Subject in Computer Science
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult
department to learn of offerings for a particular term.
Consult Department

6.S911-6.S919 Special Subject in Electrical Engineering and
Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum.
Consult Department

Prereq: None
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for study of graduate-level topics related to electrical
engineering and computer science but not included elsewhere in
the curriculum. Registration under this subject normally used for
situations involving small study groups. Normal registration is for 12
units. Registration subject to approval of professor in charge. Consult
department for details.
Consult Department

6.S974 Special Subject in Electrical Engineering and Computer
Science
Prereq: None
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult
department to learn of offerings for a particular term.
Consult Department

6.S975 Special Subject in Electrical Engineering and Computer
Science
Prereq: None
G (Fall, IAP)
Units arranged
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult
department to learn of offerings for a particular term.
Consult Department

6.S976 Special Subject in Electrical Engineering and Computer
Science
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult
department to learn of offerings for a particular term.
Consult Department
6.5977 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall; second half of term)
Units arranged
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult department to learn of offerings for a particular term.

Consult Department

6.5978 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult department to learn of offerings for a particular term.

Consult Department

6.5979 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Covers subject matter not offered in the regular curriculum. Consult department to learn of offerings for a particular term.

Consult Department

6.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of an SM, EE, ECS, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
L. A. Kolodziejski

6.THM Master of Engineering Program Thesis
Prereq: 6.UAT
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of an MEng thesis; to be arranged by the student and an appropriate MIT faculty member. Restricted to MEng graduate students.

Consult Department Undergraduate Office

6.UR Undergraduate Research in Electrical Engineering and Computer Science
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Individual research project arranged with appropriate faculty member or approved supervisor. Forms and instructions for the final report are available in the EECS Undergraduate Office.
Consult Department Undergraduate Office
ENGINEERING MANAGEMENT (EM)

System Design and Management

EM.411 Foundations of System Design and Management
Prereq: Permission of instructor
G (Fall)
4-2-9 units

Presents the foundations of systems architecture, systems engineering and project management in an integrated format, through a synchronized combination of in-class discussion, industrial guest speakers, team projects, and individual assignments. Topics include stakeholder analysis, project planning and monitoring, requirements definition, concept generation and selection, complexity management, system integration, verification and validation, cost modeling, systems safety, organizational design and effective teamwork, risk management, and leadership styles. Restricted to students in the SDM program.
B. Moser, E. Crawley, B. Cameron

EM.412 Foundations of System Design and Management II
Prereq: EM.411
G (IAP)
2-1-3 units

Deepens the foundations of systems architecture, systems engineering and project management introduced in ESD.411 through a synchronized combination of lectures, recitations, opportunity sets, guest speakers, and team projects. Topics emphasize the transition from early conceptual design to detailed design and system integration. Features a technology showcase and project forum where students, faculty and company sponsors meet to discuss and select projects for ESD.413. Includes team-based exercises and design challenges. Restricted to students in the SDM program.
B. Cameron, E. Crawley, B. Moser

EM.413 Foundations of System Design and Management III
Prereq: EM.412
G (Spring)
4-2-9 units

Presents advanced concepts in systems architecture, systems engineering and project management in an integrated manner through lectures, recitations, opportunity sets, guest lectures, and a semester-long team project. Topics emphasize complexity management, systems integration, verification, validation, and lifecycle management. Specific lifecycle properties addressed include quality, safety, robustness, resilience, flexibility and evolvability of systems over time. Additional topics include monitoring and control, the rework cycle, managing portfolios and programs of projects in a multi-cultural and global context, and managing product families and platforms. Restricted to students in the SDM program.
B. Moser, B. Cameron, E. Crawley

EM.421 SDM Certificate Capstone
Prereq: EM.413
G (Summer)
1-0-8 units

Practical application of systems management problems within a real company. Teams of 1-4 students are matched with a company to work on a project in which they identify systems challenges and devise methods for solving problems utilizing the system architecture, systems engineering and project management methodology covered in the EM core sequence. Mentors and sponsors are identified for each team. Restricted to System Design and Management Certificate students.
J. Rubin

EM.425 Advanced Practices and Research in Engineering Project Management (New)
Prereq: EM.411 or permission of instructor
G (Fall)
2-0-4 units

Seminar on emerging engineering project management methods. Begins with initial review of professional practices and project management fundamentals. Students then build models of engineering projects which integrate technical and organizational aspects, useful to stakeholders during project shaping, ideation, planning, control, adaptation, and lessons learned. Analyzes models to forecast cost, schedule, quality, and risk. Coupled with interactive visualization, experiments validate project architectural decisions and teamwork practices. In the second half, students work as individuals or in small teams on a case-based model and experiment to explore teamwork during engineering.
B. Moser
EM.427J Technology Roadmapping and Development (New)
Same subject as 16.887J
Prereq: Permission of instructor
G (Fall)
3.0-9 units
See description under subject 16.887J.
O. L. de Weck

Integrated Design and Management

EM.441 Integrated Design Lab I
Prereq: None
G (Fall)
3.5-7 units
Presents fundamentals of the integrated design and product development process. Covers methods relevant at each stage of the process; students apply them in a series of design projects. Topics include stakeholder identification, customer engagement and ethnographic methods, concept generation and selection, project planning, manufacturing methods, supply systems, cost modeling, sustainability, and safety. Restricted to Integrated Design and Management (IDM) students.
M. Kressy, T. Hu, S. Eppinger, W. Seering

EM.442 Integrated Design Lab II
Prereq: EM.441 or permission of instructor
G (Spring)
3.5-7 units
Presents advanced topics in integrated design and product development. Students pursue a product development project as a case study for understanding how teams work together to define and test a new product. Provides exposure to the state-of-the-art in product definition, product architectures, market testing, competitive analysis, product planning strategy, business case construction, and life cycle design. Students apply their previously acquired product development knowledge and engage in ongoing reflection in an action-oriented setting. Restricted to Integrated Design and Management (IDM) students.
M. Kressy, T. Hu, S. Eppinger, W. Seering

EM.443 Integrated Design Seminar I (New)
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2.0-1 units
Can be repeated for credit.
Covers a broad range of topics relevant to integrated design, engineering, and business, including leadership, entrepreneurship, social impact, sustainability, and human centered design. Includes discussion of Integrated Design & Management thesis projects. Features lectures by guest speakers and faculty. Restricted to Integrated Design and Management (IDM) students.
M. Kressy, T. Hu

EM.444 Integrated Design Seminar II (New)
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2.0-1 units
Can be repeated for credit.
Covers a broad range of topics relevant to integrated design, engineering, and business, including leadership, entrepreneurship, social impact, sustainability, and human centered design. Includes discussion of Integrated Design & Management thesis projects. Features lectures by guest speakers and faculty. Restricted to Integrated Design and Management (IDM) students.
M. Kressy, T. Hu

Internship and Thesis

EM.451 Internship Experience
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Provides insight into the challenges of an organization that develops products or systems. Before enrolling each student must have a department approved internship opportunity. At the end of the internship, students deliver a report, for evaluation by the sponsoring faculty member, documenting ways that the organization addresses product or system development issues and applies the methods taught in the SDM or IDM core. Intended for students who have completed the SDM or IDM core course sequence.
Staff
EM.S20 Special Subject in Engineering Management
Prereq: Permission of instructor
G (Fall)
Units arranged
Opportunity for study of advanced topics in Engineering Management not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to department approval.
Staff

EM.S21 Special Subject in Engineering Management
Prereq: Permission of instructor
G (Summer)
Units arranged
Opportunity for study of advanced topics in Engineering Management not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to department approval.
Staff

EM.S22 Special Subject in Engineering Management
Prereq: Permission of instructor
G (Fall)
Units arranged
Opportunity for study of advanced topics in Engineering Management not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad-hoc basis subject to department approval.
Staff

EM.THG EM Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research, leading to the writing of an SM thesis to be arranged by the student with an appropriate member of the MIT faculty.
Consult P. Hale, M. Kressy
ES.7012 Introductory Biology
Prereq: None
U (Fall)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.014, 7.015, 7.016, ES.7013
Equivalent to 7.012; see 7.012 for description. Instruction provided through small, interactive classes. Limited to students in ESG.
P. Christie

ES.7013 Introductory Biology
Prereq: None
U (Spring)
5-0-7 units. BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.014, 7.015, 7.016, ES.7012
Equivalent to 7.013; see 7.013 for description. Instruction provided through small, interactive classes. Limited to students in ESG.
P. Christie

ES.5112 Principles of Chemical Science
Prereq: None
U (Fall)
Not offered regularly; consult department
5-0-7 units. CHEMISTRY
Credit cannot also be received for 3.091, 5.111, 5.112, CC.5111, ES.5111
Equivalent to 5.112; see 5.112 for description. Instruction provided through small, interactive classes taught by ESG staff. Limited to students in ESG.
N. Boekelheide

Mathematics

ES.1801 Calculus
Prereq: None
U (Fall)
5-0-7 units. CALC I
Credit cannot also be received for 18.01, 18.01A, ES.181A
Equivalent to 18.01; see 18.01 for description. Instruction provided through small, interactive classes. Limited to students in ESG.
G. Stoy

ES.1802 Calculus
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 units. CALC II
Credit cannot also be received for 18.02, 18.022, 18.02A, CC.1802, ES.182A
Equivalent to 18.02; see 18.02 for description. Instruction provided through small, interactive classes. Limited to students in ESG.
G. Stoy

ES.1803 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
U (Fall, Spring)
5-0-7 units. REST
Credit cannot also be received for 18.03, CC.1803
Equivalent to 18.03; see 18.03 for description. Instruction provided through small, interactive classes. Limited to students in ESG.
J. Orloff

ES.181A Calculus
Prereq: Knowledge of differentiation and elementary integration
U (Fall; first half of term)
5-0-7 units. CALC I
Credit cannot also be received for 18.01, 18.01A, ES.1801
Equivalent to 18.01A; see 18.01A for description. Instruction provided through small, interactive classes. Limited to students in ESG.
J. Orloff
**ES.182A Calculus**  
Prereq: Calculus I (GIR)  
U (Fall, IAP)  
5-0-7 units. CALC II  
Credit cannot also be received for 18.02, 18.022, 18.02A, CC.1802, ES.1802

Equivalent to 18.02A; see 18.02A for description. Instruction provided through small, interactive classes. Limited to students in ESG.  

J. Orloff

**Physics**

**ES.801 Physics I**  
Prereq: None  
U (Fall)  
5-0-7 units. PHYSICS I  
Credit cannot also be received for 8.01, 8.011, 8.012, 8.01L

Equivalent to 8.01; see 8.01 for description. Instruction provided through small, interactive classes. Limited to students in ESG.  

P. Rebusco

**ES.8012 Physics I**  
Prereq: None  
U (Fall)  
5-0-7 units. PHYSICS I

Equivalent to 8.012; see 8.012 for description. Limited to students in ESG.  

A. Barrantes

**ES.802 Physics II**  
Prereq: Calculus I (GIR) and Physics I (GIR)  
U (Spring)  
5-0-7 units. PHYSICS II  
Credit cannot also be received for 8.02, 8.021, 8.022, ES.8022

Equivalent to 8.02; see 8.02 for description. Instruction done through small, interactive classes. Limited to students in ESG.  

A. Barrantes

**ES.8022 Physics II**  
Prereq: Physics I (GIR); Coreq: Calculus II (GIR)  
U (Fall, Spring)  
5-0-7 units. PHYSICS II  
Credit cannot also be received for 8.02, 8.021, 8.022, ES.802

Equivalent to 8.022; see 8.022 for description. Students complete individual and group projects; content for the last week of the term is decided by students. Limited to students in ESG.  

P. Rebusco

**ESG Writing Program**

**ES.333[J] Production of Educational Videos: Skills for Communicating Academic and Professional Content**  
Same subject as CMS.333[J]  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
3-1-8 units. HASS-E; CI-H

Develops communication and media skills through the production of educational videos. Students conceive, plan, script, shoot and edit video content to teach elements of MIT’s curriculum. Each student creates a series of short videos that concisely explains and contextualizes specific problems of importance to disciplines at MIT, especially physics, math, chemistry, biology, or the humanities. The resulting videos present these problems through compelling use of illustrations, demonstrations, animations, and commentary, all from the student’s perspective. Empowers students specifically to communicate their MIT expertise to communities of learners and generally to reach broad audiences with quality, accessible online content. Limited to 12; preference to students in ESG.  

D. Custer

**ES.729[J] Engineering Communication in Context**  
Same subject as 21W.729[J]  
Prereq: None  
U (Fall)  
Not offered regularly; consult department  
3-1-8 units. HASS-E; CI-H

Introduces writing, graphics, meetings, reading, oral presentation, collaboration, and design as tools for product development. Students work in teams to conceive, design, prototype, and evaluate energy-related mechanical engineering products. Instruction focuses on communication tasks that are integral to the design process, including design notebooks, email, informal and formal presentations, meeting etiquette, literature searches, white papers, proposals, and reports. Other assignments address the cultural situation of engineers and engineering in the world at large. Limited to 18; preference to ESG students.  

D. Custer
ESG HASS Subjects

ES.112 Philosophy of Love
Prereq: None
U (Spring)
4-0-8 units. HASS-H; CI-H
Credit cannot also be received for ES.9112

Explores the nature of love through works of philosophy, literature, film, poetry, and individual experience. Investigates the distinction among eros (desiring or appreciative love), philia (mutuality), and agape (love as pure giving). Students discuss ideas of love as a feeling, an action, a species of ‘knowing someone,’ or a way to give or take. Authors include Plato, Kant, Buber, D. H. Lawrence, Rumi, and Aristotle. Preference to students in ESG and Concourse.
L. Perlman

ES.113 Ancient Greek Philosophy and Mathematics
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H

Explores the relationship between ancient Greek philosophy and mathematics. Investigates how ideas of definition, reason, argument and proof, rationality/irrationality, number, quality and quantity, truth, and even the idea of an idea were shaped by the interplay of philosophic and mathematical inquiry. Examines how discovery of the incommensurability of magnitudes challenged the Greek presumption that the cosmos is fully understandable. Explores the influence of mathematics on ancient Greek ethical theories. Authors: Euclid, Plato, Aristotle, Nicomachus, Theon of Smyrna, Bacon, Descartes, Dedekind, and Newton. Preference to students in Concourse and ESG.
L. Perlman

ES.114 Non-violence as a Way of Life
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
Credit cannot also be received for ES.9114

Addresses the philosophical question of what a non-violent life entails. Investigates its ethical dimensions and challenges, and considers whether we can derive a comprehensive moral theory from the principle of non-violence. Discusses the issues of lying, the duty to forgive, non-violent communication, the ethics of our relationship to anger, the possibility of loving enemies, and the ethics of punishment and rehabilitation. Includes readings from primary exponents of non-violence, such as Tolstoy, Gandhi and King. Taught inside a secure Massachusetts correctional facility with a mix of MIT students and incarcerated students. Limited to 10.
L. Perlman

ES.9112 Philosophy of Love - MIT Prison Initiative
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H
Credit cannot also be received for ES.112

Explores the nature of love through works of philosophy, literature, film, poetry, and individual experience. Investigates the distinction among eros (desiring or appreciative love), philia (mutuality), and agape (love as pure giving). Students discuss ideas of love as a feeling, an action, a species of ‘knowing someone,’ or a way to give or take. Authors include Plato, Kant, Buber, D. H. Lawrence, Rumi, and Aristotle. Taught inside a secure Massachusetts correctional facility with a mix of MIT students and incarcerated students. Limited to 10.
L. Perlman

ES.9114 Non-violence as a Way of Life - MIT Prison Initiative
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-H
Credit cannot also be received for ES.114

Addresses the philosophical question of what a non-violent life entails. Investigates its ethical dimensions and challenges, and considers whether we can derive a comprehensive moral theory from the principle of non-violence. Discusses the issues of lying, the duty to forgive, non-violent communication, the ethics of our relationship to anger, the possibility of loving enemies, and the ethics of punishment and rehabilitation. Includes readings from primary exponents of non-violence, such as Tolstoy, Gandhi and King. Taught inside a secure Massachusetts correctional facility with a mix of MIT students and incarcerated students. Limited to 10.
L. Perlman

ESG Seminars

ES.010 Chemistry of Sports: Understanding How Exercise Affects Your Body
Prereq: None
U (Spring)
2-1-3 units

Students apply chemistry knowledge to physical fitness through the study of three sports: swimming, cycling, and running. Classroom component focuses on nutrition, exercise, anatomy, physiology, and the chemistry of supplements and sports equipment. Laboratory component focuses on training for and completion of triathlon competition. Students may earn up to 2 PE points during the term by attending supervised triathlon training workouts. Preference to students in ESG.
P. Christie, S. Lyons
**ES.011 Kitchen Chemistry**  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
2-1-3 units  
An experimental and “hands-on” approach to applied chemistry in cooking. Students perform experiments to illustrate chemical principles, such as extraction, denaturation, and phase changes. Preference to students in ESG.  
*P. Christie*

**ESG Teaching and Research**

**ES.200 ESG Undergraduate Teaching**  
Prereq: Permission of instructor  
U (Fall, Spring)  
2-0-4 units  
Can be repeated for credit.  
An opportunity to assist in the teaching of subjects in ESG in biology, chemistry, humanities and social sciences, mathematics, and physics. Student instructors may be involved in grading, running problemsolving sessions, or teaching classes depending on experience and interest. Qualified students may also develop and teach undergraduate seminars under the supervision of an appropriate faculty or staff member. Student instructors meet weekly with staff to discuss their teaching and cover a variety of topics related to effective teaching techniques. Limited to students in ESG.  
*P. Christie, G. Stoy*

**ES.210 ESG Independent Study**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and a final report. Limited to students in ESG.  
*L. Royden*

**ES.UR Undergraduate Research in ESG**  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
For students wishing to pursue undergraduate research opportunities in the Experimental Study Group. Limited to students in ESG.  
*L. Royden*

**ESG Special Subjects**

**ES.S10 Special Seminar in Science**  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
Units arranged [P/D/F]  
Can be repeated for credit.  
Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.  
*Staff*

**ES.S11 Special Seminar in Science**  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
Units arranged [P/D/F]  
Can be repeated for credit.  
Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.  
*Staff*

**ES.S20 Special Seminar in Mathematics**  
Prereq: None  
U (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.  
*Staff*

**ES.S21 Special Seminar in Mathematics**  
Prereq: None  
U (Fall, IAP, Spring)  
Not offered regularly; consult department  
Units arranged [P/D/F]  
Can be repeated for credit.  
Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.  
*Staff*
ES.S30 Special Seminar in Engineering and Computer Science
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S31 Special Seminar in Engineering and Computer Science
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S40 Special Seminar in the Humanities
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S41 Special Seminar in the Humanities
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S42 Special Seminar in the Humanities
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S50 Special Seminar in the Arts
Prereq: None
U (Fall)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S51 Special Seminar in the Arts
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S60 Special Seminar in Social Science
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff
**ES.S61 Special Seminar in Social Science**
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

*Staff*

**ES.S70 Special Seminar in Interdisciplinary Studies**
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

*Staff*

**ES.S71 Special Seminar in Interdisciplinary Studies**
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics not included in the permanent curriculum. May not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

*Staff*

**ES.S90 Special Studies in the MIT Initiative for Teaching Incarcerated Individuals**
Prereq: None
U (Fall)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Seminar taught inside a secure Massachusetts correctional facility with a mix of MIT students and incarcerated students. Topics vary from year to year. Limited to 10.

*Staff*

**ES.S91 Special Studies in the MIT Initiative for Teaching Incarcerated Individuals**
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Seminar taught inside a secure Massachusetts correctional facility with a mix of MIT students and incarcerated students. Topics vary from year to year. Limited to 10.

*Staff*
GLOBAL STUDIES AND LANGUAGES (COURSE 21G)

For subjects in English Language Studies, see 21G.217 - 21G.233.

Studies in International Literatures and Cultures

Studies in International Literatures and Cultures make various modes of intercultural discourse available in English. Those subjects that deal with works from more than one nation give students the opportunity to pursue comparative studies. A significant number of subjects also allow students to study works from a single country.

21G.011 Topics in Indian Popular Culture
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H
Can be repeated for credit.

Overview of Indian popular culture over the last two decades, through a variety of material such as popular fiction, music, television and Bombay cinema. Explores major themes and their representations in relation to current social and political issues, elements of the formulaic masala movie, music and melodrama, ideas of nostalgia and incumbent change in youth culture, and questions of gender and sexuality in popular fiction. Taught in English. Enrollment limited.
A. Banerjee

21G.012 Exploring Globalization through Chinese Food
Prereq: None
U (Spring)
1-0-0 units

Introduces students to some of the central themes of cultural globalization through the case study of Chinese food. An exploration of the cuisine in the local Boston area exposes students to the topics of global trade, migration, transnational business and labor, the transnational dissemination of knowledge, and cultural production. Readings and films include cookbooks, memoirs, reportage and documentaries. Includes walking tours of Boston’s Chinatown. Students produce a blog to document their findings. Concludes with a Chinese cooking workshop. Subject can count toward the 9-unit discovery-focused credit limit for first year students. Limited to 15; preference to first-year students.
E. Teng

21G.014 Introduction to Russian Politics and Society (New)
Prereq: None
U (Fall; partial term)
1-0-2 units

Introduces students to contemporary Russia through the analysis of major political, social, and cultural trends. Considers the role of identity, journalism, and music as instruments of political power. Addresses the issue of climate change and analyzes Russians’ perception of environmental threats to the country. Study materials include academic and media articles, as well as video clips. Subject can count toward the 9-unit discovery-focused credit limit for first year students. Limited to 15.
E. Wood

21G.019 Communicating Across Cultures
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Examines a range of communication styles and techniques resulting from different cultural norms and traditions. Begins with a general theoretical framework and then moves into case studies. Topics include understanding the relationship between communication and culture, differences in verbal and non-verbal communication styles, barriers to intercultural communication, modes of specific cross-cultural communication activities (argumentation, negotiation, conflict resolution) and intercultural adjustment. Case studies explore specific ways of communicating in Asian and European cultures. Graduate students are expected to complete additional assignments. Taught in English. Enrollment limited.
J. Dunphy

21G.022[J] International Women’s Voices
Same subject as 21L.522[J], WGS.141[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

See description under subject 21L.522[J].
M. Resnick

21G.024[J] The Linguistic Study of Bilingualism
Same subject as 24.906[J]
Prereq: 24.900 or 24.9000
U (Fall)
3-0-9 units. HASS-S; CI-H

See description under subject 24.906[J]. Enrollment limited.
S. Flynn
21G.025 Africa and the Politics of Knowledge
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

Considers how, despite its immense diversity, Africa continues to hold purchase as both a geographical entity and meaningful knowledge category. Examines the relationship between articulations of "Africa" and projects like European imperialism, developments in the biological sciences, African de-colonization and state-building, and the imagining of the planet’s future. Readings in anthropology and history are organized around five themes: space and place, race, representation, self-determination, and time. Enrollment limited.

A. Edoh

21G.026 Global Africa: Creative Cultures
Subject meets with 21G.326
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Examines contemporary and historical cultural production on and from Africa across a range of registers, including literary, musical and visual arts, material culture, and science and technology. Employs key theoretical concepts from anthropology and social theory to analyze these forms and phenomena. Uses case studies to consider how Africa articulates its place in, and relationship to, the world through creative practices. Discussion topics largely drawn from Francophone and sub-Saharan Africa, but also from throughout the continent and the African diaspora. Taught in English. Limited to 18.

A. Edoh

21G.027(J) Visualizing Japan in the Modern World
Same subject as CMS.874(J)
Subject meets with 21G.590
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H

Studies how visual images shape the identity of peoples, cultures, and events in Japan. Uses visuals from major collections in the US and Japan to introduce the conceptual and practical issues involved in "visualizing cultures." Projects look at American and Japanese graphics depicting contacts between Japan and the West in the 19th and early 20th centuries. Taught in English using material and features of edX subject, including videos and online discussion. Enrollment limited.

S. Miyagawa

21G.028 African Migrations
Subject meets with 21G.328
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Examines West African migration to France and to the United States from the early 20th century to the present. Centering the experiences of African social actors and historicizing recent dynamics, students consider what migration across these three regions reveals about African projects of self-determination, postcolonial nation-building, and global citizenship. Students also comparatively analyze the workings of contemporary French and American societies, in particular, the articulations of race and citizenship in the two nations. Taught in English. Limited to 18.

A. Edoh

21G.030(J) Introduction to East Asian Cultures: From Zen to K-Pop
Same subject as WGS.236(J)
Subject meets with 21G.193
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Examines traditional forms of East Asian culture (including literature, art, performance, food, and religion) as well as contemporary forms of popular culture (film, pop music, karaoke, and manga). Covers China, Japan, Korea, Taiwan, and Hong Kong, with an emphasis on China. Considers women's culture, as well as the influence and presence of Asian cultural expressions in the US. Uses resources in the Boston area, including the MFA, the Children's Museum, and the Sackler collection at Harvard. Taught in English.

E. Teng
21G.036[J] Advertising and Media: Comparative Perspectives
Same subject as CMS.356[J]
Subject meets with 21G.190, CMS.888
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Compares modern and contemporary advertising culture in China, the US, and other emerging markets. First half focuses on branding in the old media environment; second half introduces the changing practice of advertising in the new media environment. Topics include branding and positioning, media planning, social media campaigns, cause marketing 2.0, social TV, and mobility marketing. Required lab work includes interactive sessions in branding a team product for the US (or a European country) and China markets. Taught in English and requires no knowledge of Chinese. Students taking graduate version complete additional assignments.

J. Wang

21G.038 China in the News: The Untold Stories
Subject meets with 21G.194
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H

Examines issues and debates crucial to understanding contemporary Chinese society, culture, and politics. Discusses how cultural politics frames the way in which China is viewed by mass media around the world and by China scholars in the West. Topics include the Beijing Olympic Games; Mao in post-Mao China; the new patriotism; leisure and consumer culture; the rise of the internet and web culture in urban China; media censorship, remix, and creative online culture. Analyzes the central debate over progress and the role played by the state, the market, and citizen activists in engineering social change. Uses documentaries and feature films to illustrate the cultural, social and political changes that have taken place in China since the 1980s. Includes two short writing assignments and a final paper. Taught in English.

J. Wang

21G.039[J] Gender and Japanese Popular Culture
Same subject as 21A.143[J], WGS.154[J]
Subject meets with 21G.591
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Examines relationships between identity and participation in Japanese popular culture as a way of understanding the changing character of media, capitalism, fan communities, and culture. Emphasizes contemporary popular culture and theories of gender, sexuality, race, and the workings of power and value in global culture industries. Topics include manga (comic books), hip-hop and other popular music, anime and feature films, video games, contemporary literature, and online communication. Students present analyses and develop a final project based on a particular aspect of gender and popular culture. Several films screened outside of regular class meeting times. Taught in English.

I. Condry

21G.040 A Passage to India: Introduction to Modern Indian Culture and Society
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Introduction to Indian culture through films, short-stories, novels, essays, newspaper articles. Examines some major social and political controversies of contemporary India through discussions centered on India's history, politics and religion. Focuses on issues such as ethnic tension and terrorism, poverty and inequality, caste conflict, the missing women, and the effects of globalization on popular and folk cultures. Particular emphasis on the IT revolution, outsourcing, the new global India and the enormous regional and subcultural differences. Taught in English.

A. Banerjee
21G.043[J] Introduction to Asian American Studies: Historical and Contemporary Issues
Same subject as 21H.107[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Provides an overview of Asian American history and its relevance for contemporary issues. Covers the first wave of Asian immigration in the 19th century, the rise of anti-Asian movements, the experiences of Asian Americans during WWII, the emergence of the Asian American movement in the 1960s, and the new wave of post-1965 Asian immigration. Examines the role these experiences played in the formation of Asian American ethnicity. Addresses key societal issues such as racial stereotyping, media racism, affirmative action, the glass ceiling, the "model minority" syndrome, and anti-Asian harassment or violence. Taught in English.
Consult E. Teng

Same subject as WGS.235[J]
Subject meets with 21G.195
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Introduction to some of the major genres of traditional Chinese poetry, fiction, and drama. Intended to give students a basic understanding of the central features of traditional Chinese literary genres, as well as to introduce students to the classic works of the Chinese literary tradition. Works read include Journey to the West, Outlaws of the Margin, Dream of the Red Chamber, and the poetry of the major Tang dynasty poets. Literature read in translation. Taught in English.
E. Teng

21G.045 Global Chinese Food
Prereq: None
U (Spring)
Not offered regularly; consult department
2-2-8 units. HASS-H

Introduces the history of Chinese food around the world. Illustrates how the globalization of Chinese food is deeply connected to Chinese migration patterns, expansion of Western influence in Asia, and race relations in places of Chinese settlement. Focuses on the 19<sup>th</sup> and 20<sup>th</sup> centuries, specifically on major events in modern world history that affected the availability and demand for Chinese food. Also looks briefly at Chinese merchants trading in exotic foods in Southeast Asia during the 18<sup>th</sup> century. Throughout the term, students work on digital maps which serve as the basis of many assignments, including presentations and papers. Limited to 18.
E. Teng

21G.046 Modern Chinese Fiction and Cinema
Subject meets with 21G.192
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H

Covers major works of Chinese fiction and film, from mainland China, Taiwan, and Hong Kong. Focusing on the modern period, examines how Chinese intellectuals, writers, and filmmakers have used artistic works to critically explore major issues in modern Chinese culture and society. Literature read in translation. Taught in English. Enrollment limited.
J. Wang

21G.047[J] Cultures of East Asia
Same subject as 21A.140[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

See description under subject 21A.140[J].
M. Buyandelger

21G.048[J] Images of Asian Women: Dragon Ladies and Lotus Blossoms
Same subject as 21A.141[J], WGS.274[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S

See description under subject 21A.141[J].
M. Buyandelger
21G.049[J] French Photography
Same subject as 4.674[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A; CI-H
Introduces students to the world of French photography from its invention in the 1820s to the present. Provides exposure to major photographers and images of the French tradition, and encourages students to explore the social and cultural roles and meanings of photographs. Designed to help students navigate their own photo-saturated worlds; provides opportunity to gain practical experience in photography. Taught in English. Enrollment limited.
C. Clark

21G.052 French Film Classics
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-2-8 units. HASS-H
History and aesthetics of French cinema from the advent of sound to present-day. Treats films in the context of technical processes, the art of narration, directorial style, role of the scriptwriter, the development of schools and movements, the impact of political events and ideologies, and the relation between French and other national cinemas. Films shown with English subtitles. Taught in English.
C. Clark

21G.053 Understanding Contemporary French Politics
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-S; CI-H
Examines the changes in contemporary French society through the study of political debates, reforms and institutions since 1958. Analyzes the deep influence of politics on cultural and social life, despite a decline in political participation. Revisits public controversies and political cleavages, from the Algerian war to postcolonial issues, from the birth of the European Union to the recent financial crisis, and from the moral “revolution” of the seventies to the recognition of new families. Course taught in English. Enrollment limited.
B. Perreau

21G.054[J] France: Enlightenment and Revolution
Same subject as 21H.241[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H
See description under subject 21H.241[J].
J. Ravel

21G.055[J] Media in Weimar and Nazi Germany
Same subject as CMS.311[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
2-2-8 units. HASS-H; CI-H
Debates over national and media identity in Weimar and Nazi Germany. Production and use of media under extreme political and social conditions with a focus on films (such as Nosferatu, Berlin, M, and Triumph des Willens) and other media. Media approached as both texts and systems. Considers the legacy of the period, in terms of stylistic influence (e.g. film noir), techniques of persuasion, and media’s relationship to social and economic conditions. Taught in English. Enrollment limited.
W. Uricchio

21G.057[J] Gender, Race, and Environmental Justice
Same subject as STS.022[J], WGS.275[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
Provides an introduction to the analysis of gender in science, technology, and environmental politics from a global perspective. Familiarizes students with central objects, questions, and methods in the field. Examines existent critiques of the racial, sexual and environmental politics at stake in techno-scientific cultures. Draws on material from popular culture, media, fiction, film, and ethnography. Addressing specific examples from across the globe, students also explore different approaches to build more livable environments that promote social justice. Taught in English. Limited to 18.
B. Stoetzer
21G.058[[J] Race and Migration in Europe
Same subject as 21A.132[[J]]
Subject meets with 21G.418
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
Addresses the shifting politics of nation, ethnicity, and race in the context of migration and globalization in Germany and Europe. Provides students with analytical tools to approach global concerns and consider Europe and Germany from cross-cultural and interdisciplinary perspectives. Familiarizes students with the ways in which histories of migration, travel, and colonial encounters shape contemporary Europe. Introduces the concepts of transnationalism, diasporic cultures, racism, ethnicity, asylum, and mobility via case studies and materials, including film, ethnography, fiction, and autobiography. Taught in English. Limited to 18.
B. Stoetzer

21G.059 Paradigms of European Thought and Culture
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H
Subject surveys the main currents of European cultural and intellectual history in the modern period. Introduces a set of ideas and arguments that have played a formative role in European culture, and acquaints students with exemplars of critical thought. Readings begin with the Protestant Reformation and move through the French Revolution up to the post-WWII period. Figures to be considered include Luther, Descartes, Kant, Hegel, Rousseau, Smith, Marx, Freud, Beauvoir, and Foucault. Class discussions set these texts into the context of European culture. Topics to be considered are artworks by Goya, David, and Duchamp; the architecture of Schinkel; the music of Bach; and the literature of Goethe. Taught in English.
Consult E. Crocker

21G.063 Anime: Transnational Media and Culture
Subject meets with 21G.596
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
Explores anime (Japanese animated films and TV shows) as a study in flows among media and cultures. Discusses Japan’s substantial share of the TV cartoon market and the reasons for anime’s worldwide success. Focuses on cultural production and the ways anime cultures are created through the interactive efforts of studios, sponsors, fans, broadcasters, and distributors. Uses anime scholarship and media examples as a means to examine leading theories in media and cultural studies, gender and sexuality, technology and identity, and post-industrial globalization. Taught in English.
I. Condry

21G.064 Introduction to Japanese Culture
Subject meets with 21G.592
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H
Examines the major aesthetic, social, and political elements which have shaped modern Japanese culture and society. Readings on contemporary Japan and historical evolution of the culture are coordinated with study of literary texts, film, and art, along with an analysis of everyday life and leisure activities. Taught in English. Limited to 18.
Consult P. Roquet

21G.065 Japanese Literature and Cinema
Subject meets with 21G.593
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
Surveys both cinematic and literary representations of diverse eras and aspects of Japanese culture such as the classical era, the samurai age, wartime Japan and the atomic bombings, social change in the postwar period, and the appropriation of foreign cultural themes, with an emphasis on the modern period. Directors include Akira Kurosawa and Hiroshi Teshigahara. Authors include Kobo Abe and Yukio Mishima. Films shown with subtitles in English. Taught in English. Enrollment limited.
Consult P. Roquet
GLOBAL STUDIES AND LANGUAGES (COURSE 21G)

21G.067 Digital Media in Japan and Korea
Subject meets with 21G.597
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Examines the social, cultural, and political stakes of digital culture in Japan and Korea. Focuses on digital media use (and abuse), including the internet, streaming and mobile media, gaming, robots, and augmented realities; the digital remediation of older media; and methods for the study of online life. By considering how digital media use has developed in each country and reshaped identity, politics, public space, and creative practice, students build a conceptual and critical vocabulary for the comparative study of algorithmic cultures. Taught in English.

P. Roquet

21G.068[J] The Invention of French Theory: A History of Transatlantic Intellectual Life since 1945
Same subject as WGS.234[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Examines post-WWII French theory. Discusses how theorists such as Lacan, Cixous, Derrida, and Debord were perceived in France and the US. Explores transatlantic intellectual debates since 1989 and the “new” French theory. Topics include: communism, decolonization, neo-liberalism, gender and mass media. Taught in English.

B. Perreau

21G.070 Latin America and the Global Sixties: Counterculture and Revolution
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H

Close reading of political issues, cultural artifacts, and social actors of Latin America during and in the wake of the revolutionary 1960s. Examines how culture and politics addressed the need to conceptually organize a series of events that were equally momentous and confusing. Questions the established stereotypes and assumptions about Latin America and the sixties that are portrayed in its contemporary, often nostalgic, revivals. Focuses on the ideas that defined Latin America’s participation in a global trend of political upheavals, emerging youth cultures, and demands for social justice. Taught in English. Enrollment limited.

P. Duong

21G.072 The New Latin American Novel
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H

Students read newly translated, recent fiction from Latin America and consider contemporary issues in, and approaches to, reading and writing literature in the 21st century. Debates the concept of contemporary in these texts and whether we can still talk about a Latin American novel. Reflects on issues of interpretation, authorship, gender, genre, media, ideology and theories of the novel, Latin American literary history, and translation. Authors may include César Aira, Mario Levrero, Samanta Schweblin, Yuri Herrera, Ena Lucía Portela, Valeria Luiselli, Roberto Bolaño, Marlon James, and J.P. Cuenca. Enrollment limited.

P. Roquet

21G.074 Topics in Portuguese Popular Culture
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H
Can be repeated for credit.

Examines contemporary film, music, and literature of the Portuguese-speaking world. Selected literary, historical, and cultural texts serve as vehicles for a deeper understanding of the major political and social shifts that have affected the landscape of the contemporary Portuguese-speaking world: from Brazil’s military dictatorship to its transition to democracy; from Portugal’s New State to membership in the European Union; and from the wars of independence in Africa to the formation of newly independent nations. Taught in English.

A. Igrejas
Same subject as 21H.253[J]
Subject meets with 21G.196
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Examines Chinese migration in historical and comparative perspective, beginning in 1567 with the lifting of the imperial ban on private maritime trade. Covers migration to diverse venues across the globe, including tropical colonies, settler societies, Chinese frontiers, and postcolonial metropoles. Topics include the varied roles of Chinese migrants in these diverse venues, the coolie trade and anti-Chinese movements, overseas students, transnational networks, cultural adaptation, and the creolization of Chinese food in migrant communities. Critically examines the degree to which this transnational migration has produced a "Global Chinese" identity. Taught in English.

E. Teng

21G.077[J] Introduction to the Classics of Russian Literature
Same subject as 21L.490[J]
Subject meets with 21G.618
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Explores the works of classical Russian writers of the 19th and 20th centuries, including stories and novels by Pushkin, Gogol, Dostoevsky, Tolstoy, Chekhov, Bunin, Nabokov, Platonov, and others. Focuses on their approaches to portraying self and society, and on literary responses to fundamental ethical and philosophical questions about justice, freedom, free will, fate, love, loyalty, betrayal, and forgiveness. Taught in English; students interested in completing some readings and a short writing project in Russian should register for 21G.618.

M. Khotimsky

21G.078[J] Latin America Through Film
Same subject as 21H.172[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

See description under subject 21H.172[J].
T. Padilla

21G.084[J] Introduction to Latin American Studies
Same subject as 17.55[J], 21A.130[J], 21H.170[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S; CI-H

See description under subject 17.55[J].

21G.085[J] Imperial and Revolutionary Russia: Culture and Politics, 1700-1917
Same subject as 21H.244[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H

See description under subject 21H.244[J].
E. Wood

21G.086[J] Soviet and Post-Soviet Politics and Society: 1917 to the Present
Same subject as 17.57[J], 21H.245[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S; CI-H

See description under subject 21H.245[J]. Enrollment limited.
E. Wood

21G.087[J] Introduction to Russian Studies (New)
Same subject as 21H.144[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Explores Russian culture and society by analyzing its unique position at the crossroads of Europe and Asia throughout medieval, Imperial, Soviet, and contemporary periods. Investigates a variety of topics: defining the borders of the country and shaping its relationship with the outside world; changes in living spaces from rural to urban, development of cultural centers; and daily life, customs, and traditions. Includes readings in literature, history, and cultural studies, as well visual arts, music, and film. Limited to 25.
E. Wood, M. Khotimsky
21G.094 Cinema in Japan and Korea
Subject meets with 21G.594
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A
Focuses on landmark art cinema from both countries while providing a thorough introduction to film style. Each week examines a different component of film form, using the close analysis of specific films in their cultural and historical context. Explores the use of video essays as a form of critical analysis.

P. Roquet

21G.095 Cultures of Music in East Asia: Japan, Korea, China (New)
Subject meets with 21G.595
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A
Explores a variety of music cultures in contemporary East Asia. Emphasizes examples from Japan, but forays elsewhere, including South Korea and China. Uses writings, videos, and recordings of musical performances, events, and objects in a variety of contexts to better understand how the concept of culture gives insight into gender, class, sexuality, race, ethnicity, nationhood, and individual identities. Explores ethnographic approaches to musical cultures with a focus on the last thirty years. Topics include Japanese hip-hop, K-Pop idols, Vocaloids (virtual idols), Chinese popular music and protest, street music, streaming and online distribution for global music, and experimental music. Students conduct ethnographic fieldwork and produce sonic presentations. No music experience nor technical expertise required. Taught in English.

I. Condry

21G.111 Chinese Calligraphy
Prereq: None
U (IAP)
3-0-9 units. HASS-A
Provides an introduction to the ancient art of Chinese calligraphy and its traditional uses. Studies the history of the Chinese writing system and develops skills through guided reading, classroom discussion, and systematic practice with brush and ink. Students work on a small calligraphy project based on their own interest. Taught in English; no prior knowledge of Chinese language required. Limited to 25.

K. Zhou

Chinese
The subjects below are taught in Chinese and include offerings in language, literature, and cultural studies.
The indication of prerequisites for specific Chinese offerings does not apply to students who have already completed equivalent work. For further placement advice, consult one of the field advisors in Chinese.

Undergraduate Language Subjects

21G.101 Chinese I (Regular)
Subject meets with 21G.151
Prereq: None
U (Fall, IAP)
4-0-8 units. HASS-H
Introduction to modern standard Chinese (Mandarin) with emphasis on developing conversational skills by using fundamental grammatical patterns and vocabulary in functional and culturally suitable contexts. Basic reading and writing are also taught. For graduate credit, see 21G.151. Placement interview with instructors required of students who have had prior exposure to Chinese before or on Reg Day. Limited to 16 per section. No listeners.

Consult H. Liao

21G.102 Chinese II (Regular)
Subject meets with 21G.152
Prereq: 21G.101 or permission of instructor
U (Spring)
Credit cannot also be received for 21G.142
Continuation of 21G.101. For full description, see 21G.101. For graduate credit see 21G.152. Placement interview on or before Reg. Day required of students who have had prior exposure of Chinese elsewhere. Limited to 16 per section. No listeners.

Consult H. Liao

21G.103 Chinese III (Regular)
Prereq: 21G.102 or permission of instructor
U (Fall)
Continuing instruction in spoken and written Chinese, with particular emphasis on consolidating basic conversational skills and improving reading confidence and depth. Lab work required. Placement interview with instructors before or on Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.

Consult H. Liao
21G.104 Chinese IV (Regular)
Prereq: 21G.103 or permission of instructor
U (Spring)
4-0-8 units. HASS-H
Credit cannot also be received for 21G.143
Continuation of 21G.103. For full description, see 21G.103. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult H. Liao

21G.105 Chinese V (Regular): Discovering Chinese Cultures and Societies
Prereq: 21G.104 or permission of instructor
U (Fall)
3-0-9 units. HASS-H
Students develop more sophisticated conversational and reading skills by combining traditional textbook material with their own explorations of Chinese speaking societies, using the human, literary, and electronic resources available at MIT and in the Boston area. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult T. Chen

21G.106 Chinese VI (Regular): Discovering Chinese Cultures and Societies
Prereq: 21G.105 or permission of instructor
U (Spring)
3-0-9 units. HASS-H
Continuation of 21G.105. For full description see 21G.105. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult T. Chen

Undergraduate Language Subjects - Streamlined

21G.107 Chinese I (Streamlined)
Subject meets with 21G.157
Prereq: Permission of instructor
U (Fall)
3-0-9 units. HASS-H
The first term streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. For graduate credit see 21G.157. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult M. Liang

21G.108 Chinese II (Streamlined)
Subject meets with 21G.158
Prereq: 21G.107 or permission of instructor
U (Spring)
3-0-9 units. HASS-H
The second term streamlined sequence; continuation of 21G.107. The streamlined sequence is designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. For graduate credit see 21G.158. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult M. Liang

21G.109 Chinese III (Streamlined)
Prereq: 21G.108 or permission of instructor
U (Fall)
3-0-9 units. HASS-H
Intermediate level subject in streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. Consolidates conversation skills, improves reading confidence and broadens composition style. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult K. Zhou
21G.110 Chinese IV (Streamlined)
Prereq: 21G.109 or permission of instructor
U (Spring)
3.0-9 units. HASS-H
Intermediate level subject in streamlined sequence; continuation of 21G.109. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. Consolidates conversation skills, improves reading confidence and broadens composition style. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult P. Gao

21G.113 Chinese V (Streamlined)
Prereq: 21G.110 or permission of instructor
U (Fall)
3.0-9 units. HASS-H
Advanced level subject in streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. Students conduct their own explorations of modern China using online and print materials, as well as interviews with Chinese in the Boston area. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
P. Gao

21G.120 Business Chinese
Prereq: 21G.106, 21G.113, or permission of instructor
U (Spring)
3.0-9 units. HASS-H
Aimed at advanced-level students to enhance language skills and cultural knowledge specific to conducting business in Chinese societies. Topics include the specialization of materials used in commercial, economic, and business contexts; Greater China’s economic development, business culture, and etiquette; and case studies from successful international enterprises in China. Students develop project reports based on their own interests. Taught in Chinese. Limited to 16.
Consult P. Gao

Graduate Language Subjects

21G.151 Chinese I (Regular)
Subject meets with 21G.101
Prereq: None
G (Fall, IAP)
4.0-5 units
Introduction to modern standard Chinese (Mandarin). For a full description, see 21G.101. For undergraduate credit see 21G.101.
Limited to 16 per section.
Consult H. Liao

21G.152 Chinese II (Regular)
Subject meets with 21G.102
Prereq: 21G.151 or permission of instructor
G (Spring)
4.0-5 units
Credit cannot also be received for 21G.142
Continuation of 21G.151. For a description, see 21G.102. For undergraduate credit see 21G.102.
Consult H. Liao

21G.157 Chinese I (Streamlined)
Subject meets with 21G.107
Prereq: Permission of instructor
G (Fall)
3.0-6 units
Introduction to modern standard Chinese (Mandarin) for students with some speaking ability but little reading ability. For full description, see 21G.107. For undergraduate credit see 21G.107.
Limited to 16 per section.
Consult M. Liang

21G.158 Chinese II (Streamlined)
Subject meets with 21G.108
Prereq: 21G.157 or permission of instructor
G (Spring)
3.0-6 units
Continuation of 21G.157. For a description see 21G.157. For undergraduate credit see 21G.108.
Consult M. Liang
Chinese Language Option Subjects

21G.190 Advertising and Media: Comparative Perspectives
Subject meets with 21G.036[J], CMS.356[J], CMS.888
Prereq: 21G.105, 21G.110, or permission of instructor
U (Spring)
3-0-10 units. HASS-H
Compares modern and contemporary advertising culture in China, the US, and other emerging markets. First half focuses on branding in the old media environment; second half introduces the changing practice of advertising in the new media environment. Topics include branding and positioning, media planning, social media campaigns, cause marketing 2.0, social TV, and mobility marketing. Required lab work includes interactive sessions in branding a team product for the US (or a European country) and China markets. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
J. Wang

21G.192 Modern Chinese Fiction and Cinema
Subject meets with 21G.046
Prereq: 21G.105, 21G.110, or permission of instructor
U (Fall)
3-0-10 units. HASS-H; CI-H
Covers major works of Chinese fiction and film, from mainland China, Taiwan, and Hong Kong. Focusing on the modern period, examines how Chinese intellectuals, writers, and filmmakers have used artistic works to critically explore major issues in modern Chinese culture and society. Literature read in translation. Taught in English with a project that requires research in Chinese. Enrollment limited; preference to Chinese minors.
J. Wang

21G.193 Introduction to East Asian Cultures: From Zen to K-Pop
Subject meets with 21G.030[J], WGS.236[J]
Prereq: 21G.104, 21G.110, or permission of instructor
U (Fall)
3-0-10 units. HASS-H
Examines traditional forms of East Asian culture (including literature, art, performance, food, and religion) as well as contemporary forms of popular culture (film, pop music, karaoke, and manga). Covers China, Japan, Korea, Taiwan, and Hong Kong, with an emphasis on China. Considers women’s culture, as well as the influence and presence of Asian cultural expressions in the US. Uses resources in the Boston area, including the MFA, the Children’s Museum, and the Sackler collection at Harvard. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
E. Teng

21G.194 China in the News: The Untold Stories
Subject meets with 21G.038
Prereq: 21G.105, 21G.110, or permission of instructor
U (Spring)
3-0-10 units. HASS-H; CI-H
Examines issues and debates crucial to understanding contemporary Chinese society, culture, and politics. Discusses how cultural politics frames the way in which China is viewed by mass media around the world and by China scholars in the West. Topics include the Beijing Olympic Games, Mao in post-Mao China; the new patriotism; leisure and consumer culture; the rise of the internet and web culture in urban China; media censorship, remix, and creative online culture. Analyzes the central debate over progress and the role played by the state, the market, and citizen activists in engineering social change. Uses documentaries and feature films to illustrate the cultural, social and political changes that have taken place in China since the 1980s. Includes two short writing assignments and a final paper. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
J. Wang

21G.195 Classics of Chinese Literature in Translation
Subject meets with 21G.044[J], WGS.235[J]
Prereq: 21G.104, 21G.110, or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-10 units. HASS-H
Introduction to some of the major genres of traditional Chinese poetry, fiction, and drama. Intended to give students a basic understanding of the central features of traditional Chinese literary genres, as well as to introduce students to the classic works of the Chinese literary tradition. Works read include Journey to the West, Outlaws of the Margin, Dream of the Red Chamber, and the poetry of the major Tang dynasty poets. Literature read in translation. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
E. Teng
**21G.196 The Global Chinese: Chinese Migration, 1567-Present**  
Subject meets with 21G.075(J), 21H.253(J)  
Prereq: 21G.104, 21G.110, or permission of instructor  
U (Fall)  
Not offered regularly; consult department  
3-0-10 units. HASS-H

Examines Chinese migration in historical and comparative perspective, beginning in 1567 with the lifting of the imperial ban on private maritime trade. Covers migration to diverse venues across the globe, including tropical colonies, settler societies, Chinese frontiers, and postcolonial metropoles. Topics include the varied roles of Chinese migrants in these diverse venues, the coolie trade and anti-Chinese movements, overseas students, transnational networks, cultural adaptation, and the creolization of Chinese food in migrant communities. Critically examines the degree to which this transnational migration has produced a "Global Chinese" identity. Taught in English with a project that requires research in Chinese. Preference to students in the Chinese minor.  
_E. Teng_

**21G.199 Chinese Youths and Web Culture**  
Prereq: 21G.113 and permission of instructor  
U (Spring)  
Not offered regularly; consult department  
3-0-9 units. HASS-H

Introduces the cultural trends and media habits of Chinese Generation X and the post-1990s generation, and its context of the rise of Web culture. Topics include the influence of the global Web culture on China; the cross-fertilization of youth volunteer culture and Web 2.0; popular sites where Chinese college students and other youths congregate, including BBS forums and social networking platforms; and the debates in online communities that made an impact on Chinese politics and society. Students examine literature on the evolution of Chinese Web culture and conduct exercises using Web 2.0 tools. Taught in Chinese.  
_J. Wang_

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**English Language Studies (ELS)**

**Undergraduate Subjects**

**21G.218 Workshop in Strategies for Effective Teaching (ELS)**  
Prereq: None  
U (IAP; partial term)  
Not offered regularly; consult department  
1-0-2 units  
Credit cannot also be received for 21G.217

A mini-module for international teaching assistants. Covers special problems in teaching when English is a second language and the US a second culture. Videotaping of practice sessions for feedback. Individualized programs to meet different needs. Limited to 18.  
_A. C. Kemp_

**21G.220 Foundations of Academic and Professional Writing (ELS)**  
Prereq: None  
U (Fall, Spring)  
3-0-9 units. HASS-H  
Can be repeated for credit. Credit cannot also be received for 21G.219

Writing module for high intermediate ELS students who wish to review and practice accurate grammar, effective sentence and paragraph structure, punctuation, and word choice. Short weekly writing assignments with extensive editing required. Meets with 21G.219 when offered concurrently. Limited to 18.  
_E. Grunwald_

**21G.221 Communicating in American Culture (ELS)**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H; CI-H

Designed for international students who wish to refine their academic communication skills through the study of mainstream American culture. Using a variety of materials in different media, students explore how the country's history, geography, institutions, traditions and values have shaped contemporary communication styles and responses to critical events in the world. Students examine and practice principles of effective communication in genres common to the humanities and social sciences. Explores how discourse practices vary within and across cultures. Assignments include an educational memoir, project proposal, annotated bibliography, research-based cultural analysis of a current event of choice, and presentation. Limited to 18.  
_J. Dunphy_
21G.222 Expository Writing for Bilingual Students
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-HW
Can be repeated for credit.
Formulating, organizing, and presenting ideas clearly in writing. Reviews basic principles of rhetoric. Focuses on development of a topic, thesis, choice of appropriate vocabulary, and sentence structure to achieve purpose. Develops idiomatic prose style. Gives attention to grammar and vocabulary usage. Special focus on strengthening skills of bilingual students. Intended to be taken during the student’s first year at MIT. Limited to 18; undergraduates only.
E. Grunwald, A. C. Kemp

21G.223 Listening, Speaking and Pronunciation (ELS)
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H
Can be repeated for credit. Credit cannot also be received for 21G.224
Designed for high intermediate ELS students who need to develop better listening comprehension and oral skills. Involves short speaking and listening assignments with extensive exercises in accurate comprehension, pronunciation, stress and intonation, and expression of ideas. Includes frequent video- and audio-recording for analysis and feedback. Meets with 21G.224 when offered concurrently. Limited to 18 per section.
A. Kemp, E. Grunwald

21G.226 Advanced Workshop in Writing for Science and Engineering (ELS)
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H
Can be repeated for credit. Credit cannot also be received for 21G.225
Analysis and practice of various forms of scientific and technical writing, from memos to journal articles. Strategies for conveying technical information to specialist and non-specialist audiences. Comparable to 21W.780, but methods designed to deal with special problems of advanced ELS or bilingual students. The goal of the workshop is to develop effective writing skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. Meets with 21G.225 when offered concurrently. Limited to 18 per section.
J. Dunphy, A. C. Kemp

21G.228 Advanced Workshop in Writing for Social Sciences and Architecture (ELS)
Prereq: None
U (Spring)
3-0-9 units. HASS-H
Can be repeated for credit. Credit cannot also be received for 21G.227
Focuses on techniques, format, and prose used in academic and professional life. Emphasis on writing required in fields such as economics, political science, and architecture. Short assignments include business letters, memos, and proposals that lead toward a written term project. Methods designed to accommodate those whose first language is not English. Develops effective writing skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. May be repeated for credit with permission of instructor. Limited to 18.
A. C. Kemp

21G.233 Advanced Speaking and Critical Listening Skills (ELS)
Prereq: None
U (Spring)
3-3-6 units. HASS-H
Can be repeated for credit. Credit cannot also be received for 21G.232
For advanced students who wish to build confidence and skills in spoken English. Focuses on the appropriate oral presentation of material in a variety of professional contexts: group discussions, classroom explanations and interactions, and theses/research proposals. Valuable for those who intend to teach or lecture in English. Includes frequent video- and audio-recording for analysis and feedback. Develops effective speaking and listening skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. May be repeated for credit with permission of the instructor. Meets with 21G.232 when offered concurrently. Limited to 15 per section.
J. Dunphy, A. C. Kemp
21G.237 MIT Out Loud: Public Speaking for Bilingual Students (New)
Prereq: None
U (Fall)
3-0-9 units. HASS-H
Can be repeated for credit.

Develops oral communication skills for bilingual students through the lens of the MIT experience. Speaking assignments in informative and persuasive speech forms draw on examples of popular culture and MIT touchstones, such as “alternative” campus tours, interviews, MIT 100K pitches, and TED talks. Explores the role of voice and body language through improvisation and impromptus. Focuses on spoken accuracy and vocabulary through oral exercises designed for bilingual students. Frequent video-recording will be used for self-evaluation. Limited to 15.
A. Kemp

21G.240 Imagining English: Creative Writing for Bilingual Students (New)
Prereq: 21G.222 or other CI-H/CI-HW subject
U (Spring)
3-0-9 units. HASS-A

Instruction for bilingual students in writing short stories and poems in English. Involves the study of craft, revision, and creativity, as well as close reading of important works by American, British, and non-native writers’ writing in English. Analyzes “the limits of English” through group discussions of student writing to distinguish linguistic freshness from grammatical incorrectness, with review of relevant rules. Includes academic and non-academic vocabulary building, a formal writing process, literary analysis essays, short translations to and from students’ native languages, and the workshopping (peer reviewing) of creative work. Limited to 18.
E. Grunwald

Graduate Subjects

21G.217 Workshop in Strategies for Effective Teaching (ELS)
Prereq: None
G (IAP; partial term)
Not offered regularly; consult department
1-0-2 units
Credit cannot also be received for 21G.218

A mini-module for international teaching assistants. Covers special problems in teaching when English is a second language and the USA a second culture. Videotaping of practice sessions for feedback. Individualized programs to meet different needs. Graduate TA’s have priority. Limited to 18.
A. C. Kemp

21G.219 Foundations of Academic and Professional Writing (ELS)
Prereq: None
G (Fall, Spring)
3-0-9 units
Can be repeated for credit. Credit cannot also be received for 21G.220

Writing module for high-intermediate ELS students who wish to review and practice accurate grammar, effective sentence and paragraph structure, punctuation and word choice. Short weekly writing assignments with extensive editing required. Meets with 21G.220 when offered concurrently. Limited to 18.
E. Grunwald

21G.224 Listening, Speaking, and Pronunciation (ELS)
Prereq: None
G (Fall, Spring)
3-0-9 units
Can be repeated for credit. Credit cannot also be received for 21G.223

Designed for high intermediate ELS students who need to develop better listening comprehension and oral skills. Involves short speaking and listening assignments with extensive exercises in accurate comprehension, pronunciation, stress and intonation, and expression of ideas. Includes frequent video- and audio-recording for analysis and feedback. Meets with 21G.223 when offered concurrently. Limited to 18 per section.
E. Grunwald

21G.225 Advanced Workshop in Writing for Science and Engineering (ELS)
Prereq: None
G (Fall, Spring)
3-0-9 units
Can be repeated for credit. Credit cannot also be received for 21G.226

Analysis and practice of various forms of scientific and technical writing, from memos to journal articles. Strategies for conveying technical information to specialist and non-specialist audiences. Comparable to 21W.780 but methods designed to deal with special problems of advanced ELS or bilingual students. The goal of the workshop is to develop effective writing skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. Meets with 21G.226 when offered concurrently. Limited to 18 per section.
J. Dunphy
21G.227 Advanced Workshop in Writing for Social Sciences and Architecture (ELS)
Prereq: None
G (Spring)
3-0-9 units
Can be repeated for credit. Credit cannot also be received for 21G.228

Focuses on techniques, format, and prose used in academic and professional life. Emphasis on writing required in fields such as economics, political science, and architecture. Short assignments include business letters, memos, and proposals that lead toward a written term project. Methods designed to accommodate those whose first language is not English. Develops effective writing skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. May be repeated for credit with permission of instructor. Limited to 18 per section.
A. C. Kemp

21G.232 Advanced Speaking and Critical Listening Skills (ELS)
Prereq: None
G (Fall, Spring)
3-3-6 units
Can be repeated for credit. Credit cannot also be received for 21G.233

For advanced students who wish to build confidence and skills in spoken English. Focuses on the appropriate oral presentation of material in a variety of professional contexts: group discussions, classroom explanations and interactions, and theses/research proposals. Valuable for those who intend to teach or lecture in English. Includes frequent video- and audio-recording for analysis and feedback. Develops effective speaking and listening skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. May be repeated for credit with permission of the instructor. Meets with 21G.233 when offered concurrently. Limited to 15 per section.
J. Dunphy, A. C. Kemp

French

The subjects below are taught in French and include offerings in language, literature, and cultural studies.
The indication of prerequisites for specific French offerings does not apply to students who have already completed equivalent work. For further placement advice, consult one of the field advisors in French.

Fundamental Language Subjects

21G.301 French I
Subject meets with 21G.351
Prereq: None
U (Fall, IAP, Spring)
3-1-8 units. HASS-H

Introduction to the French language and culture with emphasis on the acquisition of vocabulary and grammatical concepts through active communication. Conducted entirely in French. Exposure to the language via a variety of authentic sources such as the Internet, audio, video and printed materials which help develop cultural awareness as well as linguistic proficiency. Coordinated language lab program. For graduate credit see 21G.351. Limited to 18 per section.
Consult L. Rezvani

21G.302 French II
Subject meets with 21G.352
Prereq: 21G.301 or permission of instructor
U (Fall, Spring)
3-1-8 units. HASS-H

Continuation of introductory course to the French language and culture with emphasis on acquisition of vocabulary and grammatical concepts through active communication. Conducted entirely in French. Exposure to the language via a variety of authentic sources such as the Internet, audio, video and printed materials which help develop cultural awareness as well as linguistic proficiency. Coordinated language lab. For graduate credit see 21G.352. Limited to 18 per section.
L. Rezvani

21G.303 French III
Prereq: 21G.302 or permission of instructor
U (Fall, Spring)
3-1-8 units. HASS-H

Third subject in the French language sequence. Systematic work on grammar and vocabulary expands skills in understanding, speaking, reading and writing in French. Intercultural exploration through a variety of authentic materials, such as music, videos, films, newspapers, and excerpts from literary texts. Limited to 18 per section.
C. Culot
21G.304 French IV
Prereq: 21G.303 or permission of instructor
U (Fall, Spring)
3-1-8 units. HASS-H

Fourth subject in the French language sequence. Focuses on language and intercultural understanding. Students work with a variety of materials such as surveys, newspapers, commercials, films and music. Systematic work on grammar and vocabulary expands students’ skills in understanding, speaking, reading and writing. Limited to 18 per section.
S. Levet

21G.306 French: Communication Intensive I
Prereq: None. Coreq: 21G.308, 21G.310, 21G.311, 21G.312, 21G.315, 21G.320, 21G.321, or 21G.322[1]; permission of instructor
U (Fall, Spring)
3-0-0 units

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. 21G.307 builds on writing and speaking skills acquired in 21G.306. Conducted entirely in French. Preference to French majors.
Information: B. Perreau

21G.307 French: Communication Intensive II
Prereq: None. Coreq: 21G.308, 21G.310, 21G.311, 21G.312, 21G.315, 21G.320, 21G.321, or 21G.322[1]; permission of instructor
U (Fall, Spring)
3-0-0 units

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. 21G.307 builds on writing and speaking skills acquired in 21G.306. Conducted entirely in French. Preference to French majors.
Information: B. Perreau

Intermediate Subjects in Language, Literature, and Culture
Native speakers of French who have studied French literature at a high-school level must obtain permission of the instructor to enroll in any of these subjects.

21G.308 Writing (Like the) French
Prereq: 21G.304 or permission of instructor
U (Spring)
3-0-9 units. HASS-H

For students who wish to continue with language study before taking upper-level subjects in literature or culture. Emphasis on development of reading and writing skills, review of the basic concepts of French grammar, and acquisition of precise vocabulary through the use of printed materials, short stories, and poems. Taught in French.
C. Culot

21G.310 French Conversation: Intensive Practice
Prereq: 21G.304 or permission of instructor
U (Fall)
3-0-9 units. HASS-H

Training in oral expression including communication skills, fluency, idiomatic French and pronunciation. Discussion materials include short literary and sociological texts, recent films, varied audio and digitized video interviews and the Internet. Taught in French. Limited to 16.
L. Rezvani

21G.311 Introduction to French Culture
Prereq: 21G.304 or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Examines major social and political trends, events, debates and personalities which help place various aspects of contemporary French culture in their historical perspective. Topics include the heritage of the French Revolution, the growth and consequences of colonialism, the role of intellectuals in public debates, the impact of the Occupation, the modernization of the economy and of social structures. Also studied are the sources and meanings of national symbols, monuments, myths and manifestoes. Documents include fiction, films, essays, newspaper articles, and television shows. Recommended for students planning to study abroad. Taught in French.
Consult C. Clark
21G.312 Basic Themes in French Literature and Culture
Prereq: 21G.304 or permission of instructor
U (Fall, Spring)
3-0-9 units. HASS-H
Can be repeated for credit.

Introduction to literary and cultural analysis through the close reading and discussion of texts united by a common theme. Taught in French.
Consult I. Nicholas

21G.315 A Window onto Contemporary French Society
Prereq: 21G.304 or permission of instructor
U (Spring)
3-0-9 units. HASS-H

Intermediate subject designed to help students gradually build an in-depth understanding of France. Focuses on French attitudes and values regarding education, work, family, and institutions. Deals with the differing notions that underlie interpersonal interactions and communication styles, such as politeness, friendship, and formality. Using a Web comparative, cross-cultural approach, students explore a variety of French and American materials, then analyze and compare using questionnaires, opinion polls, news reports (in different media), as well as a variety of historical, anthropological and literary texts. Students involved in team research projects. Attention given to the development of relevant linguistics skills. Recommended for students planning to study and work in France. Taught in French.
B. Perreau

Advanced Subjects in Literature and Culture

21G.320 Introduction to French Literature
Prereq: 21G.304 or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

A basic study of major French literary genres — poetry, drama, and fiction — and an introduction to methods of literary analysis. Authors include: Voltaire, Balzac, Sand, Baudelaire, Apollinaire, Camus, Sartre, Ionesco, Duras, and Tournier. Special attention devoted to the improvement of French language skills. Taught in French.
L. Rezvani

21G.321 Childhood and Youth in French and Francophone Cultures
Prereq: One intermediate subject in French
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Studies the transformation of childhood and youth since the 18th century in France, as well as the development of sentimentality within the family in a francophone context. Examines the personification of children, both as a source of inspiration for artistic creation and a political ideal aimed at protecting future generations. Considers various representations of childhood and youth in literature (e.g., Pagnol, Proust, Sarraute, Laye, Morgièvre), movies (e.g., Truffaut), and songs (e.g., Brel, Barbara). Taught in French.
S. Levet

21G.322 Frenchness in an Era of Globalization
Same subject as 21H.242
Prereq: One intermediate subject in French or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Approaches the question of what constitutes Frenchness in today's era of globalization through issues of memory, belonging, and cultural production. Explores the role of timeless traditions - common technologies, an internationally-spoken language, monuments open to the world, and foods such as wine and cheese - remain quintessentially French. Also covers recent scandals about France's role in the world, such as its colonial identity and Dominique Strauss-Kahn's New York debacle. Taught in French. Limited to 18.
C. Clark
21G.325[J] New Culture of Gender: Queer France
Same subject as WGS.233[J]
Prereq: One intermediate subject in French
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H
Can be repeated for credit.

Addresses the place of contemporary queer identities in French discourse. Discusses the new generation of queer authors and their principal concerns. Introduces students to the main classical references of queer subcultures, from Proust and Vivien to Hocquenghem and Wittig. Examines current debates on post-colonial and globalized queer identities through essays, songs, movies, and novels. Authors include Didier Eribon, Anne Garrêta, Abdellah Taïa, Anne Scott, and Nina Bouraoui. Taught in French.
B. Perreau

21G.326 Global Africa: Creative Cultures
Subject meets with 21G.026
Prereq: 21G.304 or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-10 units. HASS-H

Examines contemporary and historical cultural production on and from Africa across a range of registers, including literary, musical and visual arts, material culture, and science and technology. Employs key theoretical concepts from anthropology and social theory to analyze these forms and phenomena. Uses case studies to consider how Africa articulates its place in, and relationship to, the world through creative practices. Discussion topics largely drawn from Francophone and sub-Saharan Africa, but also from throughout the continent and the African diaspora. Taught in English with a project that requires research in French. Limited to 18.
A. Edoh

21G.328 African Migrations
Subject meets with 21G.028
Prereq: 21G.304 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-10 units. HASS-H

Examines West African migration to France and to the United States from the early 20th century to the present. Centering the experiences of African social actors and historicizing recent dynamics, students consider what migration across these three regions reveals about African projects of self-determination, postcolonial nation-building, and global citizenship. Students also comparatively analyze the workings of contemporary French and American societies, in particular, the articulations of race and citizenship in the two nations. Taught in English with a project that requires research in French. Limited to 18.
A. Edoh

21G.341 Contemporary French Film and Social Issues
Prereq: 21G.304 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
2-2-8 units. HASS-H

Issues in contemporary French society as expressed through movies made in the 1990s. Topics include France's national self-image, the women's movement, sexuality and gender, family life and class structure, post-colonialism and immigration, and American cultural imperialism. Films by Lelouch, Audiard, Doillon, Denis, Klapisch, Resnais, Rouan, Balasko, Collard, Dridi, Kassovitz, and others. Readings from French periodicals. Films shown with English subtitles. Taught in French.
C. Clark

21G.342 French Pop Music (New)
Prereq: 21G.304 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Studies the literary, political and social traditions of "la chanson française" from the early 20th century to the present. Discusses the influences of world music on both French and francophone songs. Students investigate individual musicians' careers, as well as generational phenomena, such as cabaret songs, yéyé, and French rap. Examines the impact of social media on the music industry in France, the role of television and cinema, and the influence of dance and living art. Taught in French. Limited to 18.
B. Perreau
Same subject as WGS.321[J]
Prereq: One intermediate subject in French or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H
Explores feminist literary voices in France throughout the ages.
Discusses the theory that the power of feminist writing lies in its ability to translate dominant language into a language of one’s own. Studies lifestyles, family norms, political representation, social movements, as well as the perception of the body. Investigates how feminist genealogies redefine the relationship between belonging and knowledge through a dialogue between several generations of women writers. Taught in French. Limited to 18.
B. Perreau

21G.346 Topics in Modern French Literature and Culture
Prereq: One intermediate subject in French
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
Can be repeated for credit.
Close study of history and criticism of French literature, focusing on a specific group of writers, a movement, a theme, a critical or theoretical issue, or an analytic approach. May be repeated for credit with permission of instructor. Taught in French.
Consult B. Perreau

21G.347 Social and Literary Trends in Contemporary Short French Fiction
Prereq: One intermediate subject in French or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H
Examines short stories and short novels published in France during the past 20 years, with emphasis on texts related to the dominant social and cultural trends. Themes include the legacy of France’s colonial experience, the re-examination of its wartime past, memory and the Holocaust, the specter of AIDS, changing gender relationships, new families, the quest for personal identity, and immigration narratives. Covers a wide variety of authors, including Christine Angot, Nina Bouraoui, Herve Guibert, and Patrick Modiano. Taught in French.
B. Perreau

21G.348 Global Paris
Prereq: One intermediate subject in French or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Investigates Paris' oversized status as a global capital by looking at the events, transformations, cultures, and arts for which the city is known. Explores Paris as a magnet for immigrants, and how their presence has transformed the city. Takes into account the city as a mythic place, dreamed of and reconstructed as far away as Bollywood and Las Vegas. Provides a deeper understanding of Paris and its current place in French and global cultures. Taught in French.
C. Clark

Graduate Language Subjects

21G.351 French I
Subject meets with 21G.301
Prereq: None
G (Fall, IAP, Spring)
3-1-5 units
Introduction to the French language and culture with emphasis on acquisition of vocabulary and grammatical concepts through active communication. Conducted entirely in French. Exposure to the language via a variety of authentic sources such as the Internet, audio, video and printed materials which help develop cultural awareness and linguistic proficiency. Coordinated language lab program. Meets with 21G.371 when offered concurrently. Limited to 18 per section.
C. O’Connor

21G.352 French II
Subject meets with 21G.302
Prereq: 21G.351
G (Fall, Spring)
3-1-5 units
Continuation of introductory course to the French language and culture with emphasis on acquisition of vocabulary and grammatical concepts through active communication. Conducted entirely in French. Exposure to the language via a variety of authentic sources such as the Internet, audio, video and printed materials which help develop cultural awareness as well as linguistic proficiency. Coordinated language lab. Same as 21G.372, but for graduate credit. Meets with 21G.372 when offered concurrently. Limited to 18 per section.
L. Rezvani
German

The subjects below are taught in German and include offerings in language, literature, and cultural studies. The indication of prerequisites for specific German offerings does not apply to students who have already completed equivalent work. For further placement advice, consult one of the field advisors in German.

Fundamental Language Subjects

21G.401 German I
Subject meets with 21G.451
Prereq: None
U (Fall, IAP, Spring)
4-0-8 units. HASS-H

Introduction to German language and culture. Acquisition of vocabulary and grammatical concepts through active communication. Audio, video, and printed materials provide direct exposure to authentic German language and culture. Self-paced language lab program is fully coordinated with textbook/workbook. Development of effective basic communication skills. For graduate credit see 21G.451. Limited to 18 per section.

A. Nguyen

21G.402 German II
Subject meets with 21G.452
Prereq: 21G.401 or permission of instructor
U (Fall, IAP, Spring)
4-0-8 units. HASS-H

Expansion of basic communication skills and further development of linguistic competency. Review and completion of basic grammar, building of vocabulary, and practice in writing short essays. Reading of short literary texts. Exposure to history and culture of German-speaking countries through audio, video, and Web materials. For graduate credit see 21G.452. Limited to 18 per section.

D. Jaeger

21G.403 German III
Prereq: 21G.402 or permission of instructor
U (Fall, Spring)
4-0-8 units. HASS-H

Expands skills in speaking, reading, listening, and writing. Develops analytic and interpretative skills through the reading of a full-length drama as well as short prose and poetry (Dürrenmatt, Boll, Borchert, and others) and through media selections on contemporary issues in German-speaking cultures. Discussions and compositions based on these texts. Review of grammar and development of vocabulary-building strategies. Recommended for students with two years of high school German. Limited to 18 per section.

E. Crocker

21G.404 German IV
Prereq: 21G.403 or permission of instructor
U (Fall, Spring)
4-0-8 units. HASS-H

Development of interpretive skills, using literary texts (B. Brecht, S. Zweig) and contemporary media texts (film, TV broadcasts, Web materials). Discussion and exploration of cultural topics in their current social, political, and historical context via hypermedia documentaries. Further refinement of oral and written expression and expansion of communicative competence in practical everyday situations. Limited to 18 per section.

D. Jaeger

21G.406 German: Communication Intensive I
U (Fall, Spring)
3-0-0 units

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. 21G.407 builds on writing and speaking skills acquired in 21G.406. Conducted entirely in German. Preference to German majors.

Information: B. Stoetzer

21G.407 German: Communication Intensive II
U (Fall, Spring)
3-0-0 units

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. 21G.407 builds on writing and speaking skills acquired in 21G.406. Conducted entirely in German. Preference to German majors.

Information: B. Stoetzer
**Intermediate Subjects in Language, Literature, and Culture**

**21G.405 Intermediate German: Intensive Study of Language and Culture**
Prereq: 21G.403 or permission of instructor
U (IAP)
Not offered regularly; consult department
4-0-8 units. HASS-H

Prepares students for working and living in German-speaking countries. Focuses on current political, social, and cultural issues, using newspapers, TV, radio broadcasts, podcasts, and Web sources from Germany, Austria, and Switzerland. Emphasizes speaking and listening skills for professional contexts. Project-based course includes oral presentations, group discussions, guest lectures, and live interviews with German speakers. Progress tracked with student portfolios. Taught in German. No listeners.

*E. Crocker*

**21G.409 Advanced German: Visual Arts, Media, Creative Expression**
Prereq: 21G.404
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A

Students develop their spoken and written language skills via storytelling, drama, interpretative speaking, poetry slam, writing short, creative texts; and by reading contemporary prose, plays, and poetry. Explores different art forms such as short film, photography, installation and digital art, and commercials. Discusses works by Yoko Tawada, Ernst Jandl, and Babak Saed, among others. Students create their own mini-film, commercial, or multimedia work. Taught in German.

*D. Jaeger*

**21G.410 Advanced German: Communication for Professionals**
Prereq: 21G.404
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Exposes students to current issues and language use in German technology, business, and international industrial relations; discusses ramifications of these issues in a larger social and cultural context. Prepares students who wish to work or study in a German-speaking country. Focuses on specialized vocabulary and systematic training in speaking and writing skills to improve fluency and style. Emphasizes communicative strategies that are crucial in a working environment. Includes discussion and analysis of newspaper and magazine articles, modern expository prose, and extensive use of online material. Taught in German.

*R. Sondermann*

**21G.412 Advanced German: Literature and Culture**
Prereq: 21G.404 or permission of instructor
U (Fall)
3-0-9 units. HASS-H
Can be repeated for credit.

Provides the opportunity to discuss, orally and in writing, cultural, ethical, and social issues on a stylistically sophisticated level. Explores representative and influential works from the 19th century to the present, through literary texts (prose, drama, poetry), radio plays, art, film, and architecture. Investigates topics such as the human and the machine, science and ethics, representation of memory, and issues of good and evil. Includes works by E.T.A. Hoffmann, Kafka, Brecht, Dürenmatt, Süskind, and W.G. Sebald. Topics and authors vary from term to term. May be repeated for credit with permission of instructor. Taught in German.

*D. Jaeger*

**Advanced Subjects in Language, Literature, and Culture**

**21G.414 German Culture, Media, and Society**
Prereq: 21G.404
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H
Can be repeated for credit.

Investigates current trends and topics in German literature, theater, film, television, radio, and other media arts productions. Analyzes media texts in the context of their production, reception, and distribution as well as the public debates initiated by these works. Students have the opportunity to discuss topics with a writer, filmmaker, and/or media artist from Germany. Taught in German. Topics vary from term to term.

*K. Fendt*

**21G.415 Germany and Its European Context**
Prereq: 21G.404
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H
Can be repeated for credit.

Examines the historical, political, and sociological forces that shape present-day Germany. Topics vary and may include: value changes in postwar society, coping with the legacy of the past, multiculturalism in Germany, change of gender roles, cultural differences between East and West after the unification, the role of environmentalism, the process of European integration, and Germany and its neighbors. Draws on current articles, texts and videos from newspapers, journals, the Web, and German TV. Integrates and contextualizes the first-hand experiences of German society. Taught in German.

*Staff*
21G.416 20th- and 21st-Century German Literature
Prereq: 21G.404
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H
Can be repeated for credit.
Introduces students to important 20th- and 21st-century literary texts and connects them to the often dramatic course of German history in the last century. Surveys German literature from the beginning of the 20th century to the most recent post-unification texts. Each term focuses on a different broader theme. May be repeated for credit with permission of instructor. Taught in German. Consult E. Crocker

21G.417 Cultural Geographies of Germany: Nature, Culture, and Politics
Prereq: 21G.404 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
Examines the relationship between nature, geography, and power in 20th- and 21st-century German culture. Familiarizes students with a series of themes in literature, science, engineering, urban planning and everyday life that have played a central role in German national imaginaries and concepts of citizenship. Engaging specific examples and historical, ethnographic, literary and visual material, students explore how human-environment relations have figured prominently in German national identity, its economic power, and global connections. Taught in German.
B. Stoetzer

21G.418 Race and Migration in Europe
Subject meets with 21A.132[J], 21G.058[J]
Prereq: 21G.404 or permission of instructor
U (Fall)
3-0-10 units. HASS-H; CI-H
Addresses the shifting politics of nation, ethnicity, and race in the context of migration and globalization in Germany and Europe. Provides students with analytical tools to approach global concerns and consider Europe and Germany from cross-cultural and interdisciplinary perspectives. Familiarizes students with the ways in which histories of migration, travel, and colonial encounters shape contemporary Europe. Introduces the concepts of transnationalism, diasporic cultures, racism, ethnicity, asylum, and mobility via case studies and materials, including film, ethnography, fiction, and autobiography. Taught in English with a project that requires research and writing in German. Limited to 18.
B. Stoetzer

21G.420 Visual Histories: German Cinema 1945 to Present
Prereq: 21G.404 or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
2-2-8 units. HASS-A
Can be repeated for credit.
Studies the history, aesthetics, and cultural contexts of German film since the end of World War II. Explores films of the “New German Cinema” by filmmakers Fassbinder, Wenders, Herzog, and others. Investigates and compares different film traditions of East and West Germany, new aesthetic styles of the “Berlin School” after the fall of the Berlin wall, and new filmic concepts in contemporary productions, including films from filmmakers with migration backgrounds. Special focuses on the analysis of the language of film, different genres, and aesthetic traditions in their historical and societal contexts. Taught in German. Limited to 18.
K. Fendt

Graduate Language Subjects

21G.451 German I
Subject meets with 21G.401
Prereq: None
G (Fall, IAP, Spring)
4-0-5 units
Introduction to German language and culture. Acquisition of vocabulary and grammatical concepts through active communication. Audio, video, and printed materials provide direct exposure to authentic German language and culture. Self-paced language lab program is fully coordinated with textbook/workbook. Development of effective basic communication skills. Same as 21G.401, but for graduate credit. Meets with 21G.471 when offered concurrently. Limited to 18 per section.
A. Nguyen

21G.452 German II
Subject meets with 21G.402
Prereq: 21G.451 or permission of instructor
G (Fall, IAP, Spring)
4-0-5 units
Expansion of basic communication skills and further development of linguistic competency. Review and completion of basic grammar, building of vocabulary, and practice in writing short essays. Reading of short literary texts. Exposure to history and culture of German-speaking countries through audio, video and web materials. Same as 21G.402, but for graduate credit. Limited to 18 per section.
D. Jaeger
**Japanese**

The subjects below are taught in Japanese and include offerings in language, literature, and cultural studies. The indication of prerequisites for specific Japanese offerings does not apply to students who have already completed equivalent work. For further placement advice, consult one of the field advisors in Japanese.

**Fundamental Language Subjects**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Prerequisites</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.501</td>
<td>Japanese I</td>
<td>None</td>
<td>4-0-8</td>
<td>Introduction to modern standard Japanese. Emphasis on developing proficiency in speaking and listening, using basic grammar and vocabulary. Basic skills in reading and writing are also taught. Lab work required. For graduate credit see 21G.551. Limited to 16 per section.</td>
</tr>
<tr>
<td>21G.502</td>
<td>Japanese II</td>
<td>21G.501 or placement test and permission of instructor</td>
<td>4-0-8</td>
<td>Enhancement of the four basic skills. Extension of basic grammar. Vocabulary and \textit{kanji} (Chinese characters) building. Lab work required. For graduate credit see 21G.552. Limited to 16 per section.</td>
</tr>
<tr>
<td>21G.503</td>
<td>Japanese III</td>
<td>21G.502 or placement test and permission of instructor</td>
<td>4-0-8</td>
<td>Students further develop their skills in speaking, listening, reading and writing. Involves continued vocabulary and \textit{kanji} building. Coordinated language lab. Limited to 16 per section.</td>
</tr>
</tbody>
</table>

**Graduate Language Subjects**

<table>
<thead>
<tr>
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<th>Title</th>
<th>Prerequisites</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.504</td>
<td>Japanese IV</td>
<td>21G.503 or placement test and permission of instructor</td>
<td>U (Spring)</td>
<td>4-0-8 units. HASS-H. Review and expansion of basic skills. Emphasis on application of basic grammar and vocabulary in various situations. Lab work required. Limited to 16 per section.</td>
</tr>
<tr>
<td>21G.505</td>
<td>Japanese V</td>
<td>21G.504 or placement test and permission of instructor</td>
<td>U (Fall)</td>
<td>Systematic development of reading, writing, and oral communication skills. Introduction to advanced grammar that deepens the understanding of Japanese culture and society through reading and discussion. Lab work required. Limited to 16 per section.</td>
</tr>
<tr>
<td>21G.506</td>
<td>Japanese VI</td>
<td>21G.505 or placement test and permission of instructor</td>
<td>U (Spring)</td>
<td>3-0-9 units. HASS-H. Continuation of 21G.505. Further development of reading, writing, and oral communication skills. Extension of advanced grammar and further enhancement of advanced vocabulary. Variety of cultural elements studied through readings, video, and discussion. Lab work required.</td>
</tr>
</tbody>
</table>

Consult M. Ikeda

Consult W. Maekawa
21G.552 Japanese II
Subject meets with 21G.502
Prereq: 21G.551 or (placement test and permission of instructor)
G (Spring)
4-0-5 units
Enhancement of the four basic skills. Extension of basic grammar.
Vocabulary and kanji (Chinese characters) building. Lab work required. Same as 21G.502, but for graduate credit. Limited to 16 per section.
Consult W. Maekawa

Japanese Language Option Subjects

21G.590 Visualizing Japan in the Modern World
Subject meets with 21G.027[J], CMS.874[J]
Prereq: 21G.504 or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-10 units. HASS-H; CI-H
Studies how visual images shape the identity of peoples, cultures, and events in Japan. Uses visuals from major collections in the US and Japan to introduce the conceptual and practical issues involved in "visualizing cultures." Projects look at American and Japanese graphics depicting contacts between Japan and the West in the 19th and early 20th centuries. Taught in English with a project that requires research in Japanese. Uses material and features of edX subject, including videos and online discussion. Enrollment limited; preference to Japanese minors.
S. Miyagawa

21G.591 Gender and Japanese Popular Culture
Subject meets with 21A.143[J], 21G.039[J], WGS.154[J]
Prereq: 21G.504 or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-10 units. HASS-H
Examines relationships between identity and participation in Japanese popular culture as a way of understanding the changing character of media, capitalism, fan communities, and culture. Emphasizes contemporary popular culture and theories of gender, sexuality, race, and the workings of power and value in global culture industries. Topics include manga (comic books), hip-hop and other popular music, anime and feature films, video games, contemporary literature, and online communication. Students present analyses of materials during in-class discussions and develop a final project based on a particular aspect of gender and popular culture. Several films screened outside of regular class meeting times. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.
I. Condry

21G.592 Introduction to Japanese Culture
Subject meets with 21G.064
Prereq: 21G.504 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-10 units. HASS-H; CI-H
Examines the major aesthetic, social, and political elements that have shaped modern Japanese culture and society. Includes readings on contemporary Japan and the historical evolution of the culture. Students study literary texts, film and art, and analyze everyday life and leisure activities. Taught in English with a project that requires research in Japanese. Limited to 18; preference to Japanese minors.
Consult P. Roquet

21G.593 Japanese Literature and Cinema
Subject meets with 21G.065
Prereq: 21G.504 or permission of instructor
U (Fall)
3-0-10 units. HASS-H; CI-H
Surveys both cinematic and literary representations of diverse eras and aspects of Japanese culture, with emphasis on the modern period. Includes topics such as the classical era, the samurai age, wartime Japan and the atomic bombings, social change in the postwar period, and the appropriation of foreign cultural themes. Directors include Akira Kurosawa and Hiroshi Teshigahara. Authors include Kobo Abe and Yukio Mishima. Films shown with subtitles in English. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.
Consult P. Roquet

21G.594 Cinema in Japan and Korea
Subject meets with 21G.094
Prereq: 21G.504 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-10 units. HASS-A
Focuses on landmark art cinema from both countries while providing a thorough introduction to film style. Each week examines a different component of film form, using the close analysis of specific films in their cultural and historical context. Explores the use of video essays as a form of critical analysis. Taught in English with a project that requires research in Japanese. Preference to Japanese minors. Limited to 18.
P. Roquet
21G.595 Cultures of Music in East Asia: Japan, Korea, China (New)
Subject meets with 21G.095
Prereq: 21G.504 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-10 units. HASS-A
Explores a variety of music cultures in contemporary East Asia. Emphasizes examples from Japan, but forays elsewhere, including South Korea and China. Uses writings, videos, and recordings of musical performances, events, and objects in a variety of contexts to better understand how the concept of culture gives insight into gender, class, sexuality, race, ethnicity, nationhood, and individual identities. Explores ethno-graphic approaches to musical cultures with a focus on the last thirty years. Topics include Japanese hip-hop, K-Pop idols, Vocaloids (virtual idols), Chinese popular music and protest, street music, streaming and online distribution for global music, and experimental music. Students conduct ethnographic fieldwork and produce sonic presentations. No music experience nor technical expertise required. Taught in English with a project that requires research in Japanese.
I. Condry

21G.596 Anime: Transnational Media and Culture
Subject meets with 21G.063
Prereq: 21G.504 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-10 units. HASS-H
Explores anime (Japanese animated films and TV shows) as a study in flows among media and cultures. Discusses Japan’s substantial share of the TV cartoon market and the reasons for anime’s worldwide success. Focuses on cultural production and the ways anime cultures are created through the interactive efforts of studios, sponsors, fans, broadcasters, and distributors. Uses anime scholarship and media examples as a means to examine leading theories in media and cultural studies, gender and sexuality, technology and identity, and post-industrial globalization. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.
I. Condry

21G.597 Digital Media in Japan and Korea
Subject meets with 21G.067
Prereq: 21G.504 or permission of instructor
U (Fall)
3-0-10 units. HASS-H
Examines the social, cultural, and political stakes of digital culture in Japan and Korea. Focuses on digital media use (and abuse), including the internet, streaming and mobile media, gaming, robots, and augmented realities; the digital remediation of older media; and methods for the study of online life. By considering how digital media use has developed in each country and reshaped identity, politics, public space, and creative practice, students build a conceptual and critical vocabulary for the comparative study of algorithmic cultures. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.
P. Roquet

Italian

Fundamental Language Subjects

21G.601 Italian I
Subject meets with 21G.651
Prereq: None
U (IAP)
Not offered regularly; consult department
4-0-8 units. HASS-H
Focus on basic oral expression, listening comprehension, and elementary reading and writing. Emphasis on the acquisition of vocabulary and grammatical concepts through active communication. Designed for students with no knowledge of Italian. Audio, video, and printed materials provide direct exposure to authentic Italian language and culture.
Staff

21G.651 Italian I
Subject meets with 21G.601
Prereq: None
G (IAP)
Not offered regularly; consult department
4-0-5 units
Focus on basic oral expression, listening comprehension, and elementary reading and writing. Emphasis on the acquisition of vocabulary and grammatical concepts through active communication. Designed for students with no knowledge of Italian. Audio, video, and printed materials provide direct exposure to authentic Italian language and culture.
Staff
Portuguese

The subjects below are taught in Portuguese and include offerings in language, literature, and cultural studies. The indication of prerequisites for specific Portuguese offerings does not apply to students who have already completed equivalent work. For further placement advice, consult one of the field advisors in Portuguese.

Fundamental Language Subjects

21G.800 Accelerated Introductory Portuguese
Prereq: None
U (Spring)
4-0-8 units. HASS-H
Credit cannot also be received for 21G.802, 21G.852, 21G.855, 21G.880

Accelerated introduction to the language and culture of the Portuguese-speaking world, with special attention to Brazilian Portuguese. For students with little or no previous knowledge of Portuguese. Introduction to understanding, speaking, reading, and writing Portuguese. Covers essential content of complete first-year Portuguese in one semester. Maximal use of fundamentals of grammar in active communication. Audio and video based language laboratory program coordinated with and supplemented to class work. Conducted in Portuguese. Limited to 18.  
N. Dominique

21G.801 Portuguese I
Subject meets with 21G.851
Prereq: None
U (IAP)
4-0-8 units. HASS-H

Introduction to the language and culture of the Portuguese-speaking world, with special attention to Brazilian Portuguese. Focuses on basic oral expression, listening comprehension, and elementary reading and writing. Students develop their vocabulary and understanding of grammatical concepts through active communication. Coordinated language lab program. Designed for students with no knowledge of Portuguese. Conducted entirely in Portuguese. For graduate credit, see 21G.851. Limited to 18.  
Consult N. Dominique

21G.802 Portuguese II
Prereq: 21G.801 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units. HASS-H
Credit cannot also be received for 21G.800, 21G.852, 21G.855, 21G.880

Continuation of 21G.801. Focuses on expanding communication skills and further development of linguistic competency. Uses a variety of authentic sources, such as the Internet, audio, video, and printed materials, to help develop cultural awareness and linguistic proficiency. Coordinated language lab. Conducted entirely in Portuguese. For graduate credit, see 21G.852. Limited to 18.  
N. Dominique

21G.803 Portuguese III
Prereq: 21G.802, 21G.880, or permission of instructor
U (Fall)
4-0-8 units. HASS-H

Expands the breadth and depth of students' skills in understanding, speaking, reading, and writing Portuguese while continuing to provide exposure to the history and cultures of the Portuguese-speaking world. Uses short stories, films and music to study issues of historical and current interest. Conducted entirely in Portuguese. Limited to 18.  
N. Dominique
21G.804 Portuguese IV  
Prereq: 21G.803 or permission of instructor  
U (Spring)  
4-0-8 units. HASS-H
Continued study of the language and culture to improve fluency, accuracy and style in both oral and written communication. Students discuss current news articles, short literary texts, films, music and web-based materials dealing with issues relevant to the Portuguese-speaking world. Coursework also includes grammar review. Conducted entirely in Portuguese. Limited to 18.  
N. Dominique

Intermediate Subjects in Language, Literature, and Culture

21G.811 Conversational Portuguese (New)  
Prereq: 21G.804 or permission of instructor  
U (Fall)  
3-0-9 units. HASS-H
Intermediate-level subject designed to build the student's vocabulary and improve oral communication through discussion of topics related to cultural and social aspects of Portuguese-speaking societies. Provides extensive listening and speaking practice in oral discourse, including dialogues, narrative and description, with great emphasis on everyday-life situations. Conducted entirely in Portuguese. Limited to 18.  
N. Dominique

21G.820 Topics in Modern Portuguese Literature and Culture  
Prereq: 21G.804 or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H  
Can be repeated for credit.
Close study of history and criticism of Portuguese literature, focusing on a specific group of writers, a movement, a theme, a critical or theoretical issue, or an analytic approach. May be repeated for credit with permission of instructor. Taught in Portuguese.  
N. Dominique

21G.821 The Beat of Brazil: Portuguese Language and Brazilian Society Through its Music  
Prereq: 21G.804 or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall)  
3-0-9 units. HASS-H
Presents an overview of Brazilian history, art, and culture from the late 19th century to the present day. Topics covered are woven into the larger theme of popular Brazilian music, and include the Modern Art Week of 1922, Cândido Portinari's paintings, the Tropicalist art movement, and the role of artists and intellectuals during and after the military dictatorship. Identifies and distinguishes the main Brazilian musical styles, connecting them to specific historical periods and events, discussing how they reflect different notions of identity, and analyzing cultural production from a transnational perspective. Focuses on listening and speaking, and reading and writing, with strong emphasis on developing critical thinking. Taught in Portuguese. Limited to 18.  
N. Dominique

Graduate Language Subjects

21G.851 Portuguese I  
Subject meets with 21G.801  
Prereq: None  
G (IAP)  
4-0-5 units
Introduction to the language and culture of the Portuguese-speaking world, with special attention to Brazilian Portuguese. Focuses on basic oral expression, listening comprehension, and elementary reading and writing. Students develop their vocabulary and understanding of grammatical concepts through active communication. Coordinated language lab program. Designed for students with no knowledge of Portuguese. Conducted entirely in Portuguese. For undergraduate credit, see 21G.801. Enrollment limited.  
Consult N. Dominique
21G.852 Portuguese II
Prereq: 21G.851 or permission of instructor
G (Spring)
Not offered regularly; consult department
4-0-5 units
Credit cannot also be received for 21G.800, 21G.802, 21G.855, 21G.880
Continuation of 21G.851. Focuses on expanding communication skills and further development of linguistic competency. Uses a variety of authentic sources, such as the Internet, audio, video, and printed materials, to help develop cultural awareness and linguistic proficiency. Coordinated language lab. Conducted entirely in Portuguese. For undergraduate credit, see 21G.802. Enrollment limited.
N. Dominique

21G.855 Accelerated Introductory Portuguese for Spanish Speakers
Subject meets with 21G.880
Prereq: 21G.704 or permission of instructor
G (Spring)
Not offered regularly; consult department
4-0-5 units
Credit cannot also be received for 21G.800, 21G.802, 21G.852
Accelerated introduction to the language and culture of the Portuguese-speaking world, with special attention to Brazilian Portuguese. Designed for speakers of Spanish (native or bilingual, or those who have completed two college years or the equivalent). Covers essential content of complete first-year Portuguese in one semester. Builds on the similarities and differences between both languages in grammar, vocabulary and pronunciation for speaking, listening, reading and writing skills. Conducted entirely in Portuguese. For undergraduate credit, see 21G.880. Limited to 18.
N. Dominique

21G.862 Russian II (Regular)
Prereq: 21G.611 or permission of instructor
U (Spring)
4-0-8 units. HASS-H
Continuing instruction in Russian language and culture with emphasis on acquisition of vocabulary and grammatical concepts through active communication. Conducted in both Russian and English. Provides exposure to the language via a video program, internet resources, and literary texts that are integrated in grammar instruction and conversation tasks. Limited to 18.
M. Khotimsy

21G.613 Russian III (Regular)
Prereq: 21G.612 and permission of instructor
U (Fall)
4-0-8 units. HASS-H
Includes comprehensive review and expansion of grammar and vocabulary. Emphasizes the development of speaking, reading, and writing skills. Examines adapted and authentic literary texts, media resources, and film. Develops communicative skills necessary for personal and professional interaction in a Russian-language environment. Limited to 18.
M. Khotimsy

21G.614 Russian IV (Regular)
Prereq: 21G.613 and permission of instructor
U (Spring)
4-0-8 units. HASS-H
Features intermediate to advanced study of Russian with a comprehensive review of grammar, and emphasis on more complex communicative topics. Reading and writing skills developed through study of various topics in Russian culture and society. Uses a variety of authentic literary and non-fiction texts, media resources, and film. Limited to 18.
M. Khotimsy

Russian

21G.611 Russian I (Regular)
Prereq: None
U (Fall, IAP)
4-0-8 units. HASS-H
Emphasizes the development of communicative and cultural competence, as well as mastery of the foundations of Russian grammar and vocabulary. Using video, internet resources, and varied cultural materials, students work on developing speaking, reading, and writing skills. Conducted in both Russian and English. Designed for students with no knowledge of Russian. Limited to 18.
M. Khotimsy
21G.618 Introduction to the Classics of Russian Literature -
Russian Language Option
Subject meets with 21G.077[3], 21L.490[3]
Prereq: 21G.614 or permission of instructor
U (Spring)
3-0-10 units. HASS-H

Explores the works of classical Russian writers of the 19th and
20th centuries, including stories and novels by Pushkin, Gogol,
Dostoevsky, Tolstoy, Chekhov, Bunin, Nabokov, Platonov, and others.
Focuses on their approaches to portraying self and society, and
on literary responses to fundamental ethical and philosophical
questions about justice, freedom, free will, fate, love, loyalty,
betrayal, and forgiveness. Taught in English with additional readings
and a short writing project in Russian.

M. Khotimsky

Korean

21G.901 Korean I (Regular)
Prereq: None
U (Fall, IAP)
4-0-8 units. HASS-H

Introduction to modern standard Korean with emphasis on
developing conversational skills by using fundamental grammatical
patterns and vocabulary in functional and culturally suitable
contexts. Basic reading and writing are also taught. Placement
interview with instructors on or before Registration Day required of
students who have had prior exposure to Korean elsewhere. Limited
to 16 per section. No listeners.

H. Jeong

21G.902 Korean II (Regular)
Prereq: 21G.901 or permission of instructor
U (Spring)
4-0-8 units. HASS-H

Continuation of 21G.901. For full description, see 21G.901. Placement
interview with instructors on or before Registration Day required of
students who have had prior exposure to Korean elsewhere. Limited
to 16 per section. No listeners.

H. Jeong

21G.903 Korean III (Regular)
Prereq: 21G.902 or permission of instructor
U (Fall)
4-0-8 units. HASS-H

Continuing instruction in spoken and written Korean, with particular
emphasis on consolidating basic conversational skills and improving
reading confidence and depth. Lab work required. Placement
interview with instructors on or before Registration Day required of
students who have had prior exposure to Korean elsewhere. Limited
to 16 per section. No listeners.

H. Jeong

21G.904 Korean IV (Regular)
Prereq: 21G.903 or permission of instructor
U (Spring)
4-0-8 units. HASS-H

Continuation of 21G.903. For full description, see 21G.903. Placement
interview with instructors on or before Registration Day required of
students who have had prior exposure to Korean elsewhere. Limited to 16 per section. No listeners.

H. Jeong

Spanish

The subjects below are taught in Spanish and include offerings in
language, literature, and cultural studies.
The indication of prerequisites for specific Spanish offerings does not apply to students who have already completed equivalent work.
For further placement advice, consult one of the field advisors in
Spanish.

Fundamental Language Subjects

21G.701 Spanish I
Subject meets with 21G.751
Prereq: None
U (Fall, IAP, Spring)
4-0-8 units. HASS-H

For students with no previous knowledge of Spanish. Introduction
to understanding, speaking, reading, and writing Spanish. Maximal
use of fundamentals of grammar in active communication. Audio-
and video-based language laboratory program coordinated with and
supplemented to class work. For graduate credit see 21G.751. Limited
to 18 per section.

Consult H. Belio Apaolaza
21G.702 Spanish II
Subject meets with 21G.752
Prereq: 21G.701 or permission of instructor
U (Fall, Spring)
4-0-8 units. HASS-H
Credit cannot also be received for 21G.700, 21G.705, 21G.782, 21G.783
Continues the study of Spanish language and culture using audio, video and print materials, feature films and popular music from Latin America and Spain. Emphasizes writing, vocabulary acquisition, and the study of more complex grammatical structures. Students develop oral skills through group interaction and short presentations. For graduate credit see 21G.752. Limited to 18 per section.
Consult J. Barroso, H. Belio Lapaolaza

21G.782 Spanish II (Study Abroad)
Subject meets with 21G.783
Prereq: 21G.701 or permission of instructor
U (IAP)
Not offered regularly; consult department
4-0-8 units. HASS-H
Credit cannot also be received for 21G.700, 21G.702, 21G.705, 21G.752, 21G.783
Increased practice in listening comprehension, reading, and group interaction. Class conducted in Madrid, Spain with an MIT instructor. Students responsible for travel and lodging fees. For graduate credit, see 21G.783. Enrollment limited by lottery.
A. Yáñez Rodríguez

21G.700 Intensive Spanish for Advanced Beginner Students
Prereq: Permission of instructor
U (Fall)
4-0-8 units. HASS-H
Credit cannot also be received for 21G.702, 21G.705, 21G.752, 21G.782, 21G.783
Presents, in a condensed fashion, the major vocabulary and grammar covered in Spanish I and II. Provides extensive practice in listening, speaking, reading and writing through a variety of student-centered activities and the use of authentic materials. Emphasizes the essential grammatical structures and practical vocabulary needed to function at an intermediate level of proficiency required for Spanish III. Intended for students who have taken two or more years of Spanish in high school. Limited to 18; placement interview required.
A. Yáñez Rodríguez

21G.703 Spanish III
Prereq: 21G.702 or permission of instructor
U (Fall, Spring)
4-0-8 units. HASS-H
Credit cannot also be received for 21G.793
Aims at consolidation and expansion of skills in listening comprehension, speaking, reading, and writing. Uses short stories and other readings, films, music, and Web projects (including a multimedia exchange with students in Spain) to study issues of historical and current interest in Hispanic culture. Limited to 18 per section.
Consult J. Barroso, A. Yáñez Rodríguez

21G.793 Spanish III in Madrid
Prereq: 21G.702 or permission of instructor
U (IAP)
4-0-8 units. HASS-H
Credit cannot also be received for 21G.703
Mastery of oral expression, reading, writing, and listening while experiencing life and culture in Spain’s capital, Madrid. Students use language strategically to accomplish objectives and to resolve conflicts, in culturally accurate circumstances utilizing appropriate vocabulary. Limited to 18.
J. Barroso

21G.704 Spanish IV
Prereq: 21G.703 or permission of instructor
U (Fall, Spring)
4-0-8 units. HASS-H
Continued study of the language, literature, and culture of Spanish-speaking countries to improve oral and written communication. Materials include contemporary Spanish and Latin American films, literary texts (short stories, poetry and a novel), online video interviews with a variety of Spanish-speakers and other Web resources. Limited to 18 per section.
Fall: Consult M. Ribas Groeger
Spring: Consult M. San Martín
21G.705 Intensive Beginning Spanish for Medicine and Health
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-H
Credit cannot also be received for 21G.700, 21G.702, 21G.752, 21G.782, 21G.783

Provides a review of the fundamental grammar and vocabulary covered in Spanish I and II with a focus on building specialized medical terminology and developing the linguistic skills needed to effectively communicate with, assess, and care for Spanish-speaking patients in clinical settings. Develops cross-cultural competence and awareness by giving special consideration to relevant cultural values and differences and how they may affect the doctor-patient relationship. Discusses major health issues and how they affect Hispanic communities in the US, with a focus on prevention and education, as well as the tradition of folk medicine among Hispanic cultures. Offers extensive practice in listening, speaking, reading, and writing through the use of authentic materials and student-centered activities to develop the proficiency needed for Spanish III. Intended for students who have taken two or more years of Spanish in high school. Limited to 18; placement interview required.

M. San Martín

21G.708 Spanish: Communication Intensive I
Prereq: None. Coreq: 21G.731[J], 21G.735, 21L.636[J], 21L.637[J], 21L.638[J], 21L.639[J], or 21L.640[J]; permission of instructor
U (Fall, Spring)
3-0-0 units

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. Conducted entirely in Spanish. Preference to Spanish majors.

P. Duong

21G.709 Spanish: Communication Intensive II
Prereq: 21G.708; Coreq: 21G.731[J], 21G.735, 21L.636[J], 21L.637[J], 21L.638[J], 21L.639[J], or 21L.640[J]; permission of instructor
U (Fall, Spring)
3-0-0 units

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. Conducted entirely in Spanish. Preference to Spanish majors.

P. Duong

21G.710 Advanced Communication in Spanish: Topics in Language and Culture
Prereq: 21G.704 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Can be repeated for credit.

Advanced work to further develop oral and written skills in Spanish. Emphasizes communicative tasks and the consolidation of grammatical structures. Discussion, oral presentations, essay writing and group projects improve proficiency and prepare students to pursue advanced subjects and/or professional activities in a Spanish-speaking environment. Topics vary from term to term. Taught in Spanish. Limited to 18.

J. Barroso

21G.711 Advanced Spanish Conversation and Composition: Perspectives on Technology and Culture
Prereq: 21G.704 or permission of instructor
U (Spring)
3-0-9 units. HASS-H

Focuses on expository and journalistic writing that examines the social and cultural impact of science and technology in Hispanic societies. Topics considered are: family structure and community, personal identity, gender relations, relationship to natural world, value systems and religion, education and work-life. Ethical implications of technological decision-making also discussed. Improves oral and written skills through discussions of audiovisual materials, simulations, interviews, guided compositions, regular journal writing, and participation on an online forum. Readings include: journalistic reports, essays, and literary selections offering diverse perspectives. Taught in Spanish. Enrollment limited.

M. Ribas Groeger

21G.712 Spanish Conversation and Composition
Prereq: 21G.704 or permission of instructor
U (Fall)
3-0-9 units. HASS-H
Credit cannot also be received for 21G.795

Further development of spoken and written skills to improve fluency and style. Oral reports by participants on individual topics and group Web-based and video projects. Analyses of selected literary texts, films and popular music. Taught in Spanish. Enrollment limited.

M. Ribas Groeger

Intermediate Subjects in Language, Literature, and Culture
Native speakers of Spanish who have studied Hispanic literature at a high-school level must obtain permission from the instructor to enroll in any of these subjects.
21G.795 Advanced Spanish Communication in Spain
Prereq: 21G.704 or permission of instructor
U (IAP)
4-0-8 units. HASS-H
Credit cannot also be received for 21G.712

Improves fluency and oral proficiency through the study of Spanish culture, history and society in an immersive environment. Class discussions, debates and oral presentations broaden vocabulary and idiomatic usage, and help mastery of complex grammatical structures. Provides background on Spanish cultural practices, history, and current developments. Assignments and in-class activities include oral reports based on interviews with locals. Guided cultural activities further appreciation and understanding of Spanish culture, art and history and provide topics for oral and written presentations. Conducted entirely in Spanish. Limited to 18.

M. Ribas Groeger

21G.713 Spanish through Film: Mexico, Chile, Argentina, and Spain
Prereq: 21G.704 or permission of instructor
U (Spring)
3-0-9 units. HASS-H

Aims to increase oral and written communication, grammar, and vocabulary usage in Spanish while exploring a number of contemporary Hispanic films. Covers major films from Mexico, Chile, Argentina, and Spain. Discussion, oral presentations, essay writing and group projects improve proficiency and prepare students to pursue advanced subjects and/or professional activities in a Spanish-speaking environment. Taught in Spanish. Limited to 18.

A. Yáñez Rodríguez

21G.714 Spanish for Heritage Learners
Prereq: Fluency in a Spanish dialect or permission of instructor
U (Spring)
3-0-9 units. HASS-H

Designed for students who have conversational skills (typically gained from growing up in a Spanish speaking environment) without a corresponding level of literacy. Builds upon students’ existing linguistic and cultural knowledge to develop competence and confidence in using the language in more formal contexts. Examines a variety of texts and genres, music, films and visual arts, in order to enrich vocabulary, improve grammatical accuracy, and gain a greater social, cultural, political, and historical understanding of the Spanish-speaking world. Taught in Spanish. Limited to 18.

J. Barroso

21G.715 Topics in Medicine and Public Health in the Hispanic World
Prereq: 21G.704 or permission of instructor
U (Fall)
3-0-9 units. HASS-H

Strengthens oral and written communication skills in Spanish by examining current topics in medicine and public health. Explores medical and health challenges in various Hispanic nations and among Spanish-speaking communities in the US. Topics include cultural narratives of illness, bioethical considerations of genetic research, women’s reproductive rights, Cuba’s export of healthcare workers, the ethical implications of medical decision-making, and euthanasia. Draws on sources from the humanities, social sciences and the arts that incorporate diverse perspectives on these issues. Focuses on the use of language in the construction of cultural metaphors and representations of illness and healing. Taught in Spanish. Limited to 18.

M. San Martín

Advanced Subjects in Literature and Culture

21G.716[J] Introduction to Contemporary Hispanic Literature and Film
Same subject as 21L.636[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

See description under subject 21L.636[J].

M. Resnick

21G.717[J] Introduction to Hispanic Culture
Same subject as 21L.637[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

See description under subject 21L.637[J]. Limited to 18.

M. Resnick
21G.731[J] Creation of a Continent: Representations of Hispanic America, 1492-1898, in Literature and Film
Same subject as 21H.274[J]
Prereq: One intermediate Spanish subject or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Traces the creation of a new literature in Spanish to record and interpret New World experiences. Begins with excerpts from Columbus's diary and ends with writings on the late 19th-century Cuban and Puerto Rican independence movements. Pairs some of these pre-20th-century texts with more recent literary and film interpretations of the first 400 years of Hispanic American history. Conducted in Spanish.

P. Duong

21G.732[J] The Making of the Latin American City: Culture, Gender, and Citizenship
Same subject as WGS.232[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Explores paradigms of Latin American modernity, gender, and urban cultures through primary texts and media. Examines a range of materials (literature, films, visual arts, music, and advertising) to reflect on the region's urbanization processes of the 20th and 21st centuries. Focuses on the production and representation of gender - and women, in particular - as key subjects of urbanization, mass media, and consumer culture. Discussions travel through urban centers as different as Buenos Aires, Mexico DF, Lima, Havana, Miami and New York, but are organized around four critical categories: urban spaces, labor, leisure, and citizenship. Taught in Spanish.

P. Duong

21G.735 Advanced Topics in Hispanic Literature and Film
Prereq: One intermediate Spanish subject or permission of instructor
U (Spring)
4-0-8 units. HASS-H
Can be repeated for credit.

Close study of a theme, a grouping of authors, or a historical period not covered in depth in other subjects. May be repeated for credit with permission of instructor. Taught in Spanish. Limited to 18.

P. Duong

21G.736 The Short Form: Literature and New Media Cultures in the Hispanic World
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Examines the aesthetics of the brief form across a variety of media and genres in Latin America and Spain, from short stories and snapshots to newspapers and Twitter. Explores the history and social significance of four short genres in the Hispanic world: the short story, the crónica, the poem, and the song. Discusses the rich literary and critical tradition that relates narrative length and temporality to the prose and the lyric in Spanish speaking cultures. With an emphasis on the 20th- and 21st-century epistemologies of acceleration and the remediation of literary theories of brevity, analyzes the relationship between temporality, aesthetic form, and media technologies, and the way these topics have taken shape in the imagination of writers, artists, and audiences in historically specific and politically significant contexts. Taught in Spanish. Limited to 18.

P. Duong

21G.738[J] Literature and Social Conflict: Perspectives on the Hispanic World
Same subject as 21L.638[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H
See description under subject 21L.638[J].

J. Terrones

Same subject as 21L.639[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
See description under subject 21L.639[J].

M. Resnick
Same subject as 21L.640[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H
See description under subject 21L.640[J].
M. Resnick

Graduate Language Subjects

21G.751 Spanish I
Subject meets with 21G.701
Prereq: None
G (Fall, IAP, Spring)
4-0-5 units
For students with no previous knowledge of Spanish. Introduction to understanding, speaking, reading, and writing Spanish. Maximal use of fundamentals of grammar in active communication. Audio- and video-based language laboratory program coordinated with and supplementary to class work. Same as 21G.701, but for graduate credit. Limited to 18 per section.
Consult H. Belio Apaolaza

21G.752 Spanish II
Subject meets with 21G.702
Prereq: 21G.751 or permission of instructor
G (Fall, Spring)
4-0-5 units
Credit cannot also be received for 21G.700, 21G.705, 21G.782, 21G.783
Introductory subject that continues the study of Spanish language and culture using audio, video and print materials, feature films and popular music from Latin America and Spain. Emphasizes writing, vocabulary acquisition, and the study of more complex grammatical structures. Group interaction and short oral presentations develop students’ oral skills. Limited to 18 per section.
Consult J. Barroso, H. Belio Lapaolaza

21G.783 Spanish II (Study Abroad)
Subject meets with 21G.782
Prereq: 21G.751 or permission of instructor
G (IAP)
Not offered regularly; consult department
4-0-5 units
Credit cannot also be received for 21G.700, 21G.702, 21G.705, 21G.752, 21G.782
Increased practice in listening comprehension, reading, and group interaction. Class conducted in Madrid, Spain with an MIT instructor. Students responsible for travel and lodging fees. Same as 21G.782, but for graduate credit. Enrollment limited by lottery.
A. Yanez Rodriguez

Independent Study and Special Subjects

21G.911 Independent Study
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Advanced work in languages and literatures for students wishing to pursue topics or projects not provided by regular subject offerings. Before registering, student must plan course of study with appropriate instructor in the section and secure the approval of the Section Head. Normal maximum is 6 units.
Consult Global Studies and Languages Headquarters

21G.S01 Special Subject: Global Studies and Languages
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.
Consult Global Studies and Languages Headquarters

21G.S02 Special Subject: Global Studies and Languages
Prereq: None
U (Fall)
Units arranged
Can be repeated for credit.
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.
Staff
21G.S03 Special Subject: Global Studies and Languages  
Prereq: None  
U (Spring; first half of term)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.  
*Consult Global Studies and Languages Headquarters*

21G.S04 Special Subject: Global Studies and Languages  
Prereq: None  
U (Spring; second half of term)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.  
*Consult Global Studies and Languages Headquarters*

21G.S05 Special Subject: Global Studies and Languages  
Prereq: None  
U (IAP)  
Units arranged  
Can be repeated for credit.  
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.  
*Consult Global Studies and Languages Headquarters*

21G.S06 Special Subject: Global Studies and Languages  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.  
*F. Heberer*

21G.S07 Special Subject: Global Studies and Languages  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.  
*Consult Global Studies and Languages Headquarters*

21G.S08 Special Subject: Global Studies and Languages  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.  
*Consult Global Studies and Languages Headquarters*

21G.THT Pre-Thesis Tutorial: Global Studies and Languages  
Prereq: Permission of instructor  
U (Fall, Spring)  
1-0-5 units  
Can be repeated for credit.  
Definition of and early-stage work on thesis project leading to 21G.THU Undergraduate Thesis in Global Studies and Languages. Taken during the first term of the student's two-term commitment to the thesis project. Student works closely with an individual faculty tutor.  
*Consult Global Studies and Languages Headquarters*

21G.THU Global Studies and Languages Thesis  
Prereq: 21G.THT  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.  
Completion of work on the senior major thesis under supervision of a faculty thesis advisor. Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and a final meeting with a committee of faculty evaluators to discuss the successes and limitations of the project.  
*Consult Global Studies and Languages Headquarters*

21G.UR Undergraduate Research  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit. Credit cannot also be received for 21G.URG  
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.  
*Consult Global Studies and Languages Headquarters*
21G.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit. Credit cannot also be received for 21G.UR

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.

Consult Global Studies and Languages Headquarters
HEALTH SCIENCES AND TECHNOLOGY (HST)

IMPORTANT NOTES regarding preclinical subjects (HST.011-HST.200)*:
Students not enrolled in an HST program are limited to two HST preclinical courses and must provide justification for enrolling in these courses. This action must be approved by the course director and the student's advisor. These subjects are scheduled according to the Harvard Medical School academic calendar, which differs from the MIT calendar. Students whose graduation depends upon completing one or more of these subjects should take particular care regarding the schedule. *HST.141, HST.163 HST.198 are NOT included in the two-course limit.

HST.011 Human Functional Anatomy
Subject meets with HST.010
Prereq: Permission of instructor
G (Fall)
3-11-10 units

Lectures, detailed laboratory dissections, and prosections provide a thorough exploration of the gross structure and function of the human body. Fundamental principles of bioengineering are employed to promote analytical approaches to understanding the body's design. The embryology of major organ systems is presented, together with certain references to phylogenetic development, as a basis for comprehending anatomical complexity. Correlation clinics stress both normal and abnormal functions of the body and present evolving knowledge of genes responsible for normal and abnormal anatomy. Lecturers focus on current problems in organ system research. Only HST students may register under HST.010, graded P/D/F. Lab fee. Enrollment restricted to graduate students.

L. Gehrke

HST.015 MATLAB for Medicine
Prereq: None
G (Summer)
2-0-4 units

Practical introduction to use of quantitative methods in medicine and health research. Each session covers a different topic in quantitative techniques, provides an application to medicine, and includes a modeling activity using MATLAB. Students also complete problem sets. Restricted to first year HST MD students.

M. Frosch

HST.021 Musculoskeletal Pathophysiology
Subject meets with HST.020
Prereq: Permission of instructor
G (IAP)
3-0-3 units

Growth and development of normal bone and joints, the biophysics of bone and response to stress and fracture, calcium and phosphate homeostasis and regulation by parathyroid hormone and vitamin D, and the pathogenesis of metabolic bone diseases and disease of connective tissue, joints, and muscles, with consideration of possible mechanisms and underlying metabolic derangements. Only HST students may register under HST.020, graded P/D/F. Enrollment limited; restricted to medical and graduate students.

M. Bouxsein

HST.031 Human Pathology
Subject meets with HST.030
Prereq: Biology (GIR), Physics I (GIR), and permission of instructor
G (Fall)
4-3-8 units
Credit cannot also be received for HST.034, HST.035

Introduction to the functional structure of normal cells and tissues, pathologic principles of cellular adaptation and injury, inflammation, circulatory disorders, immunologic injury, infection, genetic disorders, and neoplasia in humans. Lectures, conferences emphasizing clinical correlations and contemporary experimental biology. Laboratories with examination of microscopic and gross specimens, and autopsy case studies emphasizing modern pathology practice. Only HST students may register under HST.030, graded P/D/F. Lab fee. Enrollment limited.

R. N. Mitchell, R. Padera
HST.035 Pathology of Human Disease
Subject meets with HST.034
Prereq: 7.05 or permission of instructor
G (Spring)
4-2-10 units
Credit cannot also be received for HST.030, HST.031
Provides a comprehensive overview of human pathology with emphasis on mechanisms of disease and modern diagnostic technologies. Topics include general mechanisms of disease (inflammation, infection, immune injury, transplantation, genetic disorders and neoplasia); pathology of lipids, enzymes, and molecular transporters; pathology of major organ systems; and review of diagnostic tools from surgical pathology to non-invasive techniques such as spectroscopy, imaging, and molecular markers of disease. The objectives of this subject are achieved by a set of integrated lectures and laboratories, as well as a student-driven term project leading to a formal presentation on a medical, socioeconomic, or technological issue in human pathology. Only HST students enrolled in specific degree programs may register under HST.034, graded P/D/F. Credit cannot also be received for HST.030 or HST.031.
S. Lovitch

HST.041 Mechanisms of Microbial Pathogenesis
Subject meets with HST.040
Prereq: Biology (GIR), 7.05, and permission of instructor
G (Fall)
4-2-6 units
Deals with the mechanisms of pathogenesis of bacteria, viruses, and other microorganisms. Approach spans mechanisms from molecular to clinical aspects of disease. Topics selected for intrinsic interest and cover the demonstrated spectrum of pathophysiologic mechanisms. Only HST students may register under HST.040, graded P/D/F. Lab fee. Enrollment limited.
C. Crumpacker II, H. Simon

HST.061 Endocrinology
Subject meets with HST.060
Prereq: Biology (GIR), 7.05, and permission of instructor
G (Spring)
3-0-6 units
Physiology and pathophysiology of the human endocrine system. Three hours of lecture and section each week concern individual parts of the endocrine system. Topics include assay techniques, physiological integration, etc. At frequent clinic sessions, patients are presented who demonstrate clinical problems considered in the didactic lectures. Only HST students may register under HST.060, graded P/D/F. Enrollment limited.
W. Kettyle, D. Breault

HST.071 Human Reproductive Biology
Subject meets with HST.070
Prereq: 7.05 and permission of instructor
G (Fall; first half of term)
4-0-2 units
Lectures and clinical case discussions designed to provide the student with a clear understanding of the physiology, endocrinology, and pathology of human reproduction. Emphasis is on the role of technology in reproductive science. Suggestions for future research contributions in the field are probed. Students become involved in the wider aspects of reproduction, such as prenatal diagnosis, in vitro fertilization, abortion, menopause, contraception and ethics relation to reproductive science. Only HST students may register under HST.070, graded P/D/F.
A. Koniaris, D. Page

HST.081 Hematology
Subject meets with HST.080
Prereq: 7.05 and permission of instructor
G (Spring; partial term)
2-1-3 units
Intensive survey of the biology, physiology and pathophysiology of blood with systematic consideration of hematopoiesis, white blood cells, red blood cells, platelets, coagulation, plasma proteins, and hematologic malignancies. Emphasis given equally to didactic discussion and analysis of clinical problems. Enrollment limited.
N. Berliner

HST.091 Cardiovascular Pathophysiology
Subject meets with HST.090
Prereq: (HST.030 or HST.031) and permission of instructor
G (Spring)
4-3-8 units
Normal and pathologic physiology of the heart and vascular system. Emphasis includes hemodynamics, electrophysiology, gross pathology, and clinical correlates of cardiovascular function in normal and in a variety of disease states. Special attention given to congenital, rheumatic, valvular heart disease and cardiomyopathy. Only HST students may register under HST.090, graded P/D/F. Enrollment limited.
E. Edelman
HST.101 Respiratory Pathophysiology
Subject meets with HST.100
Prereq: Physics I (GIR), 7.05, and permission of instructor
G (Spring)
4-0-8 units

Lectures, seminars, and laboratories cover the histology, cell biology, and physiological function of the lung with multiple examples related to common diseases of the lung. A quantitative approach to the physics of gases, respiratory mechanics, and gas exchange is provided to explain pathological mechanisms. Use of medical ventilators is discussed in lecture and in laboratory experiences. For MD candidates and other students with background in science. Only HST students may register under HST.100, graded P/D/F. Enrollment limited.
J. Drazen, S. Loring

HST.111 Renal Pathophysiology
Subject meets with HST.110
Prereq: 7.05 and permission of instructor
G (Spring)
4-0-8 units

Considers the normal physiology of the kidney and the pathophysiology of renal disease. Renal regulation of sodium, potassium, acid, and water balance are emphasized as are the mechanism and consequences of renal failure. Included also are the pathology and pathophysiology of clinical renal disorders such as acute and chronic glomerulonephritis, pyelonephritis, and vascular disease. New molecular insights into transporter mutations and renal disease are discussed. Only HST students may register under HST.110, graded P/D/F. Enrollment limited.
J. Seifert, A. Lam

HST.121 Gastroenterology
Subject meets with HST.120
Prereq: Biology (GIR), Physics I (GIR), 7.05, and permission of instructor
G (Fall; second half of term)
3-1-2 units

Presents the anatomy, physiology, biochemistry, biophysics, and bioengineering of the gastrointestinal tract and associated pancreatic, liver, and biliary systems. Emphasis on the molecular and pathophysiological basis of disease where known. Covers gross and microscopic pathology and clinical aspects. Formal lectures given by core faculty, with some guest lectures by local experts. Selected seminars conducted by students with supervision of faculty. Only HST students may register under HST.120, graded P/D/F. Enrollment limited.
A. Rutherford, S. Flier

HST.131 Neuroscience
Subject meets with HST.130
Prereq: Permission of instructor
G (Fall)
6-3-6 units

Comprehensive study of neuroscience where students explore the brain on levels ranging from molecules and cells through neural systems, perception, memory, and behavior. Includes some aspects of clinical neuroscience, within neuropharmacology, pathophysiology, and neurology. Lectures supplemented by conferences and labs. Labs review neuroanatomy at the gross and microscopic levels. Only HST students may register under HST.130, graded P/D/F. Limited to 50.
J. Assad, M. Frosch

HST.141 Molecular Medicine
Subject meets with HST.140
Prereq: 7.05
G (Fall)
2-0-4 units

Conducted as a seminar to study a variety of human diseases and the underlying molecular, genetic, and biochemical basis for the pathogenesis and pathophysiology of the disorders. Lectures by faculty and seminars conducted by students, with tutorials and supervision by faculty. Patients presented when feasible. Appropriate for students who have had a course in biochemistry and/or molecular biology.
I. M. London, V. Sankaran, S. Agarwal

HST.147 Biochemistry and Metabolism
Prereq: Permission of instructor
G (Fall)
4-0-5 units

First-year graduate level intensive subject in human biochemistry and physiological chemistry that focuses on intermediary metabolism, structures of key intermediates and enzymes important in human disease. Subject is divided into four areas: carbohydrates, lipids, amino acids and nucleic acids. The importance of these areas is underscored with examples from diseases and clinical correlations. Preparatory sessions meet in August. Only HST students may register under HST.146, graded P/D/F. Enrollment limited.
M. Larvie, S. Biddinger
HST.151 Principles of Pharmacology
Subject meets with HST.150
Prereq: Biology (GIR), Physics I (GIR), and 7.05
G (IAP, Spring; partial term)
6-0-6 units
An introduction to pharmacology. Topics include mechanisms of drug action, dose-response relations, pharmacokinetics, drug delivery systems, drug metabolism, toxicity of pharmacological agents, drug interactions, and substance abuse. Selected agents and classes of agents examined in detail. Course follows HMS calendar. Restricted to HST MD HST PhD students.
C. Rosow, S. Forman

HST.161 Genetics in Modern Medicine
Subject meets with HST.160
Prereq: 7.05
G (Fall; second half of term)
2-0-4 units
Provides a foundation for understanding the relationship between molecular biology, genetics, and medicine. Starts with an introduction to molecular genetics, and quickly transitions to the genetic basis of diseases, including chromosomal, mitochondrial and epigenetic disease. Translation of clinical understanding into analysis at the level of the gene, chromosome, and molecule; the concepts and techniques of molecular biology and genomics; and the strategies and methods of genetic analysis. Includes diagnostics (prenatal and adult), cancer genetics, and the development of genetic therapies (RNA, viral, and genome editing). The clinical relevance of these areas is underscored with patient presentations. Only HST students may register under HST.160, graded P/D/F.
HST Faculty

HST.163 Molecular Diagnostics and Bioinformatics
Subject meets with HST.162
Prereq: HST.160
G (Fall; first half of term)
2-0-4 units
Introduction of molecular diagnostic methods in medicine and relevant bioinformatics methods. Discussion of principles of molecular testing for diagnosis of somatic and germline diseases using FISH, classical genotyping, array CGH, next generation sequencing, and other technologies. Case conferences emphasized clinical correlation and integration of information from multiple diagnostic tests. Bioinformatics lectures, problem sets, and laboratory sessions will introduce key concepts in biological sequence analysis and provide experience with bioinformatics tools. HST.015 and HST.191 recommended. Only HST students may register under HST.162, P/D/F. Limited to 45.
G. Gerber, L. Li

HST.165 Principles of Biomedical Imaging
Subject meets with HST.164
Prereq: Permission of instructor
G (IAP)
2-0-4 units
Reviews fundamental principles and techniques underlying modern biomedical imaging, as well as their application in modern medicine. Particular emphasis on magnetic resonance; also covers ultrasound, computed tomography, positron emission tomography and optical techniques. Didactic lectures accompanied by problem sets and experiments with portable magnetic resonance systems and ultrasound systems. Focuses on the quantitative aspects of biomedical imaging and requires a knowledge of differential equations, MATLAB, and intermediate-level physics. Only HST students may register under HST.164, P/D/F. Restricted to HST students.
S. Huang, D. Sosnovik

HST.176 Cellular and Molecular Immunology
Subject meets with HST.175
Prereq: 7.05
G (Fall)
6-0-6 units
Covers cells and tissues of the immune system, lymphocyte development, the structure and function of antigen receptors, the cell biology of antigen processing and presentation including molecular structure and assembly of MHC molecules, lymphocyte activation, the biology of cytokines, leukocyte-endothelial interactions, and the pathogenesis of immunologically mediated diseases. Consists of lectures and tutorials in which clinical cases are discussed with faculty tutors. Details of each case covering a number of immunological issues in the context of disease are posted on a student website. Only HST students may register under HST.175, graded P/D/F. Limited to 45.
S. Pillai, B. Cherayil

416 | 2019–2020 MIT Subject Descriptions
HST.191 Introduction to Biostatistics
Subject meets with HST.190
Prereq: Calculus II (GIR)
G (Summer)
3-0-3 units

Provides training on how to comprehend, critique and communicate findings from biomedical literature. Considers how to assess the importance of chance in the interpretation of experimental data. Topics include probability theory, chi-squared and t-tests, ANOVA, linear and logistic regression, survival analysis, and statistical analysis using MATLAB. Includes critical reading of studies published in medical literature. Only HST students may register under HST.190, graded P/D/F. Enrollment limited; restricted to medical and graduate students.
S. Haneuse

HST.192 Medical Decision Analysis and Probabilistic Medical Inference
Prereq: Permission of instructor
G (IAP)
2-0-2 units

Teaches the essentials of quantitative diagnostic reasoning and medical decision analysis. Guides participants through the process of choosing an appropriate contemporary medical problem in which risk-benefit tradeoffs play a prominent role, conducting a decision analysis, and ultimately publishing the results in a medical journal. Topics include decision trees, influence diagrams, Markov decision models and Monte Carlo simulation, methods for quantifying patient values, Bayesian inference, decision thresholds, and the cognitive science of medical decision making. HST.191 recommended. Limited to 8; preference to HST students.
M. B. Westover, M. Bianchi

HST.195 Clinical Epidemiology
Subject meets with HST.194
Prereq: HST.190
G (IAP, Spring; first half of term)
1-0-1 units

Introduces methods for the generation, analysis, and interpretation of data for clinical research. Major topics include the design of surveys, predictive models, randomized trials, clinical cohorts, and analyses of electronic health records. Prepares students to formulate well-defined research questions, design data collection, evaluate algorithms for clinical prediction, design studies for causal inference, and identify and prevent biases in clinical research. Emphasizes critical thinking and practical applications, including daily assignments based on articles published in major clinical journals and the discussion of a case study each week. Trains students to comprehend, critique, and communicate findings from the biomedical literature. Familiarity with regression modeling and basic statistical theory is a prerequisite. Only HST students may register under HST.194, graded P/D/F. Enrollment limited; restricted to medical and graduate students.
M. Hernan

HST.196 Teaching Health Sciences and Technology
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For teaching assistants or instructors in HST where the teaching assignment is approved for academic credit by the department.
HST Faculty

HST.198 Independent Study in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for independent study of health sciences and technology under regular supervision by an HST faculty member. Projects require prior approval from the HST Academic Office, as well as a substantive paper.
HST Faculty
HST.199 Research in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-10-0 units
Can be repeated for credit.

For HST MD students with research assistantships where the assigned research is approved for academic credit by the department.

HST Faculty

HST.200 Introduction to Clinical Medicine
Prereq: Permission of instructor
G (IAP, Spring; partial term)
9-19-12 units

Intensive preparation for clinical clerkships that introduces the basic skills involved in examination of the patient in addition to history taking and the patient interview. Provides exposure to clinical problems in medicine, surgery, and pediatrics. Students report their findings through history taking and oral presentations. Restricted to MD program students.

W. Goessling

HST.201 Introduction to Clinical Medicine and Medical Engineering I
Prereq: Permission of instructor
G (Summer)
0-20-0 units

Develop skills in patient interviewing and physical examination; become proficient at organizing and communicating clinical information in both written and oral forms; begin integrating history, physical, and laboratory data with pathophysiologic principles; and become familiar with the clinical decision-making process and broad economic, ethical, and sociological issues involved in patient care. There are two sections: one at Mount Auburn Hospital and one at West Roxbury VA Hospital, subsequent registration into HST.202 must be continued at the same hospital as HST.201. Restricted to MEMP students.

C. Stultz, N. Price, J. Strymish

HST.202 Introduction to Clinical Medicine and Medical Engineering II
Prereq: HST.201
G (Fall, IAP, Spring, Summer)
0-20-0 units

Strengthens the skills developed in HST.201 through a six-week clerkship in medicine at a Harvard-affiliated teaching hospital. Students serve as full-time members of a ward team and participate in longitudinal patient care. In addition, students participate in regularly scheduled teaching conferences focused on principles of patient management. Restricted to MEMP students.

C. Stultz, N. Price, J. Strymish

HST.211 Biomedical Inventions: Clinical Introduction
Prereq: Permission of instructor
G (IAP)
Not offered regularly; consult department
3-0-3 units

Provides students with an understanding of modern biomedicine. Explores the clinical areas where medical practice and biomedical enterprise intersect. Hear and interact with academic physicians engaged in care and treatment of patients, in the wards, ICUs, ORs and outpatient areas, and develop the knowledge base needed to obtain elective clinical experiences. Learn to interact with patients and clinicians. Focus is on the various needs of medical specialties, both device, IT and pharma to better treat common medical diseases.

W. Zapol, R. Anderson

HST.212 Biomedical Inventions: Clinical Experience and Selected Success Analysis
Prereq: HST.211
G (Spring)
Not offered regularly; consult department
3-0-3 units

Provides students with a survey of key biomedical research needs by lecture-discussions and facilitating interaction with academic-clinicians and scientists active in medical care/research. Both drug and technology development in the various medical and surgical specialties are examined. Students develop the knowledge base needed to obtain elective clinical experiences. Unsolved clinical problems are sought by each student in a biomedical area of their interest and presented to the class. Interactions with academic physicians who have successfully developed technologies and drugs that are approved by the FDA and in widespread clinical use. How, where, when and why biomedical enterprise and medical practice can successfully intersect is explored. Students can interact with academic physicians engaged in the development of novel technology and drugs, analyze successes and autopsy failed biomedical enterprises.

W. Zapol, R. Anderson
HST.220 Introduction to the Care of Patients
Prereq: Permission of instructor
G (Spring)
1-0-2 units
Elective subject for HST/MD candidates only. Provides an introduction to the care of patients through opportunities to observe and participate in doctor-patient interaction in an outpatient, office-based environment, and through patient-oriented seminars. Students are exposed to some of the practical realities of providing patient care. Topics include basic interviewing, issues of ethics and confidentiality, and other aspects of the doctor-patient relationship. Requirements include regular attendance, and a short paper on patient care. Limited to 15.
H. Heller, MIT Medical Department Staff

HST.240 Translational Medicine Preceptorship
Prereq: HST.035
G (Fall, Spring)
0-12-0 units
Individually designed preceptorship joins together scientific research and clinical medicine. Students devote approximately half of their time to clinical experiences, and the remaining part to scholarly work in basic or clinical science. The two might run concomitantly or in series. Follow a clinical preceptor’s daily activity, including aspects of patient care, attending rounds, conferences, and seminars. Research involves formal investigation of a focused and directed issue related to selected clinical area. Final paper required. Limited to students in the GEMS Program.
E. Edelman

HST.420[J] Principles and Practice of Assistive Technology
Same subject as 2.78[J], 6.811[J]
Prereq: Permission of instructor
U (Fall)
2-4-6 units
See description under subject 6.811[J].
R. C. Miller, J. E. Greenberg, J. J. Leonard

HST.431[J] Infections and Inequalities: Interdisciplinary Perspectives on Global Health
Same subject as 11.134[J], 21A.331[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
E. James, A. Chakraborty

HST.434 Evolution of an Epidemic (Study Abroad)
Prereq: None
U (IAP)
3-0-1 units
Examines the medical, scientific, public health and policy responses to a new disease by focusing on the evolution of the AIDS epidemic. Begins with a review of how the disease was first detected in the US, followed by the scientific basis as to how HIV causes profound dysfunction of the body's immune defense mechanisms, the rational development of drugs, the challenge of an HIV vaccine, and how public health and policy decisions have influenced the course of the global epidemic. Conducted in Durban, South Africa. Open to all majors. Application required. Limited to 20; preference to MIT sophomores, juniors, and seniors.
H. Heller, B. Walker

HST.450[J] Biological Physics
Same subject as 8.593[J]
Prereq: 8.044 recommended but not necessary
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units
See description under subject 8.593[J].
G. Benedek

HST.452[J] Statistical Physics in Biology
Same subject as 8.592[J]
Prereq: 8.333 or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
M. Kardar, L. Mirny

HST.460[J] Statistics for Neuroscience Research
Same subject as 9.073[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
See description under subject 9.073[J].
E. N. Brown
HST.482[J] Biomedical Signal and Image Processing
Same subject as 6.026[J]
Subject meets with 6.555[J], 16.456[J], HST.582[J]
Prereq: (6.041 or permission of instructor) and (2.004, 6.003, 16.002, or 18.085)
U (Spring)
3-3-6 units

Fundamentals of digital signal processing with emphasis on problems in biomedical research and clinical medicine. Basic principles and algorithms for processing both deterministic and random signals. Topics include data acquisition, imaging, filtering, coding, feature extraction, and modeling. Lab projects, performed in MATLAB, provide practical experience in processing physiological data, with examples from cardiology, speech processing, and medical imaging. Lectures cover signal processing topics relevant to the lab exercises, as well as background on the biological signals processed in the labs. Students taking graduate version complete additional assignments.

J. Greenberg, E. Adalsteinsson, W. Wells

HST.500 Frontiers in (Bio)Medical Engineering and Physics
Prereq: None
G (Spring)
3-0-9 units

Provides a framework for mapping research topics at the intersection of medicine and engineering/physics in the Harvard-MIT community and covers the different research areas in MEMP (for example, regenerative biomedical technologies, biomedical imaging and biooptics). Lectures provide fundamental concepts and consider what's hot, and why, in each area. Training in scientific proposal writing (thesis proposals, fellowship applications, or research grant applications) through writing workshops. Topics include how to structure a novel research project, how to position research within the scientific community, how to present preliminary data effectively, and how to give and respond to peer reviews.

S. Bhatia, S. Jhaveri

HST.504[J] Topics in Computational Molecular Biology
Same subject as 18.418[J]
Prereq: 6.047, 18.417, or permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.

See description under subject 18.418[J].
B. Berger

HST.506[J] Computational Systems Biology: Deep Learning in the Life Sciences
Same subject as 6.874[J]
Subject meets with 6.802[J], 20.390[J], 20.490
Prereq: Biology (GIR) and (18.600 or 6.041)
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 6.874[J].
D. Kifford

HST.507[J] Advanced Computational Biology: Genomes, Networks, Evolution
Same subject as 6.878[J]
Subject meets with 6.047
Prereq: (Biology (GIR), 6.006, and 6.041) or permission of instructor
G (Fall)
4-0-8 units
See description under subject 6.878[J].
M. Kellis

HST.508 Evolutionary and Quantitative Genomics
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Develops deep quantitative understanding of basic forces of evolution, molecular evolution, genetic variations and their dynamics in populations, genetics of complex phenotypes, and genome-wide association studies. Applies these foundational concepts to cutting-edge studies in epigenetics, gene regulation and chromatin; cancer genomics and microbiomes. Modules consist of lectures, journal club discussions of high-impact publications, and guest lectures that provide clinical correlates. Homework assignments and final projects develop practical experience and understanding of genomic data from evolutionary principles.

L. Mirny, T. Lieberman
HST.514[J] Sensory-Neural Systems: Spatial Orientation from End Organs to Behavior and Adaptation
Same subject as 16.430[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Introduces sensory systems and multi-sensory fusion using the vestibular and spatial orientation systems as a model. Topics range from end organ dynamics to neural responses, to sensory integration, to behavior, and adaptation, with particular application to balance, posture and locomotion under normal gravity and space conditions. Depending upon the background and interests of the students, advanced term project topics might include motion sickness, astronaut adaptation, artificial gravity, lunar surface locomotion, vestibulo-cardiovascular responses, vestibular neural prostheses, or other topics of interest. Background in neuroscience or systems engineering preferred.

K. Faisal, L. Young

HST.515[J] Aerospace Biomedical and Life Support Engineering
Same subject as 16.423[J], IDS.337[J]
Prereq: 16.06, 16.400, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

See description under subject 16.423[J].

D. J. Newman

HST.516 Sleep and Circadian Clocks: from Biology to Public Health
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Explores the neurobiology of the brain's circadian clock that regulates the timing and structure of sleep, its interaction with the periodic environment, and the consequences of circadian disruption (in our 24/7 society) on health, performance, and safety. Students must possess an understanding of biological sciences. Follows Harvard FAS calendar.

C. A. Czeisler, F. Scheer

HST.518[J] Human Systems Engineering
Same subject as 16.453[J]
Subject meets with 16.400
Prereq: 16.09, 6.041, or permission of instructor
G (Fall)
3-0-9 units

See description under subject 16.453[J].

L. A. Stirling

HST.522[J] Biomaterials: Tissue Interactions
Same subject as 2.79[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Fall)
3-0-9 units

Principles of materials science and cell biology underlying the development and implementation of biomaterials for the fabrication of medical devices/implants, including artificial organs and matrices for tissue engineering and regenerative medicine. Employs a conceptual model, the "unit cell process for analysis of the mechanisms underlying wound healing and tissue remodeling following implantation of biomaterials/devices in various organs, including matrix synthesis, degradation, and contraction. Methodology of tissue and organ regeneration. Discusses methods for biomaterials surface characterization and analysis of protein adsorption on biomaterials. Design of implants and prostheses based on control of biomaterials-tissue interactions. Comparative analysis of intact, biodegradable, and bioreplaceable implants by reference to case studies. Criteria for restoration of physiological function for tissues and organs.

I. V. Yannas, M. Spector

HST.523[J] Cell-Matrix Mechanics
Same subject as 2.785[J]
Prereq: (Biology (GIR), Chemistry (GIR), and 2.001) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

See description under subject 2.785[J].

I. V. Yannas, M. Spector
HST.524[J] Design of Medical Devices and Implants
Same subject as 2.782[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Spring)
3-0-9 units
See description under subject 2.782[J].
I. V. Yannas, M. Spector

HST.525[J] Tumor Microenvironment and Immuno-Oncology: A Systems Biology Approach
Same subject as 10.548[J]
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
2-0-4 units
Provides theoretical background to analyze and synthesize the most up-to-date findings from both laboratory and clinical investigations into solid tumor pathophysiology. Covers different topics centered on the critical role that the tumor microenvironment plays in the growth, invasion, metastasis and treatment of solid tumors. Develops a systems-level, quantitative understanding of angiogenesis, extracellular matrix, metastatic process, delivery of drugs and immune cells, and response to conventional and novel therapies, including immunotherapies. Discussions provide critical comments on the challenges and the future opportunities in research on cancer and in establishment of novel therapeutic approaches and biomarkers to guide treatment.
R. K. Jain

HST.526[J] Future Medicine: Drug Delivery, Therapeutics, and Diagnostics
Same subject as 10.643[J]
Subject meets with 10.443
Prereq: 5.12 or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
See description under subject 10.643[J]. Limited to 40.
D. G. Anderson

HST.527 Blood Vessels and Endothelial Phenotypes in Health and Disease
Prereq: Permission of instructor
G (Spring)
3-0-3 units
Overview of the endothelium as a model system for understanding biological complexity in health and disease. Emphasis placed on: mechanisms of endothelial cell heterogeneity, including genetic and microenvironmental determinants; the role of endothelial cell trafficking, hemostasis, barrier function, antigen presentation and vasomotor tone; and the role of endothelial cell dysfunction in disease, including tumors, sickle cell disease, pulmonary hypertension, veno-occlusive disease of the liver, thrombotic microangiopathies and xenotransplantation. Additional topics covered include novel proteomic and genomic strategies for mapping endothelial cell phenotypes, evolutionary (Darwinian) principles, and complexity theory. Knowledge of introductory biology or physiology, and biochemistry or molecular biology required.
W. Aird, G. Garcia-Cardena

HST.531 Medical Physics of Proton Radiation Therapy
Prereq: None
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
2-0-4 units
Acceleration of protons for radiation therapy; introduction into advanced techniques such as laser acceleration and dielectric wall acceleration. Topics include the interactions of protons with the patient, Monte Carlo simulation, and dose calculation methods; biological aspects of proton therapy, relative biological effectiveness (RBE), and the role of contaminating neutrons; treatment planning and treatment optimization methods, and intensity-modulated proton therapy (IMPT); the effect of organ motion and its compensation by use of image-guided treatment techniques; general dosimetry and advanced in-vivo dosimetry methods, including PET/CT and prompt gamma measurements. Outlook into therapy with heavier ions. Includes practical demonstrations at the Proton Therapy Center of the Massachusetts General Hospital.
B. Winey, J. Schuemann
HST.533 Medical Imaging in Radiation Therapy
Prereq: 18.06
G (Spring)
2-0-4 units
Introduces imaging concepts and applications used throughout radiation therapy workflows, including magnetic resonance imaging (MRI), positron emission tomography (PET), and computed tomography (CT). Advanced topics include proton imaging modalities, such as prompt gamma imaging and proton radiography/CT. Includes lectures regarding image reconstruction and image registration. Introduces students to open-source medical image computing software (3D Slicer, RTK, and Plastimatch). Includes imaging demonstrations at Massachusetts General Hospital.
B. Winey, J. Schuemann

HST.535[J] Tissue Engineering and Organ Regeneration
Same subject as 2.787[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Fall)
3-0-9 units
Principles and practice of tissue engineering (TE) and organ regeneration (OR). Topics include factors that prevent the spontaneous regeneration of tissues/organs in the adult (following traumatic injury, surgical excision, disease, and aging), and molecular and cell-biological mechanisms that can be harnessed for induced regeneration. Presents the basic science of organ regeneration. Principles underlying strategies for employing select biomaterial scaffolds, exogenous cells, soluble regulators, and physical stimuli, for the formation of tissue cемin vitro cем (TE) and regeneration of tissues/organs cемin vivo cем (OR). Describes the methodologies for producing biomaterial scaffolds and for incorporating cells and regulatory molecules into workable devices. Examples of clinical successes and failures of regenerative devices are analyzed as case studies.
M. Spector, I. V. Yannas

HST.537[J] Fluids and Diseases
Same subject as 1.631[J], 2.250[J]
Subject meets with 1.063
Prereq: None
G (Spring)
3-3-6 units
See description under subject 1.631[J].
L. Bourouiba

HST.539[J] Frontiers of Interdisciplinary Science in Human Health and Disease
Same subject as 5.64[J]
Prereq: 5.13, 5.60, and (5.07[J] or 7.05)
G (Spring)
3-0-9 units
See description under subject 5.64[J].
A. Shalek

HST.540[J] Human Physiology
Same subject as 7.20[J]
Prereq: 7.05
U (Fall)
5-0-7 units
See description under subject 7.20[J].
M. Krieger, D. Sabatini

HST.541[J] Cellular Neurophysiology and Computing
Same subject as 2.794[J], 6.521[J], 9.021[J], 20.470[J]
Subject meets with 2.791[J], 6.021[J], 9.21[J], 20.370[J]
Prereq: (Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, or 20.110[J])) or permission of instructor
G (Fall)
5-2-5 units
Integrated overview of the biophysics of cells from prokaryotes to neurons, with a focus on mass transport and electrical signal generation across cell membrane. First third of course focuses on mass transport through membranes: diffusion, osmosis, chemically mediated, and active transport. Second third focuses on electrical properties of cells: ion transport to action potential generation and propagation in electrically excitable cells. Synaptic transmission. Electrical properties interpreted via kinetic and molecular properties of single voltage-gated ion channels. Final third focuses on biophysics of synaptic transmission and introduction to neural computing. Laboratory and computer exercises illustrate the concepts. Students taking graduate version complete different assignments.
J. Han, T. Heldt

HST.542[J] Quantitative and Clinical Physiology
Same subject as 2.792[J], 6.022[J]
Subject meets with 2.796[J], 6.522[J]
Prereq: Physics II (GIR), 18.03, or permission of instructor
U (Spring)
4-2-6 units
See description under subject 6.022[J].
T. Heldt, R. G. Mark
HST.552[J] Medical Device Design
Same subject as 2.75[J], 6.525[J]
Subject meets with 2.750[J], 6.025[J]
Prereq: 2.008, 6.101, 6.111, 6.115, 22.071, or permission of instructor
G (Fall)
3-0-9 units
See description under subject 2.75[J]. Enrollment limited.
A. H. Slocum, G. Hom, E. Roche, N. C. Hanumara

HST.560[J] Radiation Biophysics
Same subject as 22.55[J]
Subject meets with 22.055
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
See description under subject 22.55[J].

HST.562[J] Pioneering Technologies for Interrogating Complex Biological Systems
Same subject as 9.271[J], 10.562[J]
Prereq: None
G (Spring)
3-1-8 units
Introduces pioneering technologies in biology and medicine and discusses their underlying biological/molecular/engineering principles. Topics include emerging sample processing technologies, advanced optical imaging modalities, and next-gen molecular phenotyping techniques. Provides practical experience with optical microscopy and 3D phenotyping techniques. Limited to 15.
K. Chung

HST.563 Imaging Biophysics and Clinical Applications
Prereq: (8.03 and 18.03) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-1-9 units
Introduction to the connections and distinctions among various imaging modalities (x-ray, optical, ultrasound, MRI, PET, SPECT, EEG), common goals of biomedical imaging, broadly defined target of biomedical imaging, and the current practical and economic landscape of biomedical imaging research. Emphasis on applications of imaging research. Final project consists of student groups writing mock grant applications for biomedical imaging research project, modeled after an exploratory National Institutes of Health (NIH) grant application.
C. Catana

HST.565 Medical Imaging Sciences and Applications
Prereq: None
G (Fall)
3-0-9 units
Covers biophysical, biomedical, mathematical and instrumentation basics of positron emission tomography (PET), x-ray and computed tomography (CT), magnetic resonance imaging (MRI), single photon emission tomography (SPECT), optical imaging and ultrasound. Topics include particles and photon interactions, nuclear counting statistics, gamma cameras, and computed tomography as it pertains to SPECT and PET (PET-CT, PET-MR, time-of-flight PET), MR physics and various sequences, optical and ultrasound physics foundations for imaging. Discusses clinical applications of PET and MR in molecular imaging of the brain, the heart, cancer and the role of AI in medical imaging. Includes medical demonstration lectures of SPECT, PET-CT and PET-MR imaging at Massachusetts General Hospital. Considers the ways imaging techniques are rooted in physics, engineering, and mathematics, and their respective role in anatomic and physiologic/molecular imaging.
G. El Fakhri

HST.576[J] Topics in Neural Signal Processing
Same subject as 9.272[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 9.272[J].
E. N. Brown

HST.580[J] Data Acquisition and Image Reconstruction in MRI
Same subject as 6.556[J]
Prereq: 6.011
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 6.556[J].
E. Adalsteinsson
HST.582[J] Biomedical Signal and Image Processing
Same subject as 6.555[J], 16.456[J]
Subject meets with 6.026[J], HST.482[J]
Prereq: (6.041 and (2.004, 6.003, 16.002, or 18.085)) or permission of instructor
G (Spring)
3-3-6 units
Fundamentals of digital signal processing with emphasis on problems in biomedical research and clinical medicine. Basic principles and algorithms for processing both deterministic and random signals. Topics include data acquisition, imaging, filtering, coding, feature extraction, and modeling. Lab projects, performed in MATLAB, provide practical experience in processing physiological data, with examples from cardiology, speech processing, and medical imaging. Lectures cover signal processing topics relevant to the lab exercises, as well as background on the biological signals processed in the labs. Students taking graduate version complete additional assignments.
J. Greenberg, E. Adalsteinsson, W. Wells

HST.583[J] Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Same subject as 9.583[J]
Prereq: 18.05 and (18.06 or permission of instructor)
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
2-3-7 units
Provides background necessary for designing, conducting, and interpreting fMRI studies in the human brain. Covers in depth the physics of image encoding, mechanisms of anatomical and functional contrasts, the physiological basis of fMRI signals, cerebral hemodynamics, and neurovascular coupling. Also covers design methods for stimulus-, task-driven and resting-state experiments, as well as workflows for model-based and data-driven analysis methods for data. Instruction in brain structure analysis and surface- and region-based analyses. Laboratory sessions include data acquisition sessions at the 3 Tesla MRI scanner at MIT and the Connectom and 7 Tesla scanners at the MGH/HST Martins Center, as well as hands-on data analysis workshops. Introductory or college-level neurobiology, physics, and signal processing are helpful.
J. Polimeni, A. Yendiki

HST.584[J] Magnetic Resonance Analytic, Biochemical, and Imaging Techniques
Same subject as 22.561[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-12 units
Introduction to basic NMR theory. Examples of biochemical data obtained using NMR summarized along with other related experiments. Detailed study of NMR imaging techniques includes discussions of basic cross-sectional image reconstruction, image contrast, flow and real-time imaging, and hardware design considerations. Exposure to laboratory NMR spectroscopic and imaging equipment included.
L. Wald, K. Setsompop

HST.590 Biomedical Engineering Seminar Series
Prereq: None
G (Fall, Spring)
1-0-0 units
Can be repeated for credit.
Seminars focused on the development of professional skills. Each term focuses on a different topic, resulting in a repeating cycle that covers medical ethics, responsible conduct of research, written and oral technical communication, and translational issues. Includes guest lectures, case studies, interactive small group discussions, and role-playing simulations.
HST Faculty

HST.599 Research in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For students conducting pre-thesis research or lab rotations in HST, in cases where the assigned research is approved for academic credit by the department. Hours arranged with research supervisor. Restricted to HST students.
Consult Faculty

HST.712[J] Laboratory on the Physiology, Acoustics, and Perception of Speech
Same subject as 6.542[J], 24.966[J]
Prereq: Permission of instructor
G (Spring)
2-2-8 units
See description under subject 6.542[J].
L. D. Braid, S. Shattuck-Hufnagel, J.-Y. Choi
HST.714[J] Acoustics, Production and Perception of Speech
Same subject as 9.016[J]
Prereq: (6.003 and 8.03) or permission of instructor
G (Fall)
4-0-8 units

Reviews the physical processes involved in the production and propagation of sound, and acoustics related to hearing. Particular attention to how the acoustics and mechanics of the speech and auditory system define what sounds we are capable of producing and how we sense sound. Introduces acoustic theory of speech production, digital speech processing, and neural mechanisms of speech production and perception. Exposes students to applications around acoustics, recognition, and speech disorders. Also introduces analysis of various types of sounds. Includes take-home laboratory assignments and discussions of classic papers.
S. S. Ghosh, H. H. Nakajima

HST.716[J] Signal Processing by the Auditory System: Perception
Same subject as 6.552[J]
Prereq: (6.003 and 6.041B or 6.431) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

See description under subject 6.552[J].
L. D. Braida

HST.718 Anatomy of Speech and Hearing
Prereq: Biology (GIR) and permission of instructor
G (IAP)
2-2-2 units

Studies the anatomy of the human head and neck, focusing on structures involved in speech and hearing. Covers general organization of the nervous system and control of the peripheral structures. Involves dissection of a human cadaver, examination of brain specimens, and analysis of cross-sectional radiographic images. Limited to 12; undergraduates admitted based on seniority.
B. C. Fullerton

HST.721 The Biology of the Inner Ear
Prereq: Permission of instructor
G (Fall)
3-1-8 units

Reviews the normal biology, biophysics, physiology and morphology of the inner ear and auditory nerve, as well as the mechanisms underlying sensorineural hearing loss.
M. C. Liberman, S. F. Maison

Same subject as 9.285[J]
Prereq: Permission of instructor
G (Spring)
6-0-6 units

Neural structures and mechanisms mediating the detection, localization and recognition of sounds. General principles are conveyed by theme discussions of auditory masking, sound localization, musical pitch, cochlear implants, cortical plasticity and auditory scene analysis. Follows Harvard FAS calendar.
J. McDermott, D. Polley, B. Delgutte, M. C. Brown

HST.725 Music Perception and Cognition
Prereq: HST.723[J] or permission of instructor
G (Spring)
Not offered regularly; consult department
4-0-8 units

Survey of perceptual and cognitive aspects of the psychology of music, with special emphasis on underlying neurocomputational representations and mechanisms. Systematically explores basic dimensions of hearing (pitch, timbre, consonance, loudness) and the time sense (duration, temporal pattern) that form our perception of tonal quality, melody, harmony, meter, and rhythm in music. Examines mechanisms responsible for separation of multiple voices/instruments (polyphony), and for melodic and rhythmic grouping of events (musical phrase structure). Special topics include comparative, evolutionary, and developmental psychology of music; biological vs. cultural influences; Gestaltist, associationist, and schema-based theories; music vs. speech perception; music vs. language cognition; music and cortical function, music therapy, and neural basis of music performance.
P. Cariani

HST.728[J] Automatic Speech Recognition
Same subject as 6.345[J]
Prereq: 6.011 and 6.036
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-1-8 units

See description under subject 6.345[J].
J. R. Glass, V. W. Zue
HST.914[J] Frontiers in Therapeutics and Drug Delivery
Same subject as 10.644[J]
Prereq: 7.05 or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-6 units
See description under subject 10.644[J]. Limited to 40.
D. G. Anderson

HST.916[J] Case Studies and Strategies in Drug Discovery and Development
Same subject as 7.549[J], 15.137[J], 20.486[J]
Prereq: None
G (Spring)
2-0-4 units
See description under subject 20.486[J].
A. W. Wood

HST.918[J] Economics of Health Care Industries
Same subject as 15.141[J]
Prereq: None
G (Spring; first half of term)
3-0-3 units
See description under subject 15.141[J].
J. Doyle

HST.920[J] Principles and Practice of Drug Development
Same subject as 7.547[J], 10.547[J], 15.136[J], IDS.620[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units
See description under subject 15.136[J].
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

HST.928[J] Engineering Health: Understanding and Designing Affordable Health Diagnostics
Same subject as MAS.534[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
3-1-8 units
See description under subject MAS.534[J].
R. Raskar

HST.929[J] Engineering Health: Designing and Deploying Affordable Health Diagnostics and Therapeutics
Same subject as MAS.535[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
6-0-0 units
See description under subject MAS.535[J].
R. Raskar

HST.936 Global Health Informatics to Improve Quality of Care
Subject meets with HST.937, HST.938
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-0-1 units
Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik, M. Somai

HST.937 Global Health Informatics to Improve Quality of Care
Subject meets with HST.936, HST.938
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-2-2 units
Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik. M. Somai
HST.938 Global Health Informatics to Improve Quality of Care
Subject meets with HST.936, HST.937
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-2-8 units
Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik, M. Somai

HST.940[J] Bioinformatics: Principles, Methods and Applications
Same subject as 10.555[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
See description under subject 10.555[J].
Gr. Stephanopoulos, I. Rigoutsos

HST.950[J] Biomedical Computing
Same subject as 6.872[J]
Prereq: 6.034, 6.036, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 6.872[J].
G. Alterovitz, P. Szolovits

HST.939 Collaborative Data Science in Medicine
Prereq: Permission of instructor
G (Fall)
3-0-9 units
A guide for students who are interested in performing retrospective research using data from electronic health records (Medical Information Mart for Intensive Care or MIMIC database and the eICU Collaborative Research Database). Covers steps in parsing a clinical question into a study design and methodology for data analysis and interpretation, but the emphasis is on the data curation that is required before any analysis can be performed. Activities include review of case studies using the MIMIC and the eICU CRD, and a team project. Student teams choose a question and clinician to work with for their project. Teams meet weekly with clinicians at the hospitals at pre-arranged time.
L. A. Celi, J. Raffa, T. Pollard, A. Johnson

HST.956[J] Machine Learning for Healthcare
Same subject as 6.871[J]
Prereq: 6.034, 6.036, 6.438, 6.806, 6.867, or 9.520[J]
G (Spring)
4-0-8 units
Introduces students to machine learning in healthcare, including the nature of clinical data and the use of machine learning for risk stratification, disease progression modeling, precision medicine, diagnosis, subtype discovery, and improving clinical workflows. Topics include causality, interpretability, algorithmic fairness, time-series analysis, graphical models, deep learning and transfer learning. Guest lectures by clinicians from the Boston area, and projects with real clinical data, emphasize subtleties of working with clinical data and translating machine learning into clinical practice. Limited to 55.
D. Sontag, P. Szolovits

HST.962 Medical Product Development and Translational Biomedical Research
Prereq: Permission of instructor
G (Spring; second half of term)
1-0-3 units
Explores the translation of basic biomedical science into therapies. Topics span pharmaceutical, medical device, and diagnostics development. Exposes students to strategic assessment of clinical areas, product comparison, regulatory risk assessment by indication, and rational safety program design. Develops quantitative understanding of statistics and trial design.
M. Cima
HST.971[J] Strategic Decision Making in the Life Sciences
Same subject as 15.363[J]
Prereq: None
G (Spring)
3-0-6 units
See description under subject 15.363[J].
J. Fleming, A. Zarur

HST.972[J] Medicine for Managers and Entrepreneurs Proseminar
Same subject as 15.132[J]
Prereq: None
G (Spring)
3-0-6 units
See description under subject 15.132[J].
R. J. Cohen

HST.973[J] Evaluating a Biomedical Business Concept
Same subject as 15.124[J]
Prereq: None
G (Fall)
3-0-6 units
Involves critical analysis of new biomedical business ideas. Inventors or principals of early stage companies present their ideas and provide background material including scientific papers and patents. Student teams interact with the companies, potential customers, other stakeholders and experts to develop a series of analyses concerning the critical issues. Company and student presentations supplemented by topic-specific lectures and presentations by biomedical entrepreneurs. Enrollment limited.
R. J. Cohen

HST.978[J] Healthcare Ventures
Same subject as 15.367[J]
Prereq: None
G (Spring)
3-0-9 units
Addresses healthcare entrepreneurship with an emphasis on startups bridging care re-design, digital health, medical devices, and high-tech. Includes prominent speakers and experts from key domains across medicine, pharma, med devices, regulatory, insurance, software, design thinking, entrepreneurship, and investing. Provides practical experiences in venture validation/creation through team-based work around themes. Illustrates best practices in identifying and validating health venture opportunities amid challenges of navigating healthcare complexity, team dynamics, and venture capital raising process. Intended for students from engineering, medicine, public health, and MBA programs. Video conference facilities provided to facilitate remote participation by Executive MBA and traveling students.
M. Gray, Z. Chu

HST.980 Emerging Problems in Infectious Diseases
Prereq: None
G (IAP)
1-0-2 units
Introduces contemporary challenges in preventing, detecting, diagnosing and treating emerging and newly emerging pathogens. Provides students with team-based opportunities to brainstorm, propose and present innovative solutions to such challenges. Expert lecturers discuss emerging problems in infectious diseases. Includes brainstorming sessions in which student teams identify problems in infectious diseases and propose innovative solutions. The teams then prepare and deliver short presentations, outlining identified problems and solutions.
J. J. Collins
HST.999 Practical Experience in Health Sciences and Technology (New)
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For HST students who seek practical off-campus research experiences or internships related to health sciences and technology. Before enrolling, students must have a written offer from the outside organization, approval from their HST thesis supervisor (not required for summer registration), and approval of HST’s Academic Office. Upon completion of the activity, the student must submit a letter from the employer describing the work accomplished, along with a substantive final report written by the student. Consult HST’s Academic Office for details on procedures and restrictions.

J. Greenberg

HST.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of a PhD or ScD thesis or an HST SM thesis; to be arranged by the student and an appropriate faculty advisor.

Faculty

HST.UR Undergraduate Research in Health Sciences and Technology
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Extended participation in the work of a faculty member or research group. Research is arranged by mutual agreement between the student and a member of the faculty of the Harvard-MIT Program in Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal to the MIT UROP Office; signed by the faculty supervisor and approved by the department. A summary report must be submitted at the end of each term.

J. Greenberg

HST.URG Undergraduate Research in Health Sciences and Technology
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Extended participation in the work of a faculty member or research group. Research is arranged by mutual agreement between the student and a member of the faculty of the Harvard-MIT Program in Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal to the MIT UROP Office; signed by the faculty supervisor and approved by the department. A summary report must be submitted at the end of each term.

J. Greenberg

HST.S16 Special Graduate Subject: Health Sciences and Technology
Prereq: None
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects related to Health Sciences and Technology not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty

HST.S17 Special Graduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects related to Health Sciences and Technology not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty
HST.S18 Special Graduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects related to Health Sciences and Technology not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty

HST.S19 Special Graduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects related to Health Sciences and Technology not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty

HST.S46 Special Undergraduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty

HST.S47 Special Undergraduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty

HST.S48 Special Undergraduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty

HST.S49 Special Undergraduate Subject: Health Sciences and Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Group study of subjects related to health sciences and technology not otherwise included in the curriculum. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty

HST.S56 Special Graduate Subject: Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (IAP)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

IMES/HST Faculty
HST.S57 Special Graduate Subject: Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S58 Special Subject: Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
HST Faculty

HST.S59 Special Graduate Subject: Medical Engineering and Medical Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by IMES/HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
IMES/HST Faculty

HST.S78 Special Subject: Speech and Hearing Sciences
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for group study of advanced subjects related to the Speech and Hearing Sciences not otherwise included in the curriculum. Offerings initiated by members of the SHS faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.
P. Cariani

HST.S96 Special Graduate Subject: Biomedical Entrepreneurship
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for group study of advanced subjects relating to biomedical entrepreneurship not otherwise included in the curriculum. Offerings are initiated by HST/IMES faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.
HST/IMES Faculty

HST.S97 Special Graduate Subject: Biomedical Entrepreneurship
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for group study of advanced subjects relating to biomedical entrepreneurship not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.
HST Faculty
**HST.S98 Special Graduate Subject: Biomedical Entrepreneurship**
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Opportunity for group study of advanced subjects relating to biomedical entrepreneurship not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.
*M. Gray, F. Murray*

**HST.S99 Special Graduate Subject: Biomedical Entrepreneurship**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for group study of advanced subjects relating to biomedical entrepreneurship not otherwise included in the curriculum. Offerings are initiated by HST faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic. Consult faculty at time of offering.
*HST/IMES Faculty*
HISTORY (COURSE 21H)

Introductory

21H.000 The History of Now (New)
Prereq: None
U (Spring)
1-0-0 units
Explores current events in a historical perspective. Each week a different MIT historian will discuss their research in the context of what is happening in the world today.
J. Ravel

21H.001 How to Stage a Revolution
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H
Explores fundamental questions about the causes and nature of revolutions by looking at how people overthrow their rulers and establish new governments. Considers a set of major political transformations throughout the world and across centuries to understand the meaning of revolution and evaluate its impact. Examines how revolutionaries have attempted to establish their ideals and realize their goals. Asks whether radical upheavals require bloodshed, violence, or even terror. Seeks to explain why some revolutions succeed and others fail. Materials include the writings of revolutionaries, declarations and constitutions, music, films, art, novels, memoirs, and newspapers.
P. Alimagham, T. Padilla, J. Ravel

21H.007[J] Introduction to Ancient and Medieval Studies
Same subject as 21L.014[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H
Explores the fascinating history, culture, and society of the ancient and medieval worlds and the different methodologies scholars use to interpret them. Wrestles with big questions about the diversity of life and thought in pre-modern societies, the best ways to study the distant past, and the nature (and limitations) of knowledge about long-ago eras. Considers a wide range of scholarly subjects such as the rise and fall of the Roman empire, the triumph of Christianity and Islam, barbarian invasions and holy wars, courts and castles, philosophy and religion, and the diversity of art, literature, and politics. Ponders different types of evidence, reads across a variety of disciplines, and develops skills to identify continuities and changes in ancient and medieval societies.
S. Frampton, E. Goldberg

21H.009 World History and Its Fault Lines Since 1800
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H
Explores how the world, as we know it today, came to be. Examines what it means to be modern and the consequences of modernity on people’s everyday lives. Introduces real and perceived changes that made the world recognizably “modern.” Surveys the rise of empires, nation-states, industrialized economies, mass consumption, popular culture, and political ideas and movements, and studies how they resulted in new, often contested, dynamics of racial, class, religious, gendered, and political identity. Instruction provided in how the evolving relationships of people with political, social, and economic structures produced a world that is highly interconnected and, at the same time, divided along different fault lines.
S. Aiyar, H. Nagahara
21H.101 American History to 1865
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

A basic history of American social, economic, and political development from the colonial period through the Civil War. Examines the colonial heritages of Spanish and British America; the American Revolution and its impact; the establishment and growth of the new nation; and the Civil War, its background, character, and impact. Readings include writings of the period by Winthrop, Paine, Jefferson, Madison, W. H. Garrison, G. Fitzhugh, H. B. Stowe, and Lincoln.

21H.102 American History since 1865
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H

Examines the social, cultural, political, and economic history of the United States, from the Civil War to the present. Uses secondary analysis and primary documents, such as court cases, personal accounts, photographs, and films, to examine some of the key issues in the shaping of modern America, including industrialization and urbanization, immigration, the rise of a mass consumer society, the emergence of the US as a global power, and the development of civil rights activism and other major social movements.

Same subject as 24.912[J], 21L.008[J], 21W.741[J], WGS.190[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-A, HASS-H; CI-H

See description under subject 24.912[J].

M. Degraff

21H.107[J] Introduction to Asian American Studies: Historical and Contemporary Issues
Same subject as 21G.043[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

See description under subject 21G.043[J].

Consult E. Teng

21H.108[J] Sexual and Gender Identities
Same subject as WGS.110[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H

See description under subject WGS.110[J].

K. Surkan

21H.130 The Ancient World: Greece
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H

History of Ancient Greece from the Bronze Age to the death of Alexander. Major social, economic, political, and religious trends. Homer, heroism, and the Greek identity; the hoplite revolution and the rise of the city-state; Herodotus, Persia, and the (re)birth of history; Empire, Thucydidean rationalism, and the Peloponnesian War; Aristotle, Macedon, and Hellenism. Emphasis on use of primary sources in translation.

N. Susmann

21H.132 The Ancient World: Rome
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H

History of Rome from its humble beginnings to the 5th century A.D. First half: Kingship to Republican form; the conquest of Italy; Roman expansion: Pyrrhus, Punic Wars and provinces; classes, courts, and the Roman revolution; Augustus and the formation of empire. Second half: Virgil to the Vandals; major social, economic, political and religious trends at Rome and in the provinces. Emphasis on use of primary sources in translation. Enrollment limited.

W. Broadhead

21H.133 The Medieval World
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Investigates the dynamic history of Europe and the wider world between the late Roman empire and voyages of discovery. Examines the rise of Christianity, the cult of the saints, and monasticism; the decline of the Roman empire, the barbarian invasions, and the foundation of post-Roman kingdoms; the meteoric rise of Islam; the formation of the Carolingian, Byzantine, and Islamic empires; the Vikings and Mongols; castles, knights, and crusades; religious thinkers, reformers, and heretics; changes in art, architecture, and literature; the Black Death and the fall of Constantinople; the Italian Renaissance and the voyages of discovery.

E. Goldberg
**21H.134[J] Medieval Economic History in Comparative Perspective**  
Same subject as 14.70[J]  
Prereq: None  
U (Spring)  
3-0-9 units. HASS-S; CI-H  

Surveys the conditions of material life and changing social and economic relations in medieval Europe using the comparative context of contemporary Islamic, Chinese, and Japanese experiences. Covers the emergence and decline of feudal institutions, the transformation of peasant agriculture, living standards and the course of epidemic disease, and the ebb and flow of long-distance trade across the Eurasian system. Particular emphasis placed on the study of those factors, both institutional and technological, which contributed to the emergence of capitalist organization and economic growth in western Europe in contrast to the trajectories followed by the other major medieval economies.  

A. McCants

**21H.141 Renaissance to Revolution: Europe, 1300-1800**  
Prereq: None  
U (Spring)  
3-0-9 units. HASS-H; CI-H  

Provides an introduction to major political, social, cultural and intellectual changes in Europe from the beginnings of the Renaissance in Italy around 1300 to the outbreak of the French Revolution at the end of the 1700s. Focuses on the porous boundaries between categories of theology, magic and science. Examines how developments in these areas altered European political institutions, social structures, and cultural practices. Studies men and women, nobles and commoners, as well as Europeans and some non-Europeans with whom they came into contact.  

V. Pugliano

**21H.144[J] Introduction to Russian Studies (New)**  
Same subject as 21G.087[J]  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall)  
3-0-9 units. HASS-H  

See description under subject 21G.087[J]. Limited to 25.  

E. Wood, M. Khotimsky

**21H.151 Traditional China: Earliest Times to 1644**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall)  
3-0-9 units. HASS-H  

Examines how traditional China originated a civilization of universal meaning and persistent influence, including ideologies, technologies, and culture. Explains how this unique civilization and the Chinese state at its center developed, considers its patterns, and assesses its impact. Emphasizes analysis of structures as well as knowledge of events.  

Staff

**21H.152 Modern China: 1644 to the Present**  
Prereq: None  
U (Spring)  
3-0-9 units. HASS-H  

Surveys China from its last empire through its reemergence as a power in modern times. Examines how China’s contemporary transformation has lifted hundreds of millions from poverty, refashioned social relations, and altered international politics. Students debate the causes and consequences of these major events and speculate on China’s future in the light of its past.  

Staff

**21H.154 Inventing the Samurai**  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
3-0-9 units. HASS-H  

Explores the historical origins of the Japanese warrior class as well as its reinvention throughout the archipelago’s history. Special focus on the pre-modern era (200-1600 CE). Highlights key historical contexts including the rise of the imperial court, interactions with the broader world, and the establishment of a warrior-dominated state. Also considers the modern imaginations and uses of the warrior figure.  

H. Nagahara
**21H.155 Modern Japan: 1600 to Present**
Prereq: None  
U (Spring)  
3-0-9 units. HASS-H

Surveys Japanese history from the establishment of the Tokugawa shogunate in 1603 to the present and explores the local and global nature of modernity in Japan. Highlights key themes, including the emergence of a modern nation-state, the rise and fall of the Japanese Empire, the development of mass consumer culture and the middle class, and the continued importance of historical memory in Japan today.

*H. Nagahara*

**21H.157 Modern South Asia**
Prereq: None  
U (Fall)  
3-0-9 units. HASS-S

Explores the political, social, and economic history of South Asia from the 18th century to the present day. Topics include colonial rule; anti-colonial movements; nationalism and the creation of modern India, Pakistan, and Bangladesh; the post-colonial nation state; social movements; religious identity; involvement of the United States in the region; and economic development. Students develop an understanding of the current successes, failures, and challenges facing the people and states of contemporary South Asia from a historical perspective.

*S. Aiyar*

**21H.160 Islam, the Middle East, and the West**
Prereq: None  
U (Fall)  
3-0-9 units. HASS-H

Provides students with an overview of basic themes and issues in Middle Eastern history from the rise of Islam to the present, with an emphasis on exchanges and encounters between the Middle East and Europe/North America. Examines the history of the notion of "East" and "West;" the emergence of Islam and the Christianization of Europe; Ottoman expansion; the flourishing of European powers; European competition with and colonization of Middle Eastern societies, and Middle Eastern responses, including Arab and Iranian nationalisms as well as the rise of Political Islam, the "Clash of Civilizations", and Islamophobia.

*P. Alimagham*

**21H.161 The Modern Middle East**
Prereq: None  
U (Spring)  
3-0-9 units. HASS-H; CI-H

Surveys the history of the Middle East, from the end of the 19th century to the present. Examines major political, social, intellectual and cultural issues and practices. Focuses on important events, movements, and ideas that prevailed during the last century and affect its current realities. Enrollment limited.

*P. Alimagham*

**21H.165 A Survey of Modern African History**
Prereq: None  
U (Spring)  
3-0-9 units. HASS-H

Surveys the history of 19th- and 20th-century Africa. Focuses on the European conquest of Africa and the dynamics of colonial rule, especially its socioeconomic and cultural consequences. Looks at how the rising tide of African nationalism, in the form of labor strikes and guerrilla wars, ushered out colonialism. Examines the postcolonial states, focusing on the politics of development, recent civil wars in countries like Rwanda and Liberia, the AIDS epidemic, and the history of Apartheid in South Africa up to 1994.

*K. Mutongi*

**21H.170[J] Introduction to Latin American Studies**
Same subject as 17.55[J], 21A.130[J], 21G.084[J]  
Prereq: None  
Acad Year 2019-2020: U (Fall)  
Acad Year 2020-2021: Not offered  
3-0-9 units. HASS-S; CI-H

See description under subject 17.55[J].

*T. Padilla, P. Duong*

**21H.171 Latin America: Revolution, Dictatorship, and Democracy, 1850 to Present**
Prereq: None  
U (Fall)  
Not offered regularly; consult department  
3-0-9 units. HASS-H

Selective survey of Latin American history from the mid-19th century to the present. Issues studied include: dictators and democracies in the 20th century, revolution in Mexico, Cuba, and Central America, Latin America in the global economy, relations between Latin America and the U.S., indigenismo, feminism, and the varieties of religion in Latin America.

*T. Padilla*
HISTORY (COURSE 21H)

21H.172[J] Latin America Through Film
Same subject as 21G.078[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Traces Latin American history through film and analyzes how this medium represents events in the recent and distant past. Weekly movies provide a window through which to analyze themes such as colonialism, national formation, revolution, gender, race relations, popular mobilizations and counterinsurgency. Examines films for how they represent a particular group or country, the reality they capture or obscure, and the message they convey.
T. Padilla

21H.181[J] Libertarianism in History
Same subject as 17.035[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Explores the history of the ideal of individual liberty in light of contemporary arguments over the proper scope of the regulatory state. Surveys the political theory of freedom and its relationship to competing norms (property, equality, community, republicanism, and innovation). Considers examples of modern liberation movements, including abolitionism and the Civil Rights movement, religious liberty, and LGBT rights. Concludes with a set of policy debates about the role of government in regulating health care, the financial markets, and the internet.
M. Ghachem

21H.185[J] Environment and History
Same subject as 12.386[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-S; CI-H

Examines the culture that developed in the US during the early years of the Cold War, at the dawn of the nuclear age. Topics include new family structures and civil defense strategies that emerged in response to the promise and perils of nuclear power; the role of anxiety and insecurity in transforming American politics and psychology; the development of computing technology and the changes it brought to American workspaces; the social impacts of space exploration, suburbanization, and the construction of highways and shopping malls; and new models used by social scientists and other experts to predict human behavior and the future.
C. Horan

Intermediate

21H.201 The American Revolution
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

English and American backgrounds of the Revolution; issues and arguments in the Anglo-American conflict; colonial resistance and the beginnings of republicanism; the Revolutionary War; constitution writing for the states and nation; and effects of the American Revolution. Concerned primarily with the revolutionary origins of American government and laws. Readings emphasize documents from the period—pamphlets, correspondence, the minutes or resolutions of resistance organizations, constitutional documents and debates.
Staff

Same subject as STS.027[J]
Subject meets with STS.427
Prereq: Permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

See description under subject STS.027[J].
M. R. Smith

21H.211 The United States in the Nuclear Age
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Examines the culture that developed in the US during the early years of the Cold War, at the dawn of the nuclear age. Topics include new family structures and civil defense strategies that emerged in response to the promise and perils of nuclear power; the role of anxiety and insecurity in transforming American politics and psychology; the development of computing technology and the changes it brought to American workspaces; the social impacts of space exploration, suburbanization, and the construction of highways and shopping malls; and new models used by social scientists and other experts to predict human behavior and the future.
C. Horan
HISTORY (COURSE 21H)

Same subject as 17.28[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

See description under subject 17.28[J].
A. Berinsky, C. Capozzola

21H.214 War and American Society
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Examines how issues of war and national security have affected politics, economics, and society from the First World War to the war in Iraq. Draws on historical evidence as well as representations in film, music and popular culture.
C. Capozzola

21H.217[J] American Urban History
Same subject as 11.013[J]
Prereq: None
U (Fall)
2-0-7 units. HASS-H; CI-H

See description under subject 11.013[J].
R. M. Fogelson

21H.218[J] History of the Built Environment in the US
Same subject as 11.014[J]
Prereq: None
U (Fall)
2-0-7 units. HASS-H; CI-H

See description under subject 11.014[J].
R. M. Fogelson

21H.220[J] Metropolis: A Comparative History of New York City
Same subject as 11.150[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Examines the evolution of New York City from 1607 to the present. Readings focus on the city's social and physical histories. Discussions compare New York's development to patterns in other cities.
C. Wilder

21H.226[J] Riots, Strikes, and Conspiracies in American History
Same subject as 11.015[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H

Focuses on a series of short, complicated, traumatic events that shed light on American politics, culture, and society. Events studied may include the rendition of Anthony Burns in 1854, the most famous fugitive slave controversy in US history; the Homestead strike/lockout of 1892; the quiz show scandal of the 1950s; and the student uprisings at Columbia University in 1968. Emphasis on finding ways to make sense of these events and on using them to understand larger processes of change in American history.
R. M. Fogelson

21H.227 Constitutional Law in US History
Prereq: None
U (Spring)
3-0-9 units. HASS-S

Introduces major themes and patterns of change in American constitutional law since 1787, including federal-state relations, racial and gender equality, economic regulation, and civil liberties. Readings consist of original court cases, especially from the US Supreme Court, including cases of the current term. Emphasis on the historical development of constitutional law and on the relationship between the Supreme Court and broader social, political, and cultural trends.
C. Capozzola

21H.228 American Classics
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H

Students read, discuss, and write about critical works in American history from the 17th through the 20th centuries. Includes writings by early Puritan writers, Franklin, Paine, Jefferson, and Madison; Lewis and Clark; Frederick Douglass; Harriet Beecher Stowe; the Lincoln-Douglas debates; U. S. Grant, W. E. B. Du Bois, Andrew Carnegie, Horatio Alger, F. D. Roosevelt, Betty Friedan, and Martin Luther King, Jr. May also include music, recorded speeches, television programs, visual images, or films. Enrollment limited.
C. Wilder
21H.229 The Black Radical Tradition in America
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Focuses on American history from the African-American perspective. Includes alternative visions of the nation's future, and definitions of its progress, that have called for a fundamental restructuring of political, economic and social relations. Introduces events, figures and institutions that have shaped African-American history, from the struggles to dominate the African coast and the emergence of a modern slave trade, through the fall of the Western slave societies. Also examines the experiences of Africans in other parts of North America, as well as South America and the Caribbean.

C. Wilder

21H.230 Barbarians, Saints, and Emperors
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Explores the late Roman Empire and its transformations during Late Antiquity (c. 300-c. 700). Questions the traditional decline and fall narrative of the period, which argues that Christianity and barbarians destroyed classical civilization and ushered in the Dark Ages. Explores such topics as Romans and barbarians, paganism and Christianity, politics and war, Rome and Constantinople, and bishops and saints. Discusses the influence of such characters as Constantine the Great, St. Augustine, Attila the Hun, and the prophet Mohammed.

E. Goldberg

21H.237 The City of Athens in the Age of Pericles
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Historical topography of ancient Athens. Investigates the relationship between urban architecture and political, social, and cultural history of Athens in the 5th and 4th centuries BC. Surveys and analyzes archeological and literary evidence, including the sanctuary of Athena on the Acropolis, the Agora, Greek houses, the histories of Herodotus and Thucydides, plays of Sophocles and Aristophanes, and the panhellenic sanctuaries of Delphi and Olympia.

W. Broadhead

21H.238 The Vikings
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Explores the complex relationship of the Vikings with the medieval world. Investigates the dynamics of Viking expansion, not only in terms of raiding and conflict, but also as a process of diplomacy, settlement, assimilation, and colonization. Examines developments within Scandinavian society such as state formation, social structures, trade, shipbuilding, slavery, urban growth, and Christianization. Considers the methodological difficulties presented by the diverse and often contradictory historical sources for information about the Vikings, such as chronicles, archaeology, coin hoards, stone inscriptions, and sagas.

E. Goldberg

21H.239 The City of Rome in the Age of the Caesars
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Historical topography of Ancient Rome. Investigates the relationship between urban architecture and the political, social, and cultural history of Rome from the 1st century BC to the 2nd century AD. Surveys and analyzes archaeological and literary evidence, including the Roman Forum, the Imperial fora, the palace of the emperors, the atrium houses of Roman Pompeii, the Colosseum, the Pantheon, Polybius' history, Martial's Epigrams, and Vitruvius' treatise on architecture.

W. Broadhead

21H.240 The World of Charlemagne
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H; CI-H

Investigates the world of the first medieval emperor, Charles the Great, or Charlemagne (768-814). Focuses on how Charlemagne and his dynasty, the Carolingians (ruled 751-888), forged a vast empire out of the diverse peoples and territories of Europe - not only through conquests and military might, but through Christianity and the Church, education and literacy, government and law, art and architecture, and a fundamental reorganization of the economy and society. Considers the enduring contributions of Charlemagne and his family to the formation of Europe as well as the shortcomings and failures of their empire.

E. Goldberg
Same subject as 21G.054[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H
Explores the question of whether the French Enlightenment caused the French Revolution. Studies France prior to 1789, analyzes some of the most critically corrosive works of the French Enlightenment, and considers how ideas circulated through France and Europe in the eighteenth century. Examines the role of enlightened ideas in France during the revolutionary decade from 1789 to 1799.
J. Ravel

21H.242[J] Frenchness in an Era of Globalization
Same subject as 21G.322[J]
Prereq: One intermediate subject in French or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H
See description under subject 21G.322[J]. Limited to 18.
C. Clark

21H.244[J] Imperial and Revolutionary Russia: Culture and Politics, 1700-1917
Same subject as 21G.085[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H
Analyzes Russia's social, cultural, and political heritage in the 18th and 19th centuries, up to and including the Russian Revolution of 1917. Compares reforming and revolutionary impulses in the context of serfdom, the rise of the intelligentsia, and debates over capitalism. Focuses on historical and literary texts, especially the intersections between the two.
E. Wood

21H.245[J] Soviet and Post-Soviet Politics and Society: 1917 to the Present
Same subject as 17.57[J], 21G.086[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S; CI-H
Explores the political and historical evolution of the Soviet state and society from the 1917 Revolution to the present. Covers the creation of a revolutionary regime, causes and nature of the Stalin revolution, post-Stalinist efforts to achieve political and social reform, and causes of the Soviet collapse. Also examines current developments in Russia in light of Soviet history. Enrollment limited.
E. Wood

Same subject as 21G.075[J]
Subject meets with 21G.196
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H
See description under subject 21G.075[J].
E. Teng

21H.260 Cities in the Middle East: History, Politics and Society
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-S
Examines the role and centrality of cities in the history of the modern Middle East, through political, social, cultural and urban interactions. Begins with a theoretical introduction of the different approaches for investigating urban spaces, and follows with discussions of case studies that demonstrate the diversity of urban centers in the Middle East, including Beirut, Istanbul, Jerusalem, Mecca, Algiers, and Cairo.
Staff
21H.261 Modern Iran: A Century of Revolution
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Provides an overview of Iran's modern history from a social, cultural, and political perspective while also considering factors as they relate to gender and race. Covers the country's long and complicated interaction with the "West." Situates Iran in the wider region, thereby delineating how political trends in the Middle East influenced the country and how its history of revolution has in turn impacted the region. Unpacks the Sunni-Shiite divide as a modern phenomenon rooted more in inter-state rivalry than in a theological dispute, Western perceptions of the Iranian and the Middle Eastern "Other," the Iranian Diaspora, political Islam, and post-Islamism.

P. Alimagham

21H.262 Palestine and the Arab-Israeli Conflict
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Surveys the history and various realities and challenges of the Israeli-Palestinian conflict. Introduces the fundamental historical trajectories of the conflict. Analyzes the conflicting narratives and perceptions of both Palestinians and Israelis over key moments and issues in the conflict’s history. Considers current challenges and possible solutions to the conflict. Limited to 15.

P. Alimagham

21H.263[)] Women and Gender in the Middle East and North Africa
Same subject as WGS.220[)]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

See description under subject WGS.220[)].

L. Eckmekcioglu

21H.265 Humanitarianism and Africa: A Critical History (New)
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Examines two centuries of foreign interventions in Africa in the name of humanitarian principles, from the abolition of the slave trade to the most recent Ebola crisis in West Africa. Explores humanitarianism and how it informs the understanding of poverty, race, and violence; and who gives and receives aid. Scrutinizes the prejudices about Africans embedded within salvation projects and how these campaigns have been part of the larger dynamics of power that have defined Africa's position in the world before, during, and after the European colonization of the continent. Reflects upon the practical and morally ethical alternatives in a world still shaped by suffering and injustice.

K. Mutongi

21H.266 South Africa and Apartheid (New)
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Explores the spatial, legal, economic, social and political structures that created Apartheid in South Africa, and the factors that led to the collapse of the racist order. Examines the many forces of black oppression and the various forms of resistance to Apartheid. Themes include industrialization and the formation of the black working classes, constructions of race, ethnicities and sexualities, land alienation and rural struggles, township poverty and violence, black education, and the Black Consciousness Movement.

K. Mutongi

21H.273 From Coca to Cocaine: Drug Economies in Latin America
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Explores how drug production and consumption has affected Latin America's political, cultural and economic life and shaped US foreign policy toward the region. Discusses the history of different psychoactive substances and analyzes why certain drugs became illegal. Pays particular attention to the relationship between strategies of interdiction, poverty, and drug violence. Limited to 35.

T. Padilla
21H.274[J] Creation of a Continent: Representations of Hispanic America, 1492-1898, in Literature and Film
Same subject as 21G.731[J]
Prereq: One intermediate Spanish subject or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

See description under subject 21G.731[J].
P. Duong

21H.281 MIT and Slavery: Research
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H

Explores the influence of slavery and race on MIT’s founding and early development, and the connections between slavery and the rise of sciences and engineering. Students will have their research projects published through the MIT and Slavery website. While 21H.281 and 21H.282 are sequential, students have the option of taking either or both.
N. Murphy, C. Wilder

21H.282 MIT and Slavery: Publication
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Students work on turning research from 21H.281 into publishable quality essays, researching images and other supporting documentary materials, and developing the main narrative of the MIT and Slavery website, for which they receive editorial credit. While 21H.281 and 21H.282 are sequential, students have the option of taking either or both.
N. Murphy, C. Wilder

Same subject as STS.025[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

See description under subject STS.025[J].
M. R. Smith

Seminars

21H.315 American Consumer Culture
Prereq: None
U (Spring)
Not offered regularly; consult department
2-0-10 units. HASS-H

Examines how and why 20th-century Americans came to define the “good life” through consumption, leisure, and material abundance. Explores how such things as department stores, advertising, mass-produced cars, and suburbs transformed the American economy, society, and politics.
C. Horan

21H.319 Race, Crime, and Citizenship in American Law
Prereq: None
U (Fall)
3-0-9 units. HASS-S

Provides an introduction to the law of race in the United States, focusing on the development of America’s criminal justice system since Reconstruction. Examines ongoing debates over whether “mass incarceration” amounts to an instrument of racial control. Considers the relationship between American race legislation and changing definitions of citizenship at key moments in the late 19th and 20th centuries. Case studies include immigration restriction, the death penalty, criminal procedure, and national security policing before and after 9/11.
M. Ghachem

21H.320[J] Gender and the Law in US History
Same subject as WGS.161[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Explores the legal history of the US as a gendered system. Examines how women have shaped the meanings of American citizenship through pursuit of political rights such as suffrage, jury duty, and military service, as well as how the legal system has shaped gender relations through regulation of such issues as marriage, divorce, work, reproduction, and the family. Readings draw from primary and secondary materials, focusing on the broad historical relationship between law and society. No legal knowledge is required or assumed.
C. Capozzola
21H.321[J] Downtown
Same subject as 11.026[J]
Subject meets with 11.339
Prereq: None
U (Spring)
Not offered regularly; consult department
2-0-7 units. HASS-H

Seminar on downtown in US cities from the late 19th century to the late 20th. Emphasis on downtown as an idea, place, and cluster of interests, on the changing character of downtown, and on recent efforts to rebuild it. Considers subways, skyscrapers, highways, urban renewal, and retail centers. Focus on readings, discussions, and individual research projects. Students taking graduate version complete additional assignments.
R. M. Fogelson

21H.322 Christianity in America
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

C. Wilder

21H.331 Julius Caesar and the Fall of the Roman Republic
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Ancient Rome from 133 to 27 BC. Explores political, social, and economic factors commonly offered to explain the fall of the Roman Republic: growth of the territorial empire, increased intensity of aristocratic competition, transformation of the Italian economy, growth of the city of Rome and dependence of the urban plebs, changes in military recruitment and dependence of soldiers on their generals. Emphasis on the reading of ancient sources in translation, including Cicero, Sallust, Caesar, Augustus, Appian, Plutarch, and Suetonius. Instruction and practice in oral and written communication provided. Taught in seminar format with emphasis on class participation. Limited to 15.
W. Broadhead

21H.333 Early Christianity
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Introduction to the history of early Christianity, from Jesus to Muhammad. Investigates the origins and spread of the Jesus movement within the ancient Jewish and Roman worlds, the emergence of the Church, and the diversity of early Christian thought, spirituality, literature, and art. Examines such topics as the historical Jesus and Paul, relations among Jews, Romans, and Christians, debates over orthodoxy and heresy, the conversion of the Roman empire, the rise of bishops and monasticism, the Church Fathers, and the cult of the saints.
E. Goldberg

21H.336 The Making of a Roman Emperor
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Through close examination of the emperor Augustus and his Julio-Claudian successors, this subject investigates how Roman emperors used art, architecture, coinage, and other media to create and project an image of themselves, how the surviving literary sources from the Roman period reinforced or subverted that image, and how both phenomena have contributed to post-classical perceptions of Roman emperors. Also considers works of Suetonius and Tacitus, and modern representations of the emperors such as those found in the films I, Claudius, Quo Vadis, and HBO’s Rome series. Enrollment limited to 15.
W. Broadhead

Same subject as CC.120[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-A

Explores the impact of new technology on the recording and distribution of words and images in Europe from 1400-1800. Assignments include essays and online projects. Students participate in the design and printing of an eight-page pamphlet on a hand-set printing press. Limited to 12.
E. Zimmer
21H.350 Business in China Since 1800
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Analyzes the characteristics of business in China since 1800 to provide a historical context for its contemporary economic development. Topics include China’s place in the world economy; early efforts at state-led industrialization; legal and social frameworks for business; foreign investments, companies, and competition; the emergence of a Chinese business class; the influence of socialism and reform-era politics on business. Includes case studies of contemporary companies and a research project. 

Staff

21H.351 Shanghai and China's Modernization
Same subject as 11.153
Prereq: None
U (Fall)
Not offered regularly; consult department
2-0-10 units. HASS-H

Considers the history and function of Shanghai, from 1840 to the present, and its rise from provincial backwater to international metropolis. Examines its role as a primary point of economic, political, and social contact between China and the world, and the strong grip Shanghai holds on both the Chinese and foreign imagination. Students discuss the major events and figures of Shanghai, critique the classic historiography, and complete an independent project on Shanghai history.

Staff

21H.354 World War II in Asia
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Examines World War II in the Asia-Pacific region, starting with the rise of the Japanese Empire after World War I and ending with the Allied occupation of Japan from 1945 to 1952. Highlights the diverse and, at times, contradictory forces in politics, society, and culture that shaped the wartime experiences of the empire’s inhabitants.

H. Nagahara

21H.357 South Asian Migrations
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Provides a global history of South Asians and introduces students to the cultural, social, economic, and political experiences of immigrants who traveled across the world. Studies how and why South Asians, who have migrated to America, Europe, Africa, the Caribbean and the Middle East, are considered a model minority in some countries and unwanted strangers in others. Through literature, memoirs, films, music, and historical writing, follows South Asian migrants as they discovered the world beyond India, Pakistan, and Bangladesh.

S. Aiyar

21H.358 Colonialism in South Asia and Africa
Subject meets with 21H.958
Prereq: None
U (Spring)
2-0-10 units. HASS-H

Provides a comparative perspective on the history of colonialism in India and Africa. Explores the political, social, and economic changes brought about by colonial rule. Discusses the international context for the emergence of European Imperialism in the 19th century; the nature of early colonial expansion and consolidation; the re-invention of tradition in colonial societies, especially with regard to racial and ethnic identity, gender, religion, and caste; and expressions of anti-colonial resistance. Students taking graduate version complete additional assignments.

S. Aiyar

21H.365 Minorities and Majorities in the Middle East
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Seminar considers "difference" and "sameness" as they have been conceived, experienced, and regulated by peoples of the Middle East, with a focus on the 19th and 20th centuries. First half discusses the Ottoman Empire. Explores how this multiethnic, polyglot empire survived for several relatively peaceful centuries and what happened when its formula for existence was challenged by politics based on mono-ethnic states. Second half focuses on post-Ottoman nation-states, such as Turkey and Egypt, and Western-mandated Arab states, such as Syria, Lebanon, Palestine, and Iraq. Concludes with a case analysis of Israel.

L. Ekmekcioglu
HISTORY (COURSE 21H)

21H.380 [J] People and Other Animals
Same subject as 21A.411 [J]
Subject meets with 21A.419 [J], 21H.980 [J]
Prereq: None
U (Fall)
Not offered regularly; consult department
2-0-10 units. HASS-S

Historical exploration of the ways that people have interacted with their closest animal relatives, for example: hunting, domestication of livestock, exploitation of animal labor, scientific study of animals, display of exotic and performing animals, and pet-keeping. Themes include changing ideas about animal agency and intelligence, our moral obligations to animals, and the limits imposed on the use of animals. Students taking the graduate version complete additional assignments.

H. Ritvo

21H.381 [J] Women and War
Same subject as WGS.222 [J]
Prereq: None
U (Fall)
3-0-9 units. HASS-S

Examines women’s experiences during and after war and genocide, covering the first half of the 20th century in Europe and the Middle East. Addresses ways in which women’s wartime suffering has been used to further a variety of political and social agendas. Discussions focus on a different topic each week, such as sexual violence, women survivors, female perpetrators of genocide, nurses, children of genocidal rape, and the memory of war.

L. Ekmekcioglu

21H.382 Capitalism in the Age of Revolution
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Examines the critical period from the late 17th to the early 19th centuries during which the North Atlantic economies (France, Britain, the Netherlands, and their colonial dependencies) developed recognizably modern, capitalist institutions and practices. Focuses on the rise of publicly traded companies, the relationship between war and state debt, stock markets, and the transition from metallic to paper currency. Considers the role of plantation slavery in the growth of financial capitalism, and the explosive politics of speculation in the American and French revolutions.

M. Ghachem

21H.383 Technology and the Global Economy, 1000–2000
Subject meets with 21H.982
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

Examines the global history of the last millennium, including technological change, commodity exchange, systems of production, and economic growth. Students engage with economic history, medieval and early modern origins of modern systems of production, consumption and global exchange. Topics include the long pre-history of modern economic development; medieval world systems; the age of discovery, the global crisis of the 17th century; demographic systems, global population movements; the industrial revolution, the rise of the modern consumer; colonialism and empire building; patterns of inequality, within and across states; the curse of natural resources fate of Africa; and the threat of climate change to modern economic systems. Students taking graduate version complete additional assignments.

A. McCants

21H.385 [J] The Ghetto: From Venice to Harlem
Same subject as 11.152 [J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

Provides an in-depth look at a modern institution of oppression: the ghetto. Uses literature to examine ghettoization over time and across a wide geographical area, from Jews in Medieval Europe to African-Americans and Latinos in the 20th-century United States. Also explores segregation and poverty in the urban “Third World.”

C. Wilder

21H.390 Theories and Methods in the Study of History
Subject meets with 21H.991
Prereq: Two History subjects or permission of instructor
U (Fall)
3-0-9 units. HASS-H

Examines the distinctive ways in which historians in different parts of the world have approached the task of writing history. Explores methodologies used, such as political, social, economic, cultural, and popular histories through the reading and discussion of relevant and innovative texts. Introduces a variety of sources (archival documents, statistical data, film, fiction, memoirs, artifacts, and images) and the ways they can be used to research, interpret, and present the past. Assignments include an original research paper. Students taking graduate version complete additional assignments.

H. Ritvo
21H.391 Undergraduate Independent Study
Prereq: None
U (Fall, IAP)
Units arranged
Can be repeated for credit.
Individual supervised work for students who wish to explore an area of interest in history. Before registering, a student must plan a course of study with a member of the History Faculty and secure approval from the Head of the History Faculty. Normal maximum is 6 units; exceptional 9-unit projects occasionally approved.
M. Ghachem

21H.392 Undergraduate Independent Study
Prereq: Permission of instructor
U (Spring)
Units arranged
Can be repeated for credit.
Individual supervised work for students who wish to explore an area of interest in history. Before registering, a student must plan a course of study with a member of the History Faculty and secure approval from the Head of the History Faculty. Normal maximum is 6 units; exceptional 9-unit projects occasionally approved.
M. Ghachem

Special Subjects

21H.S01 Special Subject: History
Prereq: Permission of instructor
U (Fall)
3-0-9 units
Can be repeated for credit.
Opportunity for group study of special subject not listed in the regular History curriculum.
Staff

21H.S02 Special Subject: History
Prereq: Permission of instructor
U (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Opportunity for group study of special subject not listed in the regular History curriculum.
Staff

21H.S03 Special Subject: History
Prereq: None
U (Fall, IAP, Spring; partial term)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for group study of special subject not listed in the regular History curriculum.
Staff

21H.S04 Special Subject: History
Prereq: Permission of instructor
U (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for group study of special subject not listed in the regular History curriculum.
Staff

Undergraduate Research

21H.THT History Pre-Thesis Tutorial
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Students writing a thesis in History develop their research topics, review relevant research and scholarship, frame their research questions and arguments, choose an appropriate methodology for analysis, and draft the introductory and methodology sections of their theses. Includes substantial practice in writing (with revision) and oral presentations.
M. Ghachem

21H.THU History Thesis
Prereq: 21H.THT
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Completion of work on the senior major thesis under supervision of a faculty thesis advisor. Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and a final meeting with a committee of faculty evaluators to discuss the successes and limitations of the project. Required for students pursuing a full major in History.
M. Ghachem
**21H.UR Undergraduate Research**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.
*Ekmekcioglu*

**21H.URG Undergraduate Research**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.
*Ekmekcioglu*

**Graduate Subjects**

**21H.902 Reading Seminar in American History: 1877 to Present**
Prereq: 21H.991 and permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Develops teaching knowledge and research skills through extensive reading and discussion of major works in modern US history. Readings cover a range of topics and historical methods. Students make frequent oral presentations and submit a major work consisting of original research or historiographic interpretation.
*Wilder*

**21H.958 Colonialism in South Asia and Africa**
Subject meets with 21H.358
Prereq: None
G (Spring)
2-0-10 units
Provides a comparative perspective on the history of colonialism in India and Africa. Explores the political, social, and economic changes brought about by colonial rule. Discusses the international context for the emergence of European Imperialism in the 19th century; the nature of early colonial expansion and consolidation; the re-invention of tradition in colonial societies, especially with regard to racial and ethnic identity, gender, religion, and caste; and expressions of anti-colonial resistance. Students taking graduate version complete additional assignments.
*Aiyar*

**21H.980[J] People and Other Animals**
Same subject as 21A.419[J]
Subject meets with 21A.411[J], 21H.380[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
2-0-10 units
Historical exploration of the ways that people have interacted with their closest animal relatives, for example: hunting, domestication of livestock, exploitation of animal labor, scientific study of animals, display of exotic and performing animals, and pet-keeping. Themes include changing ideas about animal agency and intelligence, our moral obligations to animals, and the limits imposed on the use of animals. Students taking the graduate version complete additional assignments.
*Ritvo*

**21H.981 Seminar in Nature, Environment, and Empire**
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-9 units
Explores the relationship between the study of natural history, both domestic and exotic, by Europeans and Americans, and concrete exploitation of the natural world. Focuses on the 18th and 19th centuries.
*Ritvo*

**21H.982 Technology and the Global Economy, 1000-2000**
Subject meets with 21H.383
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units
Examines the global history of the last millennium, including technological change, commodity exchange, systems of production, and economic growth. Students engage with economic history, medieval and early modern origins of modern systems of production, consumption and global exchange. Topics include the long pre-history of modern economic development; medieval world systems; the age of discovery, the global crisis of the 17th century; demographic systems, global population movements; the industrial revolution, the rise of the modern consumer; colonialism and empire building; patterns of inequality, within and across states; the curse of natural resources fate of Africa; and the threat of climate change to modern economic systems. Students taking graduate version complete additional assignments.
*McCants*
21H.983[J] Gender
Same subject as WGS.310[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Examines the definition of gender in scientific, societal, and historical contexts. Explores how gender influences state formation and the work of the state, what role gender plays in imperialism and in the welfare state, the ever-present relationship between gender and war, and different states’ regulation of the body in gendered ways at different times. Investigates new directions in the study of gender as historians, anthropologists and others have taken on this fascinating set of problems. Open to advanced undergraduates with permission of instructor.
L. Ekmekcioglu, E. Wood

21H.984[J] Risk, Fortune, and Futurity
Same subject as STS.414[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units
Exploration of interdisciplinary scholarship on risk, chance, and fortune. Begins with a survey of theoretical approaches to the field, then proceeds chronologically to explore the emergence of risk and its impacts on human life in multiple arenas including economics, politics, culture, environment, science, and technology from the 16th century to the present. Open to undergraduates with permission of instructor; consult department for details.
W. Deringer, C. Horan

21H.991 Theories and Methods in the Study of History
Subject meets with 21H.390
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Examines the distinctive ways in which historians in different parts of the world have approached the task of writing history. Explores methodologies used, such as political, social, economic, cultural, and popular histories through the reading and discussion of relevant and innovative texts. Introduces a variety of sources (archival documents, statistical data, film, fiction, memoirs, artifacts, and images) and the ways they can be used to research, interpret, and present the past. Assignments include an original research paper. Students taking graduate version complete additional assignments.
H. Ritvo

21H.992 Graduate Independent Study
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Individual supervised work for students who wish to explore an area of interest in history. Before registering, a student must plan a course of study with a member of the History Faculty and secure approval from the Head of the History Faculty.
Staff

21H.993 Graduate Independent Study
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Individual supervised work for students who wish to explore an area of interest in history. Before registering, a student must plan a course of study with a member of the History Faculty and secure approval from the Head of the History Faculty.
Staff

21H.999 Teaching History
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
For qualified graduate students serving as either a teaching assistant or instructor for subjects in History. Enrollment limited by availability of suitable teaching assignments.
Staff
HUMANITIES (COURSE 21)

Research subjects are also offered by programs within the Department of Humanities: Anthropology (21A), Comparative Media Studies/Writing (CMS/21W), Global Studies and Languages (21G), History (21H), Literature (21L), Music and Theater Arts (21M), Science, Technology, and Society (STS), and Women’s and Gender Studies (WGS). Consult those listings for details.

21.00 SHASS Exploration (New)
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
1-0-0 units
Provides a better understanding of what the humanities, arts, and social sciences at MIT are all about. Each week, a different faculty member from a SHASS unit discusses their research, giving students a sense of what they might expect from a major, minor, or concentration in their field. Subject can count toward the 9-unit discovery-focused credit limit for first year students.
Consult A. Rayo

21.THT Humanities Pre-Thesis Tutorial
Prereq: As specified for particular field
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Definition of and early-stage work on thesis project leading to 21.THU Undergraduate Thesis in Humanities. Taken during the first term of the student's two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Required for all students in Course 21, and those doing 21-E and 21-S degrees, for whom the thesis is a degree requirement.
Information: SHASS Dean's Office

21.THU Undergraduate Thesis in Humanities
Prereq: 21.THT
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Completion of work on the senior major thesis under supervision of a faculty tutor. Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and meeting at the close with a committee of faculty evaluators to discuss the successes and limitations of the project. Required for most students in Course 21 and those doing 21-E and 21-S degrees.
Information: SHASS Dean's Office

21.UR Undergraduate Research in Humanities
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.
Information: SHASS Dean's Office

21.URG Research in Humanities
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program.
Information: SHASS Dean's Office
**LINGUISTICS AND PHILOSOPHY (COURSE 24)**

**Discovery-focused**

**24.93 The Search for Meaning (New)**
- Subject meets with 24.A03
- Prereq: None
- U (Fall)
- 1-0-1 units

"We create islands of meaning in the sea of information" (Freeman Dyson). In this subject, we will explore a central feature of human nature: we are meaning-seeking engines. There are many ways of encoding and extracting meaning. We will talk about smoke signals, talking drums, alphabets, Universal Grammar, artificial languages, the problem of first contact, code breaking, Sherlock Holmes, the genetic code, and much more. We will bring in ideas from information theory, cryptography, linguistics, logic, psychology, anthropology, computer science, philosophy, and literature. Includes some reading and thinking outside class, but no problem sets or papers. Subject can count toward the 9-unit discovery-focused credit limit for first year students.

*K. von Fintel*

**Philosophy**

**Undergraduate Subjects**

**24.00 Problems of Philosophy**
- Prereq: None
- U (Fall)
- 3-0-9 units. HASS-H; CI-H

Introduction to the problems of philosophy- in particular, to problems in ethics, metaphysics, theory of knowledge, and philosophy of logic, language, and science. A systematic rather than historical approach. Readings from classical and contemporary sources, but emphasis is on examination and evaluation of proposed solutions to the problems.

*M. Schoenfield*

**24.01 Classics of Western Philosophy**
- Prereq: None
- U (Spring)
- 3-0-9 units. HASS-H; CI-H

Introduction to Western philosophical tradition through the study of selected major thinkers such as Plato, Aristotle, Lucretius, Descartes, Hobbes, Leibniz, Locke, Berkeley, Hume, Kant, Nietzsche and Marx. Emphasis on changes of intellectual outlook over time, and the complex interplay of scientific, religious and political concerns that influence the development of philosophical ideas.

*S. Haslanger*

**24.013 Philosophy and the Arts**
- Prereq: None
- U (Spring)
- 3-0-9 units. HASS-H; CI-H

Explores philosophical questions about art in general, and about the particular arts, such as literature and music. Measures the answers philosophers have proposed to these questions against our own experiences with the arts. Readings include short works of literature. Includes a museum visit with no charge to students.

*B. Skow*

**24.02 Moral Problems and the Good Life**
- Prereq: None
- U (Fall)
- 3-0-9 units. HASS-H; CI-H

Introduction to important philosophical debates about moral issues and what constitutes a good life: What is right, what is wrong, and why? How important are personal happiness, longevity, and success if one is to live a good life? When is it good for you to get what you want? To what extent are we morally obliged to respect the rights and needs of others? What do we owe the poor, the discriminated, our loved ones, animals and fetuses?

*K. Setiya*

**24.03 Good Food: The Ethics and Politics of Food**
- Prereq: None
- Acad Year 2019-2020: Not offered
- Acad Year 2020-2021: U (Spring)
- 3-0-9 units. HASS-H; CI-H

Explores the values (aesthetic, moral, cultural, religious, prudential, political) expressed in the choices of food people eat. Analyzes the decisions individuals make about what to eat, how society should manage food production and consumption collectively, and how reflection on food choices might help resolve conflicts between different values.

*S. Haslanger*
24.04[J] Justice
Same subject as 17.01[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H; CI-H

Introduces contemporary political thought centered around the ideal of justice and the realities of injustice. Examines what a just society might look like and how we should understand various forms of oppression and domination. Studies three theories of justice (utilitarianism, libertarianism, and egalitarian liberalism) and brings them into conversation with other traditions of political thought (critical theory, communitarianism, republicanism, and post-structuralism). Readings cover foundational debates about equality, freedom, recognition, and power.

B. Zacka

24.05 Philosophy of Religion
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H

Uses key questions in the philosophy of religion to introduce tools of contemporary philosophy. Explores what defines a god, the possibility of the existence of gods, the potential conflict between religion and science, whether morality requires a divine author, and religious tolerance.

J. Spencer

24.06[J] Bioethics
Same subject as STS.006[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H

Considers ethical questions that have arisen from the growth of biomedical research and the health-care industry since World War II. Should doctors be allowed to help patients end their lives? If so, when and how? Should embryos be cloned for research and/or reproduction? Should parents be given control over the genetic make-up of their children? What types of living things are appropriate to use as research subjects? How should we distribute scarce and expensive medical resources? Draws on philosophy, history, and anthropology to show how problems in bioethics can be approached from a variety of perspectives.

A. Chaudhuri, Q. White

24.07 The Ethics of Climate Change
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H

Deals with ethical questions raised by the way in which our climate is changing as a result of fossil fuel consumption. Explores the moral problems raised by these effects, the obligations of individuals and governments, the difficulties involved in dealing with uncertainty, catastrophe, and the ethics of future generations.

C. Hare, K. Setiya

24.08[J] Philosophical Issues in Brain Science
Same subject as 9.48[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H

An introduction to some central philosophical questions about the mind, specifically those intimately connected with contemporary psychology and neuroscience. Discussions focus on arguments over innate concepts; ‘mental images’ as pictures in the head; whether color is in the mind or in the world; and whether there can be a science of consciousness. Explains the relevant parts of psychology and neuroscience as the subject proceeds.

E. J. Green

24.09 Minds and Machines
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H

Introduction to philosophy of mind. Can computers think? Is the mind an immaterial thing? Alternatively, is the mind the brain? How can creatures like ourselves think thoughts that are about things? Can I know whether your experiences are the same as mine when we both look at raspberries, fire trucks, and stoplights? Can consciousness be given a scientific explanation?

J. Kiernan
24.111 Philosophy of Quantum Mechanics
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Quantum mechanics is said to describe a world in which physical objects often lack “definite” properties, indeterminism creeps in at the point of “observation,” ordinary logic does not apply, and distant events are perfectly yet inexplicably correlated. Examination of these and other issues central to the philosophical foundations of quantum mechanics, with special attention to the measurement problem, no-hidden-variables proofs, and Bell’s Inequalities. Rigorous approach to the subject matter nevertheless neither presupposes nor requires the development of detailed technical knowledge of the quantum theory.
B. Skow

24.118 Paradox and Infinity
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Presents highlights of the more technical side of philosophy. Studies a cluster of puzzles, paradoxes, and intellectual wonders - from the higher infinite to Gödel’s Theorem - and discusses their philosophical implications. Recommended prerequisites: 6.0001, 18.01.
A. Rayo

24.120 Moral Psychology
Prereq: None
U (Fall)
3-0-9 units. HASS-H

An examination of philosophical theories of action and motivation in the light of empirical findings from social psychology, sociology and neuroscience. Topics include belief, desire, and moral motivation; sympathy and empathy; intentions and other committing states; strength of will and weakness of will; free will; addiction and compulsion; guilt, shame and regret; evil; self-knowledge and self-deception; virtues and character traits.
E. J. Green

24.131 Ethics of Technology
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Introduces the tools of philosophical ethics through application to contemporary issues concerning technology. Takes up current debates on topics such as privacy and surveillance, algorithmic bias, the promise and peril of artificial intelligence, automation and the future of work, and threats to democracy in the digital age from the perspective of users, practitioners, and regulatory/governing bodies.
M. Phillips-Brown, Q. White

24.132 Workshop in Ethical Engineering
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (IAP)
2-0-1 units

Students study and apply a protocol for identifying and addressing ethical issues in a computer science, software development, or other engineering project. Builds a vocabulary to advocate for and justify ethical decisions in engineering contexts. For the final project, students either apply the protocol to a project they are working on, or develop their own protocol.
E. Awad, A. Jaques, M. Phillips-Brown

24.140[J] Literature and Philosophy
Same subject as 21L.452[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Highlights interactions between literary and philosophical texts, asking how philosophical themes can be explored in fiction, poetry, and drama. Exposes students to diverse modes of humanistic thought, interpretation, and argument, putting the tools and ideas of philosophy into conversation with those of the literary humanities. Students engage closely with selected literary and philosophical texts, explore selected topics in philosophy - such as ethics, epistemology, and aesthetics - through a literary lens, and participate in class discussion with peers and professors. Limited to 20.
M. Gubar, K. Setiya
**24.200 Ancient Philosophy**  
Prereq: One Philosophy subject or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H

Investigates the origins of Western philosophy in ancient Greece. Aims both to understand the philosophical questions the Greeks were asking on their own terms, and to assess their answers to them. Examines how a human being can lead a good life, the relationship between morality and happiness, our knowledge of the world around us, and the entities we need to appeal to in order to explain that world. Students taking graduate version complete additional assignments.  
*Staff*

**24.201 Topics in the History of Philosophy**  
Prereq: One philosophy subject or permission of instructor  
U (Fall)  
3-0-9 units. HASS-H  
Can be repeated for credit.

Close examination of a text, an author, or a theme in the history of philosophy. Can be repeated for credit with permission of the instructor and advisor.  
*T. Schapiro*

**24.211 Theory of Knowledge**  
Prereq: One philosophy subject  
U (Fall)  
3-0-9 units. HASS-H

Study of problems concerning our concept of knowledge, our knowledge of the past, our knowledge of the thoughts and feelings of ourselves and others, and our knowledge of the existence and properties of physical objects in our immediate environment.  
*M. Schoenfield*

**24.212 Philosophy of Perception**  
Prereq: None  
U (Fall)  
Not offered regularly; consult department  
3-0-9 units. HASS-H

In-depth examination of philosophical issues concerning perception, such as whether we see mind-independent physical objects or, alternatively, mind-dependent representations; whether perception is a source of theory-neutral observations or is affected by the perceiver’s beliefs in a way that compromises the objectivity of science. Readings primarily drawn from contemporary literature in both philosophy and psychology.  
*Staff*

**24.215 Topics in the Philosophy of Science**  
Prereq: One philosophy subject  
U (Fall)  
3-0-9 units. HASS-H  
Can be repeated for credit.

Close examination of a small number of issues central to recent philosophy of science, such as the demarcation problem, causal relations, laws of nature, underdetermination of theory by data, paradoxes of confirmation, scientific realism, the role of mathematics in science, elimination of bias, and the objectivity of scientific discourse.  
*B. Skow*

**24.221 Metaphysics**  
Prereq: One philosophy subject  
U (Spring)  
3-0-9 units. HASS-H

Study of basic metaphysical issues concerning existence, the mind-body problem, personal identity, and causation plus its implications for freedom. Classical as well as contemporary readings. Provides practice in written and oral communication.  
*J. Spencer*

**24.222 Decisions, Games and Rational Choice**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H

Foundations and philosophical applications of Bayesian decision theory, game theory and theory of collective choice. Why should degrees of belief be probabilities? Is it always rational to maximize expected utility? If so, why and what is its utility? What is a solution to a game? What does a game-theoretic solution concept such as Nash equilibrium say about how rational players will, or should, act in a game? How are the values and the actions of groups, institutions and societies related to the values and actions of the individuals that constitute them?  
*V. McGee*

**24.230 Meta-ethics**  
Prereq: One philosophy subject or permission of instructor  
U (Spring)  
3-0-9 units. HASS-H

Considers a range of philosophical questions about the foundations of morality, such as whether and in what sense morality is objective, the nature of moral discourse, and how we can come to know right from wrong.  
*J. Khoo*
24.231 Ethics
Prereq: One philosophy subject
U (Spring)
3-0-9 units. HASS-H

Systematic study of central theories in ethics, including egoism, act
and rule utilitarianism, intuitionism, emotivism, rights theories, and
contractualism. Discussion and readings also focus on problems
associated with moral conflicts, justice, the relationship between
rightness and goodness, objective vs. subjective moral judgments,
moral truth, and relativism.
T. Schapiro

24.235[J] Philosophy of Law
Same subject as 17.021[J]
Prereq: One Philosophy subject or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

Examines fundamental issues in philosophy of law, such as the
nature and limits of law and a legal system, and the relation of law to
morality, with particular emphasis on the philosophical issues and
problems associated with privacy, liberty, justice, punishment, and
responsibility. Historical and contemporary readings, including court
cases. Instruction and practice in oral and written communication
provided.
E. Wood

24.236 Topics in Social Theory and Practice
Subject meets with 24.636
Prereq: One philosophy subject or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

An in-depth consideration of a topic in social theory with reflection
on its implications for social change. Examples of topics include
race and racism; punishment and prison reform; global justice and
human rights; gender and global care chains; environmentalism
and industrial agriculture; bioethics, disability, and human
enhancement; capitalism and commodification; and sexuality and
the family. Readings draw from both social science and philosophy
with special attention to the normative literature relevant to the
issue. Students taking graduate version complete additional
assignments.
S. Haslanger

24.237[J] Feminist Thought
Same subject as 17.007[J], WGS.301[J]
Subject meets with 17.006[J], 24.637[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Analyzes theories of gender and politics, especially ideologies of
gender and their construction; definitions of public and private
spheres; gender issues in citizenship, the development of the
welfare state, experiences of war and revolution, class formation,
and the politics of sexuality. Graduate students are expected to
pursue the subject in greater depth through reading and individual
research.
E. Wood

24.241 Logic I
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Introduction to the aims and techniques of formal logic. The logic of
truth functions and quantifiers. The concepts of validity and truth
and their relation to formal deduction. Applications of logic and the
place of logic in philosophy.
V. McGee

24.242 Logic II
Prereq: 24.241 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

The central results of modern logic: the completeness of predicate
logic, recursive functions, the incompleteness of arithmetic, the
unprovability of consistency, the indefinability of truth, Skolem-
Löwenheim theorems, and nonstandard models.
V. McGee

24.243 Classical Set Theory
Prereq: 24.241 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Introduction to the basic concepts and results of standard, i.e.,
Zermelo-Fraenkel, set theory, the axioms of ZF, ordinal and cardinal
arithmetic, the structure of the set-theoretic universe, the axiom of
choice, the (generalized) continuum hypothesis, inaccessibles, and
beyond.
V. McGee
24.244 Modal Logic
Prereq: 24.241
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Sentential and quantified modal logic, with emphasis on the model theory ("possible worlds semantics"). Soundness, completeness, and characterization results for alternative systems. Tense and dynamic logics, epistemic logics, as well as logics of necessity and possibility. Applications in philosophy, theoretical computer science, and linguistics.
V. McGee

24.245 Theory of Models
Prereq: 24.241 or permission of instructor
U (Spring)
3-0-9 units. HASS-H

Studies fundamental results in the model theory of the first-order predicate calculus. Includes completeness, compactness, Löwenheim-Skolem, omitting types, ultraproducts, and categoricity in a cardinal, starting with Tarski's definition of logical consequence, in terms of truth in a model.
V. McGee

24.251 Introduction to Philosophy of Language
Prereq: One philosophy subject
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Examines views on the nature of meaning, reference, and truth, and their bearing on the use of language in communication. No knowledge of logic or linguistics presupposed. Instruction and practice in oral and written communication provided.
J. Khoo

24.252 Language and Power (New)
Prereq: One philosophy subject or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Explores topics at the intersection of philosophy of language and social/political philosophy. Topics may include linguistic harm, free speech, speech in non-cooperative contexts (lying, insincerity, antagonistic interlocutors), propaganda, pejoratives, and the relationship of language to features of the social world (race, gender, ideology).
J. Khoo

24.253 Philosophy of Mathematics
Prereq: One philosophy subject or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Philosophical issues about or related to mathematics, including the existence and nature of basic mathematical objects such as numbers and sets, how we can come to have knowledge of such objects, the status of mathematical truth, the relation of mathematics to logic, and whether classical logic can be called into question.
V. McGee

24.260 Topics in Philosophy
Prereq: Two subjects in philosophy
U (Fall)
3-0-9 units. HASS-H

Close examination of a single book, or group of related essays, with major significance in recent philosophy. Subject matter varies from year to year. Intended primarily for majors and minors in philosophy. Opportunities are provided for oral presentation. Students will be required to revise at least one paper in response to instructor's comments.
C. Hare

24.280 Foundations of Probability
Prereq: One philosophy subject or one subject on probability
U (Spring)
3-0-9 units. HASS-H

Topics include probability puzzles, common fallacies in probabilistic reasoning, defenses and criticisms of Kolmogorov’s axiomatization, interpretations of probability (including the frequency, logical, propensity, and various subjectivist interpretations), the relation of objective chance to rational subjective credence, conditional probability, rules for updating probability, and proposals for supplementing the probability calculus with further principles.
R. White

24.292 Independent Study: Philosophy
Prereq: Any two subjects in philosophy
U (Fall)
Units arranged

Open to qualified students who wish to pursue special studies or projects. Students electing this subject must consult the undergraduate officer.
Staff
24.293 Independent Study: Philosophy
Prereq: Any two subjects in philosophy
U (Spring)
Units arranged
Open to qualified students who wish to pursue special studies or projects. Students electing this subject must consult the undergraduate officer.

24.S00 Special Subject: Philosophy
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Undergraduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.

24.S20 Special Subject: Philosophy
Prereq: One philosophy subject or permission of instructor
U (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Undergraduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.

24.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Research opportunities in linguistics and philosophy. For further information, consult the departmental coordinators.

24.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Research opportunities in linguistics and philosophy. For further information consult the departmental coordinators.

Undergraduate Seminars

24.191 Being, Thinking, Doing (or Not): Ethics in Your Life
Prereq: None
U (Spring)
2-0-4 units
Provides an opportunity to explore a wide range of ethical issues through guided discussions that are geared to equip students for ongoing reflection and action. Lectures and discussions with guest faculty, as well as attendance at on-and off-campus events, expose students to ethical problems and resources for addressing them. Encourages students to work collaboratively as they clarify their personal and vocational principles. Topics vary each term and will reflect the interests of those enrolled.
P. Weinmann, Q. White

24.192 Language, Information, and Power
Prereq: One philosophy subject or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-0-4 units
Explores foundational issues about language and communication by investigating different ways language and its use affects various aspects of lived experience. Topics include speech act theory, lying, propaganda, censorship, expressions of knowledge, communication in non-cooperative contexts.
J. Khoo

Graduate Subjects

24.400 Proseminar in Philosophy I
Prereq: Permission of instructor
G (Fall)
6-0-18 units
Advanced study of the basic problems of philosophy. Intended for first-year graduate students in philosophy.
S. Haslanger, S. Yablo

24.401 Proseminar in Philosophy II
Prereq: Permission of instructor
G (Spring)
6-0-18 units
Advanced study of the basic problems of philosophy. Intended for first-year graduate students in philosophy.
A. Byrne, R. White
24.410 Topics in the History of Philosophy
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.

Intensive study of a philosopher or philosophical movement. Content varies from year to year and subject may be taken repeatedly with permission of instructor and advisor.

Staff

24.420 Ancient Philosophy
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Investigates the origins of Western philosophy in ancient Greece. Aims both to understand the philosophical questions the Greeks were asking on their own terms, and to assess their answers to them. Examines how a human being can lead a good life, the relationship between morality and happiness, our knowledge of the world around us, and the entities we need to appeal to in order to explain that world. Students taking graduate version complete additional assignments.

Staff

24.500 Topics in Philosophy of Mind
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 units
Can be repeated for credit.

Selected topics in philosophy of mind. Content varies from year to year. Topics may include consciousness, mental representation, perception, and mental causation.

Fall: E. J. Green. Spring: J. Kiernan

24.501 Problems in Metaphysics
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Can be repeated for credit.

Systematic examination of selected problems in metaphysics. Content varies from year to year and subject may be taken repeatedly with permission of instructor and advisor.

R. Stalnaker

24.502 Topics in Metaphysics and Ethics
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.

Systematic examination of selected problems concerning the relation between metaphysics and ethics, for example questions about personal identity and its relation to issues about fairness and distribution, or questions about the relation between causation and responsibility. Content may vary from year to year, and the subject may be taken repeatedly with the permission of the instructor and the student’s advisor.

Staff

24.503 Topics in Philosophy of Religion
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.

Selected topics in philosophy of religion. Content varies from year to year. Topics may include the traditional arguments for the existence of God, religious experience, the problem of evil, survival after death, God and ethics.

A. Byrne

24.504 Topics in Aesthetics (New)
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Can be repeated for credit.

Selected topics in aesthetics. Content varies from year to year. Topics may include the definition of art, the expression of emotion in music, the nature of depiction, the role of artists intentions in interpretation, and the relationship between moral and aesthetic value.

B. Skow

24.601 Topics in Moral Philosophy
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 units
Can be repeated for credit.

Systematic examination of selected problems in moral philosophy. Content varies from year to year. Subject may be repeated only with permission of instructor and advisor.

Fall: K. Setiya, J. Doyle. Spring: J. Khoo, M. Schoenfield
24.602 Topics in the Philosophy of Agency
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.
Systematic examination of selected problems in the theory of agency. Content varies from year to year and subject may be taken repeatedly with permission of instructor and advisor.
T. Schapiro

24.611[J] Political Philosophy
Same subject as 17.000[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Can be repeated for credit.
See description under subject 17.000[J].
B. Zacka

24.635 Topics in Critical Social Theory
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.
Explores topics arising within critical race theory, feminist theory, queer theory, disability studies, working class studies, and related interdisciplinary efforts - both historical and contemporary - to understand and promote social justice.
S. Haslanger

24.636 Topics in Social Theory and Practice
Subject meets with 24.236
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
An in-depth consideration of a topic in social theory with reflection on its implications for social change. Examples of topics include race and racism; punishment and prison reform; global justice and human rights; gender and global care chains; environmentalism and industrial agriculture; bioethics, disability, and human enhancement; capitalism and commodification; and sexuality and the family. Readings draw from both social science and philosophy with special attention to the normative literature relevant to the issue. Students taking graduate version complete additional assignments.
S. Haslanger

24.637[J] Feminist Thought
Same subject as 17.006[J]
Subject meets with 17.007[J], 24.237[J], WGS.301[J]
Prereq: Permission of instructor, based on previous coursework
G (Spring)
3-0-9 units
See description under subject 17.006[J].
E. Wood

24.711 Topics in Philosophical Logic
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Can be repeated for credit.
Problems of ontology, epistemology, and philosophy of language that bear directly on questions about the nature of logic and the conceptual analysis of logical theory, such as logical truth, logical consequence, and proof. Content varies from year to year and subject may be taken repeatedly upon permission of instructor and advisor.
V. McGee

24.729 Topics in Philosophy of Language
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.
Major issues in the philosophy of language. Topics change each year and subject may be taken repeatedly with permission of instructor.
J. Spencer

24.805 Topics in Theory of Knowledge
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.
Major issues in theory of knowledge. Topics change each year and subject may be taken repeatedly with permission of instructor.
M. Schoenfield, R. White
24.810 Topics in Philosophy of Science
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.

Topics in the foundations of science: the nature of concepts and theories, the distinction between empirical and theoretical knowledge claims, realist and instrumentalist interpretation of such claims, and the analysis of scientific explanation. The central topic varies from year to year. Subject may be taken repeatedly with the permission of instructor and advisor.

Staff

24.891 Independent Study: Philosophy
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Open to qualified graduate students in philosophy who wish to pursue special studies or projects. Consult with the intended supervisor and the Chair of the Committee on Graduate Students in Philosophy before registering.

B. Skow

24.892 Independent Study: Philosophy
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Open to qualified graduate students in philosophy who wish to pursue special studies or projects. Consult with the intended supervisor and the Chair of the Committee on Graduate Students in Philosophy before registering.

Consult B. Skow

24.893 Dissertation Workshop
Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 units
Workshop for students working on their dissertations. Restricted to philosophy doctoral students.

C. Hare

24.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research and writing of thesis, to be arranged by the student with supervising committee.

Staff

24.540 Special Seminar: Philosophy
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Graduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.

Staff

24.541 Special Seminar: Philosophy
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units

Graduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.

Staff

Linguistics

Undergraduate Subjects

24.900 Introduction to Linguistics
Prereq: None
U (Fall, Spring)
4-0-8 units. HASS-S; CI-H
Credit cannot also be received for 24.9000

Studies what is language and what does knowledge of a language consist of. It asks how do children learn languages and is language unique to humans; why are there many languages; how do languages change; is any language or dialect superior to another; and how are speech and writing related. Context for these and similar questions provided by basic examination of internal organization of sentences, words, and sound systems. Assumes no prior training in linguistics.

Fall: A. Albright. Spring: D. Pesetsky
24.9000 How Language Works
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-S
Credit cannot also be received for 24.900

Introduces the field of linguistics as the scientific study of the human capacity for language, and its interaction with other cognitive systems. Examines specific phenomena that reveal the general laws and principles that govern the structure of all human languages, as well as the ways in which languages do differ. Topics include language acquisition and use, language change, dialects, and language technologies, with a special focus on collection and analysis of linguistic data. Assumes no prior training in linguistics.

K. von Fintel

24.901 Language and Its Structure I: Phonology
Subject meets with 24.931
Prereq: 24.900 or 24.9000
U (Fall)
3-0-9 units. HASS-S

Introduction to fundamental concepts in phonological theory and their relation to issues in philosophy and cognitive psychology. Articulatory and acoustic phonetics, distinctive features and the structure of feature systems, underlying representations and underspecification, phonological rules and derivations, syllable structure, accentual systems, and the morphology-phonology interface. Examples and exercises from a variety of languages. Students taking graduate version complete different assignments.

D. Steriade

24.902 Language and Its Structure II: Syntax
Subject meets with 24.932
Prereq: 24.900 or 24.9000
U (Fall)
3-0-9 units. HASS-S

Introduction to fundamental concepts in syntactic theory and its relation to issues in philosophy and cognitive psychology. Examples and exercises from a variety of languages. Students taking graduate version complete different assignments.

P. Elliott

24.903 Language and Its Structure III: Semantics and Pragmatics
Subject meets with 24.933
Prereq: 24.900 or 24.9000
U (Spring)
3-0-9 units. HASS-S

Introduction to fundamental concepts in semantic and pragmatic theory. Basic issues of form and meaning in natural languages. Ambiguities of structure and of meaning. Compositionality, Word meaning. Quantification and logical form. Contexts: indexicality, discourse, presupposition and conversational implicature. Students taking graduate version complete different assignments.

R. Schwarzschild

24.904 Language Acquisition
Prereq: 24.900, 24.9000, or permission of instructor
U (Spring)
3-0-9 units. HASS-S

Covers the major results in the study of first-language acquisition concentrating on the development of linguistic structure, including morphology, syntax, and semantics. Universal aspects of development are discussed, as well as a variety of cross-linguistic phenomena. Theories of language learning are considered, including parameter-setting and maturation.

A. Aravind

24.905[J] Laboratory in Psycholinguistics
Same subject as 9.59[J]
Prereq: None
U (Spring)
3-3-6 units. Institute LAB

See description under subject 9.59[J].

E. Gibson

24.906[J] The Linguistic Study of Bilingualism
Same subject as 21G.024[J]
Prereq: 24.900 or 24.9000
U (Fall)
3-0-9 units. HASS-S; CI-H

Development of bilingualism in human history (from Australopithecus to present day). Focuses on linguistic aspects of bilingualism; models of bilingualism and language acquisition; competence versus performance; effects of bilingualism on other domains of human cognition; brain imaging studies; early versus late bilingualism; opportunities to observe and conduct original research; and implications for educational policies among others. Students participate in six online web meetings with partner institutions. Taught in English. Enrollment limited.

S. Flynn
**24.908 Creole Languages and Caribbean Identities**  
Prereq: None  
U (Spring)  
3-0-9 units. HASS-S; CI-H  
Caribbean Creole languages result from language contact via colonization and the slave trade. Explores creolization from cognitive, historical and comparative perspectives and evaluates popular theories about "Creole genesis" and the role of language acquisition. Also explores non-linguistic creolization in literature, religion and music in the Caribbean and addresses issues of Caribbean identities by examining Creole speakers' and others' beliefs toward Creole cultures. Draws comparisons with aspects of African-American culture.  
M. DeGraff

**24.909 Field Methods in Linguistics**  
Prereq: 24.901, 24.902, and permission of instructor  
U (Fall)  
3-1-8 units. Institute LAB  
Explores the structure of an unfamiliar language through direct work with a native speaker. Students complete a grammatical sketch of the phonology and syntax, work in groups on specific aspects of the language's structure, and assemble reports to create a partial grammar of the language. Provides instruction and practice in written and oral communication. Enrollment limited.  
Staff

**24.910 Advanced Topics in Linguistic Analysis**  
Prereq: (24.901, 24.902, and 24.903) or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-S  
Can be repeated for credit.  
In-depth study of an advanced topic in phonetics, phonology, morphology, syntax or semantics, with a focus on the interfaces among these grammar components. Provides practice in written and oral communication.  
S. Flynn

Same subject as 21H.106[J], 21L.008[J], 21W.741[J], WGS.190[J]  
Prereq: None  
U (Spring)  
3-0-9 units. HASS-A, HASS-H; CI-H  
Interdisciplinary survey of people of African descent that draws on the overlapping approaches of history, literature, anthropology, legal studies, media studies, performance, linguistics, and creative writing. Connects the experiences of African-Americans and of other American minorities, focusing on social, political, and cultural histories, and on linguistic patterns. Includes lectures, discussions, workshops, and required field trips that involve minimal cost to students.  
M. Degraff

**24.914 Language Variation and Change**  
Prereq: 24.900 or 24.9000  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-S  
Explores how linguistic systems vary across time and space. Uses case studies in particular languages to examine how language transmission and social factors shape the grammatical systems of individual speakers, and how grammar constrains variation and change. Students work in groups to analyze corpus or survey data. Provides instruction and practice in written and oral communication.  
E. Flemming

**24.915 Linguistic Phonetics**  
Subject meets with 24.963  
Prereq: 24.900 or 24.9000  
U (Fall)  
3-0-9 units. HASS-S  
The study of speech sounds: how we produce and perceive them and their acoustic properties. The influence of the production and perception systems on phonological patterns and sound change. Acoustic analysis and experimental techniques. Students taking the graduate version complete different assignments.  
E. Flemming

**24.916[J] Old English and Beowulf**  
Same subject as 21L.601[J]  
Prereq: None  
Acad Year 2019-2020: U (Fall)  
Acad Year 2020-2021: Not offered  
3-0-9 units. HASS-H  
See description under subject 21L.601[J]. Limited to 16.  
A. Bahr
24.917 ConLangs: How to Construct a Language
Prereq: None
U (Fall)
3-0-9 units. HASS-S

Explores languages that have been deliberately constructed (ConLangs), including Esperanto, Klingon, and Tolkien’s Elvish. Students construct their own languages while considering phenomena from a variety of languages of the world. Topics include writing systems, phonology (basic units of speech and how they combine), morphology (structure of words), syntax (how words are put together), and semantics (the expression of meaning, and what language leaves unexpressed). Through regular assignments, students describe their constructed language in light of the topics discussed. Final assignment is a grammatical description of the new language.

N. Richards

24.918 Workshop in Linguistic Research
Prereq: (24.901, 24.902, and 24.903) or permission of instructor
U (Spring)
3-0-9 units. HASS-S

Students pursue individual research projects in linguistic analysis under the guidance of an advisor. Class meets weekly for presentation of student research and to critically discuss background reading. Focuses on developing skills in linguistic argumentation and presentation of findings. Provides practice in written and oral communication. Includes a 20-page final paper that each student presents to the class.

S. Flynn

24.919 Independent Study: Linguistics
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Open to qualified students who wish to pursue special studies or projects.
Consult Department Headquarters

24.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Research opportunities in linguistics and philosophy. For further information, consult the departmental coordinators.

Staff

24.590 Special Subject: Linguistics
Prereq: 24.900 or permission of instructor
U (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Undergraduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.

Staff

Graduate Subjects

24.921 Independent Study: Linguistics
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Open to qualified graduate students in linguistics who wish to pursue special studies or projects.
Consult Department Headquarters

24.922 Independent Study: Linguistics
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Open to qualified graduate students in linguistics who wish to pursue special studies or projects.
Consult Department Headquarters
24.931 Language and Its Structure I: Phonology
Subject meets with 24.901
Prereq: 24.900, 24.9000, or permission of instructor
G (Fall)
3-0-9 units
Introduction to fundamental concepts in phonological theory and their relation to issues in philosophy and cognitive psychology. Articulatory and acoustic phonetics, distinctive features and the structure of feature systems, underlying representations and underspecification, phonological rules and derivations, syllable structure, accentual systems, and the morphology-phonology interface. Examples and exercises from a variety of languages. Students taking graduate version complete different assignments.
D. Steriade

24.932 Language and Its Structure II: Syntax
Subject meets with 24.902
Prereq: 24.900, 24.9000, or permission of instructor
G (Fall)
3-0-9 units
Introduction to fundamental concepts in syntactic theory and its relation to issues in philosophy and cognitive psychology. Examples and exercises from a variety of languages. Students taking graduate version complete different assignments.
P. Elliott

24.933 Language and Its Structure III: Semantics and Pragmatics
Subject meets with 24.903
Prereq: 24.900, 24.9000, or permission of instructor
G (Spring)
3-0-9 units
Introduction to fundamental concepts in semantic and pragmatic theory. Basic issues of form and meaning in natural languages. Ambiguities of structure and of meaning. Compositionality. Word meaning. Quantification and logical form. Contexts: indexicality, discourse, presupposition and conversational implicature. Students taking graduate version complete different assignments.
R. Schwarzschild

24.942 Topics in the Grammar of a Less Familiar Language
Prereq: 24.951
G (Spring)
3-0-9 units
Can be repeated for credit.
Students work with a native speaker of a language whose structure is significantly different from English, examining aspects of its syntax, semantics, and phonology. In the course of doing this, students will acquire techniques for gathering linguistic data from native speakers. Enrollment limited.
M. Kenstowicz, N. Richards

24.943 Syntax of a Language (Family)
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Detailed examination of the syntax of a particular language or language family, and theories proposed in the existing literature to account for the observed phenomena.
M. DeGraff

24.946 Linguistic Theory and Japanese Language
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-6 units
Detailed examination of the grammar of Japanese and its structure which is significantly different from English, with special emphasis on problems of interest in the study of linguistic universals. Data from a broad group of languages studied for comparison with Japanese. Assumes familiarity with linguistic theory.
S. Miyagawa

24.947 Language Disorders in Children
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Reading and discussion of current linguistic theory, first language acquisition and language disorders in young children. Focus on development of a principled understanding of language disorders at the phonological, morphological and syntactic levels. Examines ways in which these disorders confront theories of language and acquisition.
S. Flynn
24.948 Linguistic Theory and Second and Third Language Acquisition in Children and Adults
Prereq: Permission of instructor
G (Spring)
3-0-6 units
Students read and discuss current linguistic theory, first language acquisition research, and data concerning second and third language acquisition in adults and children. Focuses on development of a theory of second and third language acquisition within current theories of language. Emphasizes syntactic, lexical, and phonological development. Examines ways in which these bodies of data confront theories of language and the mind. When possible, students participate in practica with second and/or third language learners.
S. Flynn

24.949[J] Language Acquisition I
Same subject as 9.601[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units
See description under subject 9.601[J].
A. Aravind, M. Hackl

24.951 Introduction to Syntax
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Introduction to theories of syntax underlying work currently being done within the lexical-functional and government-binding frameworks. Organized into three interrelated parts, each focused upon a particular area of concern: phrase structure; the lexicon; and principles and parameters. Grammatical rules and processes constitute a focus of attention throughout the course that serve to reveal both modular structure of grammar and interaction of grammatical components.
N. Richards

24.952 Advanced Syntax
Prereq: 24.951
G (Spring)
3-0-9 units
Problems in constructing an explanatory theory of grammatical representation. Topics drawn from current work on anaphora, casemarking, control, argument structure, Wh- and related constructions. Study of language-particular parameters in the formulation of linguistic universals.
S. Iatridou, D. Pesetsky

24.954 Pragmatics in Linguistic Theory
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Formal theories of context-dependency, presupposition, implicature, context-change, focus and topic. Special emphasis on the division of labor between semantics and pragmatics. Applications to the analysis of quantification, definiteness, presupposition projection, conditionals and modality, anaphora, questions and answers.
R. Schwarzschild, P. Elliott

24.955 More Advanced Syntax
Prereq: 24.951 and 24.952
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
An advanced-level survey of topics in syntax.
S. Iatridou

24.956 Topics in Syntax
Prereq: 24.951
G (Fall)
3-0-9 units
Can be repeated for credit.
The nature of linguistic universals that make it possible for languages to differ and place limits on these differences. Study of selected problem areas show how data from particular languages contribute to the development of a strong theory of universal grammar and how such a theory dictates solutions to traditional problems in the syntax of particular languages.
A. Aravind, D. Pesetsky

24.960 Syntactic Models
Prereq: 24.951 and 24.952
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Comparison of different proposed architectures for the syntax module of grammar. Subject traces several themes across a wide variety of approaches, with emphasis on testable differences among models. Models discussed include ancient and medieval proposals, structuralism, early generative grammar, generative semantics, government-binding theory/minimalism, LFG, HPSG, TAG, functionalist perspectives and others.
D. Pesetsky
24.961 Introduction to Phonology
Prereq: Permission of instructor
G (Fall)
3-0-9 units
First half of a year-long introduction to the phonological component of grammar. Introduces the major research results, questions, and analytic techniques in the field of phonology. Focuses on segmental feature structure and prosodic structure while the sequel (24.962) considers the interfaces of phonology with morphology, syntax, and the lexicon. Students should have basic knowledge of articulatory phonetic description and phonetic transcription.
E. Flemming, M. Kenstowicz

24.962 Advanced Phonology
Prereq: 24.961
G (Spring)
3-0-9 units
Continuation of 24.961.
A. Albright, D. Steriade

24.963 Linguistic Phonetics
Subject meets with 24.915
Prereq: None
G (Fall)
3-0-9 units
The study of speech sounds: how we produce and perceive them and their acoustic properties. The influence of the production and perception systems on phonological patterns and sound change. Acoustic analysis and experimental techniques. Students taking the graduate version complete different assignments.
E. Flemming

24.964 Topics in Phonology
Prereq: 24.961
G (Fall, Spring)
3-0-9 units
Can be repeated for credit.
In-depth study of a topic in current phonological theory.
Fall: D. Steriade. Spring: E. Flemming, S. Iatridou

24.965 Morphology
Prereq: Permission of instructor
G (Spring)
3-0-9 units
A. Albright

24.966[J] Laboratory on the Physiology, Acoustics, and Perception of Speech
Same subject as 6.542[J], HST.712[J]
Prereq: Permission of instructor
G (Spring)
2-2-8 units
See description under subject 6.542[J].
L. D. Braida, S. Shattuck-Hufnagel, J.-Y. Choi

24.967 Topics in Experimental Phonology
Prereq: 24.961, 24.963, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Experimental techniques to test predictions drawn from current phonological theory. Includes a survey of experimental methodologies currently in use, an introduction to experimental design and analysis, and critical consideration of how experimental results are used to inform theory.
E. Flemming

24.970 Introduction to Semantics
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Basic issues of form and meaning in formalized and natural languages. Conceptual, logical, and linguistic questions about truth. Reference, modal, and intensional notions. The role of grammar in language use and context-dependency. Ambiguities of structure and meaning, and dimensions of semantic variation in syntax and the lexicon.
M. Hackl, R. Schwarzschild

466 | 2019–2020 MIT Subject Descriptions
24.973 Advanced Semantics
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Current work on semantics and questions of logic and meaning for syntactic systems in generative grammar.
K. von Fintel

24.979 Topics in Semantics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 units
Can be repeated for credit.
Seminar on current research in semantics and generative grammar. Topics may vary from year to year.
Fall: K. von Fintel, S. Iatridou, Spring: P. Elliott, M. Hackl

24.981 Topics in Computational Phonology
Prereq: 24.961 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Exploration of issues in the computational modeling of phonology: finding generalizations in data, formalisms for representing phonological knowledge, modeling grammar acquisition, and testing phonological theories by means of implemented models. Experience using and developing models, including preparing training data, running simulations, and interpreting their results. No background in programming or machine learning is assumed.
A. Albright

24.991 Workshop in Linguistics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 units
Can be repeated for credit.
An intensive group tutorial/seminar for discussion of research being conducted by participants. No listeners.
Fall: A. Albright, S. Iatridou Spring: K. von Fintel, M. Kenstowicz

24.993 Tutorial in Linguistics and Related Fields
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Individual or small-group tutorial in which students, under the guidance of a faculty member, explore the interrelations with linguistics of some specified area.
Consult Department Headquarters

24.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research and writing of thesis, to be arranged by the student with supervising committee.
Staff

24.593 Special Seminar: Linguistics
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Staff

24.594 Special Seminar: Linguistics
Prereq: Permission of instructor
G (Fall; first half of term)
3-0-3 units
Can be repeated for credit.
Half-term subject that covers topics in linguistics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Staff

24.595 Special Seminar: Linguistics
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Graduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Staff
24.596 Special Seminar: Linguistics
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Graduate subject that covers topics not offered in the regular
curriculum. Consult department to learn of offerings for a particular
term.
Staff
LITERATURE (COURSE 21L)

The subjects listed below are arranged in three graduated categories or tiers:
1) Introductory subjects (21L.000[J]-21L.024) all carry HASS Distribution and Communications Intensive (CI-H or CI-HW) credit.
2) Samplings (21L.310-21L.338, 21L.345-21L.355) are 6-unit subjects that provide both an alternative route into literary study and a less intensive means for students to sustain a commitment to reading and textual interpretation. Their focus is on critical exploration, comprehension, and group discussion, with less sustained attention to analytic writing skills. Students can combine two 6-unit Samplings subjects to count as a HASS subject in the Humanities category and the equivalent of a subject in the Intermediate tier. See the HASS Requirement website (https://registrar.mit.edu/registration-academics/academic-requirements/hass-requirement/substitutions-within-hass-requirement) or contact Literature Headquarters for details.
3) Intermediate subjects (21L.430-21L.639[J]) explore literary and visual forms in greater depth and center on historical periods, literary themes, or genres; others focus on media studies, comparative cultural studies, or national literatures.
4) Seminars (21L.640[J]-21L.715) are more advanced and are often communication intensive.

A supplement to this catalog, available online and from the Literature Section offices, offers more detailed descriptions of all literature subjects and includes specific information about required texts, writing assignments, and examinations.

Introductory Subjects

21L.000[J] Writing About Literature
Same subject as 21W.041[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW

Intensive focus on the reading and writing skills used to analyze literary texts such as poems by Emily Dickinson, Shakespeare or Langston Hughes; short stories by Chekhov, Joyce, or Alice Walker; and a short novel by Melville or Toni Morrison. Designed not only to prepare students for further work in writing and literary and media study, but also to provide increased confidence and pleasure in their reading, writing, and analytical skills. Students write or revise essays weekly. Enrollment limited.
W. Kelley, I. Lipkowitz

21L.001 Foundations of Western Literature: Homer to Dante
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H

Studies a broad range of texts essential to understanding the two great sources of Western conceptions of the world and humanity’s place within it: the ancient world of Greece and Rome and the Judeo-Christian world that challenged and absorbed it. Readings vary but usually include works by Homer, Sophocles, Aristotle, Plato, Virgil, St. Augustine, and Dante. Enrollment limited.
S. Frampton

21L.002 Foundations of Western Literature: From Shakespeare to the Present
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H

A broad survey of texts, literary, philosophical, and sociological, studied to trace the growth of secular humanism, the loss of a supernatural perspective upon human events, and changing conceptions of individual, social, and communal purpose. Stresses appreciation and analysis of texts that came to represent the common cultural possession of our time. Enrollment limited.
J. Buzard

21L.003 Reading Fiction
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-H

Introduces prose fiction, both stories and novels. Emphasizes historical context, narrative structure and close reading. Enrollment limited.
D. Thorburn

21L.004 Reading Poetry
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-H

A. Bahr, S. Tapscott, M. Fuller, N. Jackson
21L.005 Introduction to Drama
Prereq: None
U (Spring)
3-0-9 units. HASS-A; CI-H

A study of the history of theater art and practice from its origins to the modern period, including its roles in non-Western cultures. Special attention to the relationship between the literary and performative dimensions of drama, and the relationship between drama and its cultural context. Enrollment limited.
A. Fleche, D. Henderson

21L.008[JJ] Black Matters: Introduction to Black Studies
Same subject as 24.912[JJ], 21H.106[JJ], 21W.741[JJ], WGS.190[JJ]
Prereq: None
U (Spring)
3-0-9 units. HASS-A, HASS-H; CI-H

See description under subject 24.912[JJ].
M. Degraff

21L.009 Shakespeare
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H

Focuses on the close reading of six to eight of Shakespeare plays, as well as their adaptation for stage and/or film. Selected texts cover the range of genres in which Shakespeare wrote (i.e., history, comedy, tragedy, and romance). Special emphasis in some terms on performances and adaptations of Shakespearean drama around the world. Plays studied vary across sections and from term to term, and have recently included Henry IV Part 1, Hamlet, A Midsummer Night’s Dream, King Lear, Othello, and The Tempest. Enrollment limited.
S. Raman, P. Donaldson

21L.010[JJ] Writing with Shakespeare
Same subject as 21W.042[JJ]
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-HW

Focuses on writing and speaking using Shakespeare as a model and means for mastery of English language skills. Emphasizes development of students’ ability to write clearly and effectively in a range of genres with an awareness of audience. Designed to increase students’ confidence and pleasure in verbal communication and analysis of language. Students write frequently, give and receive feedback, improve their work through revision, and participate actively in class discussions and presentations. Enrollment limited.
D. Henderson

21L.011 The Film Experience
Prereq: None
U (Fall, Spring)
3-3-6 units. HASS-A; CI-H

Concentrates on close analysis and criticism of a wide range of films, including works from the early silent period, documentary and avant-garde films, European art cinema, and contemporary Hollywood fare. Through comparative reading of films from different eras and countries, students develop the skills to turn their in-depth analyses into interpretations and explore theoretical issues related to spectatorship. Syllabus varies from term to term, but usually includes such directors as Eisenstein, Fellini, Godard, Griffith, Hawks, Hitchcock, Kubrick, Kurosawa, Tarantino, Welles, and Wiseman.
E. Brinkema, D. Thorburn

21L.012 Forms of Western Narrative
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H

Examines a wide assortment of narrative forms, from Homer to the present, and considers why and how stories are told. Focuses on the close reading of literary and cultural issues, the emergence of different narrative genres, and how different media affect the construction and interpretation of narratives. Syllabus varies by term, but usually includes materials such as epics, novels, tales, short stories, films, television programs, graphic novels, and interactive games. Enrollment limited.
S. Frampton

21L.013[JJ] The Supernatural in Music, Literature and Culture
Same subject as 21M.013[JJ]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A, HASS-H; CI-H

See description under subject 21M.013[JJ]. Limited to 36.
C. Shadle, M. Fuller

21L.014[JJ] Introduction to Ancient and Medieval Studies
Same subject as 21H.007[JJ]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H

See description under subject 21H.007[JJ].
S. Frampton, E. Goldberg
**21L.015 Children’s Literature**  
Prereq: None  
U (Fall, Spring)  
3–0–9 units. HASS-H; CI-H

Analyzes children’s literature from a variety of eras and genres, taking even the most playful texts seriously as works of art and powerful cultural influences. Considers the types of stories adults consider appropriate for children, and why; how opinions about this subject have changed over time and across cultures; and the complex interplay of words and images in children’s books. Enrollment limited.  
*M. Gubar*

**21L.017 The Art of the Probable**  
Prereq: None  
U (Spring)  
Not offered regularly; consult department  
3–0–9 units. HASS-H; CI-H

Examines literary texts and/or films in relation to the history of the idea of probability. Traces the growing importance of probability as a basic property of things and the world, as well as a measure of the reliability of our ideas and beliefs. Connects the development and use of probabilistic reasoning (e.g., in the lottery and in statistics) with literary and cultural concerns regarding the rationality of belief, risk and uncertainty, free will and determinism, chance and fate. Discussion of the work of scientific and philosophical pioneers of probabilistic thought (e.g., Pascal, Leibniz, Bernoulli, Laplace) in conjunction with works by Shakespeare, Voltaire, H. G. Wells, Pynchon and Stoppard, among others. Enrollment limited.  
*S. Raman*

**21L.018 Introduction to English Literature**  
Prereq: None  
U (Fall)  
Not offered regularly; consult department  
3–0–9 units. HASS-H; CI-H

Examines the rich heritage of English literature across genre and historical period. Designed for students who want to know more about English literature or about English culture and history. Studies the relationships between literary themes, forms, and conventions and the times in which they were produced. Explores (for instance) Renaissance lyrics and drama, Enlightenment satires in word image, the 19th-century novel, and modern and contemporary stories, poems and film.  
*S. Tapscott*

**21L.019 Introduction to European and Latin American Fiction**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3–0–9 units. HASS-H; CI-H

Studies great works of European and Latin American fiction. Attention to a variety of forms including: the picaresque, epistolary, realist, naturalist, and magical realist fiction. Emphasizes ways in which the unique history of each country shaped the imaginative responses of its writers. Authors include Cervantes, Laclos, Goethe, Mann, Dostoevsky, Flaubert, Zola, Unamuno, Wolf, García Márquez, and Allende. Taught in English.  
*M. Resnick*

**21L.021 Comedy**  
Prereq: None  
U (Fall)  
3–0–9 units. HASS-H; CI-H

Surveys a range of comic texts in different media, the cultures that produced them, and various theories of comedy. Authors and directors studied may include Aristophanes, Shakespeare, Moliere, Austen, Wilde and Chaplin.  
*P. Donaldson*

**21L.022[J] Darwin and Design**  
Same subject as 21W.739[J]  
Prereq: None  
U (Fall)  
Not offered regularly; consult department  
3–0–9 units. HASS-H; CI-H

In *The Origin of Species*, Darwin provided a model for understanding the existence of objects and systems manifesting evidence of design without positing a designer, and of purpose and mechanism without intelligent agency. Texts deal with pre-Darwinian and later treatment of this topic within literature and speculative thought since the 18th century, with some attention to the modern study of feedback mechanism in artificial intelligence. Readings in Hume, Voltaire, Malthus, Darwin, Butler, Hardy, H. G. Wells, and Freud.  
*A. Kibel*

**21L.023[J] Folk Music of the British Isles and North America**  
Same subject as 21M.223[J]  
Prereq: None  
Acad Year 2019-2020: U (Fall)  
Acad Year 2020-2021: Not offered  
3–1–8 units. HASS-A; CI-H

See description under subject 21M.223[J]. Enrollment limited.  
*R. Perry, W. Donaldson*
21L.024 Literature and Existentialism
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H
Studies major literary works associated with the 19th- and 20th-century philosophical movement known as existentialism. Through close reading of these works, students explore how existentialist writers grappled with the question of death; the nature of free will; emotions like boredom, disgust, and radical doubt; and the fate of the individual in a modernity marked by war, illogic, and absurdity. Includes novels, short stories, and aphorisms by Sartre, Camus, Dostoevsky, Kafka, Hesse, Chopin, and Nietzsche; plays by Beckett and Stoppard; and films by Bergman, Tarkovsky, and others. Enrollment limited.
E. Brinkema

21L.310 Bestsellers
Prereq: None
U (Fall; first half of term)
2-0-4 units
Can be repeated for credit.
Focuses on works that caught the popular imagination in the past or present. Emphasizes texts that are related by genre, theme or style. Books studied vary from term to term. May be repeated once for credit if content differs. Enrollment limited.
W. Kelley

21L.315 Prizewinners
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
2-0-4 units
Can be repeated for credit.
Examines the work of major prize-winning writers or filmmakers. Texts and authors are chosen that have won such prestigious literary awards as the Nobel Prize, the Booker Prize, or the National Book Award, or films that have been feted at major international film festivals. Authors and works vary from term to term. May be repeated once for credit if the specific works studied differ. Enrollment limited.
Staff

21L.320 Big Books
Prereq: None
U (Fall, Spring)
2-0-4 units
Can be repeated for credit.
Intensive study of a single major literary work or a very small set of related literary works. Emphasizes texts that encourage close analysis in a way that cannot easily be integrated into the regular literature curriculum. The Big Books taught in previous terms include Moby-Dick, Canterbury Tales, and the Faerie Queene. May be repeated once for credit if the works studied differ. Enrollment limited.
N. Jackson

21L.325 Small Wonders
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall; first half of term)
2-0-4 units
Can be repeated for credit.
Close examination of a coherent set of short texts and/or visual works. The selections may be the shorter works of one or more authors (poems, short stories or novellas), or short films and other visual media. Content varies from term to term. May be repeated once for credit if the works studied differ.
W. Kelley

21L.338 Reading in the Original
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-0-4 units
Can be repeated for credit.
Close examination of literary texts in their original languages. Language and texts studied vary from term to term. May be repeated once for credit if content differs.
S. Frampton
**21L.340 Pleasures of Poetry**  
Prereq: Permission of instructor  
U (IAP)  
Not offered regularly; consult department  
3-0-3 units  
Can be repeated for credit.

Strengthens writing and reading comprehension skills. Students attend all public sessions of the *Pleasures of Poetry* readings and discussions as well as several additional classes. The poems chosen by the various moderators range across the history of literature, from ancient Chinese lyrics to contemporary texts. May be repeated for credit with permission of instructor.  
$\text{Staff}$

**21L.345 On the Screen**  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall; second half of term)  
2-0-4 units  
Can be repeated for credit.

Examines works of film, television or other screen-based media, with emphasis on texts that are related by genre, time period, style, or director. Works studied vary from term to term. May be repeated for credit once with permission of instructor.  
$S. \text{Tapscott}$

**21L.350 Science and Literature**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall; second half of term)  
2-0-4 units  
Can be repeated for credit.

Examines intersections and channels of influence between the sciences and forms of imaginative literature. Topics, historical periods, and syllabi will vary. May be repeated once for credit if content differs.  
$N. \text{Jackson}$

**21L.355 Literature in the Digital Age**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring; first half of term)  
2-0-4 units  
Can be repeated for credit.

Examines how emerging computational methods and tools are transforming practices of reading and writing in the present. Topics may include the exploration of experimental literary forms and digital media practices (hypertext, Twitter fiction, etc.) or focus on the use of digital tools for analyzing literature (GIS mapping, data mining, etc.). May be repeated once for credit if content differs.  
$W. \text{Kelley}$

**Intermediate Subjects**

**Genres and Themes**

**21L.400 Medical Narratives: Compelling Accounts from Antiquity to Grey's Anatomy**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-3-6 units. HASS-H

Explores fundamental questions about the experience of illness from the points of view of the patient, the physician, and the caretaker. Examines the ways in which these narratives have changed across centuries and across cultures. Asks about the physician's role in determining treatment; whether storytelling leads to more ethical life and death decisions; what special insights patient narratives provide; and what new awareness physicians derive from narrating illness. Materials include essays, fiction, poetry, memoir, blogs, film and television. As a capstone project, students develop their own medical narratives that emerge in interaction with a mentor from the greater-Boston medical community.  
$M. \text{Resnick}$
21L.430 Popular Culture and Narrative
Subject meets with CMS.920
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Can be repeated for credit.

Examines relationships between popular culture and art, focusing on problems of evaluation and audience, and the uses of different media within a broader social context. Typically treats a range of narrative and dramatic works as well as films. Previously taught topics include Elements of Style; Gender, Sexuality and Popular Narrative. Students taking graduate version complete additional assignments. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. May be repeated for credit with permission of instructor.
W. Donaldson

21L.431 Shakespeare on Film and Media
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Examines the adaptation, performance and interpretation of Shakespearean plays on film and video. Focus varies from term to term, to include films such as the Olivier and Almereyda versions of Hamlet and Baz Luhrmann’s Romeo + Juliet; "spin-offs" such as Kurosawa’s Throne of Blood and Shakespeare in Love; or theatrical videos of English language and international productions.
P. Donaldson

21L.432 Understanding Television
Subject meets with CMS.915
Prereq: One subject in Literature or Comparative Media Studies
U (Spring)
3-0-9 units. HASS-H
Can be repeated for credit.

A cultural approach to television’s evolution as a technology and system of representation. Considers television as a system of storytelling and mythmaking, and as a cultural practice studied from anthropological, literary, and cinematic perspectives. Focuses on prime-time commercial broadcasting, the medium’s technological and economic history, and theoretical perspectives. Considerable television viewing and readings in media theory and cultural interpretation are required. Previously taught topics include American Television: A Cultural History. Students taking graduate version complete additional assignments.
D. Thorburn

21L.433 Film Styles and Genres
Prereq: 21L.011 or permission of instructor
U (Fall)
3-0-9 units. HASS-H
Can be repeated for credit.

Close study of one or more directors, genres, periods, artistic movements, or national cinemas which have been of major significance in the history of film. Previously taught topics include Hollywood and Hong Kong, and Movie Realists: Chaplin, Renoir, Neorealism, Truffaut. May be repeated for credit by permission of instructor.
A. Fleche

21L.434 Science Fiction and Fantasy
Prereq: None
U (Fall)
3-0-9 units. HASS-H
Can be repeated for credit.

Traces the history of science fiction as a generic tradition in literature, media, and popular culture. Considers formal ideological and cultural approaches to the analysis and interpretation of science fiction and fantasy texts. May be repeated for credit with permission of instructor if content differs.
L. Finch

21L.435 Literature and Film
Subject meets with CMS.840
Prereq: One subject in Literature or Comparative Media Studies
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-3-6 units. HASS-H
Can be repeated for credit.

Investigates relationships between the two media, including film adaptations as well as works linked by genre, topic, and style. Explores how artworks challenge and cross cultural, political, and aesthetic boundaries. Students taking graduate version complete additional assignments. May be repeated for credit with permission of instructor if content differs.
A. Fleche
21L.449 The Wilds of Literature
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Can be repeated for credit.

Immerses students in literature that represents the interaction between humans and nature as sublime, revelatory, and mutually sustaining. Without denying the damage humans have wreaked on the environment, explores the role that pleasure, wonder, and hope might play in helping us to envision new modes of engagement. Examples of authors studied include William Wordsworth, Henry David Thoreau, Walt Whitman, Frances Hodgson Burnett, Annie Dillard, and Lauret Savoy. May be repeated for credit with permission of instructor if content differs.

M. Gubar

21L.451 Literary Theory
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Examines how we read texts and the questions that we, as readers, ask of them. Introduces different critical approaches to literature by examining the relationship between readers and text, between different texts, and between text and context. Topics vary but usually include reader-response theory, structuralism and semiotics, post-structuralism and post-modernism, historicism, psychoanalysis, intertextuality, cultural criticism, and media theory.

S. Raman

21L.452[J] Literature and Philosophy
Same subject as 24.140[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H


M. Gubar, K. Setiya

Periods of World Literature

21L.455 Ancient Authors
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H
Can be repeated for credit.

Close examination of major works of classical Greek and Roman literature in translation. Topics may include epic, history, lyric poetry, or drama and the works of authors such as Thucydides, Homer, Virgil, and Cicero. Texts vary from term to term. May be repeated once for credit if content differs. Enrollment limited.

S. Frampton

21L.458 The Bible
Prereq: None
U (Spring)
3-0-9 units. HASS-H

An introduction to major books from both the Hebrew Bible and the New Testament. Particular attention given to literary techniques, issues resulting from translation from the original Hebrew and Greek, and the different historical periods that produced and are reflected in the Bible.

I. Lipkowitz

21L.460 Arthurian Literature
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Tracing the evolution of King Arthur (and principal knights), students consider what underlies the appeal of this figure whose consistent reappearance in western culture has performed the medieval prophecy that he would be rex quondam et futurus: the once and future king. Examines how Arthur’s persona has been reinvented and rewritten throughout history, including portrayals as Christian hero and war-leader, ineffective king and pathetic cuckold, and as a tragic figure of noble but doomed intentions. Enrollment limited.

A. Bahr
**21L.471 Major Novels**  
Prereq: One subject in Literature  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H  
Can be repeated for credit.

Studies important examples of the literary form that, from the beginning of the 18th century to the present day, has become an indispensable instrument for representing modern life, in the hands of such writers as Cervantes, Defoe, Richardson, Sterne, Burney, Austen, Scott, Dickens, the Brontes, Eliot, Balzac, Stendhal, Flaubert, Hardy, Conrad, Woolf, Dostoevsky, Tolstoy, Proust, and others. May be repeated for credit with permission of instructor.  
I. Lipkowitz

**21L.473[J] Jane Austen**  
Same subject as WGS.240[J]  
Prereq: One subject in Literature  
Acad Year 2019-2020: U (Fall)  
Acad Year 2020-2021: Not offered  
3-0-9 units. HASS-H  
An examination of Jane Austen’s satire in her seven complete novels, several fragments, and juvenilia. Students read these texts in relation to her letters and other biographical and historical information.  
R. Perry

**21L.475 Enlightenment and Modernity**  
Prereq: One subject in Literature  
U (Spring)  
3-0-9 units. HASS-H  
Can be repeated for credit.

Examines selected topics in 18th- and 19th-century English/European literature and culture from the restoration of the English monarchy in 1660 to the end of Queen Victoria's reign in 1901. Topics vary by term; authors may include Jonathan Swift, Laurence Sterne, William Blake, William Wordsworth, Jane Austen, Charles Dickens, George Eliot, Lewis Carroll, Oscar Wilde, and Arthur Conan Doyle, among others. May be repeated for credit with permission of instructor.  
J. Buzard

**21L.480[J] Identities and Intersections: Queer Literatures**  
Same subject as WGS.245[J]  
Prereq: None  
U (Spring)  
3-0-9 units. HASS-H  
See description under subject WGS.245[J].  
J. Terrones

**21L.485 Modern Fiction**  
Prereq: One subject in Literature  
Acad Year 2019-2020: U (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units. HASS-H  
Can be repeated for credit.

Tradition and innovation in representative fiction of the early modern period. Recurring themes include the role of the artist in the modern period; the representation of psychological and sexual experience; and the virtues (and defects) of the aggressively experimental character. Works by Conrad, Kipling, Babel, Kafka, James, Lawrence, Mann, Ford Madox Ford, Joyce, Woolf, Faulkner, and Nabokov. May be repeated for credit with permission of instructor if content differs.  
D. Thorburn

**21L.486 Modern Drama**  
Prereq: One subject in Literature  
U (Spring)  
Not offered regularly; consult department  
3-0-9 units. HASS-A  
Can be repeated for credit.

Explores major modern plays with special attention to performance, sociopolitical and aesthetic contexts, and the role of theater in the contemporary multimedial landscape. Includes analysis of class, gender, and race as modes of performance. Typically features Beckett and Brecht, as well as some of the following playwrights: Chekov, Churchill, Deavere Smith, Ibsen, Fornes, Friel, Kushner, O'Neill, Shaw, Stoppard, Soyinka, Williams, Wilson. May be repeated for credit with permission of instructor if content differs.  
D. Henderson

**21L.487 Modern Poetry**  
Prereq: One subject in Literature  
Acad Year 2019-2020: U (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units. HASS-H  
Can be repeated for credit.

Study of major modern texts and manifestos from the late 19th century through the 20th century. Examines works written in English, with attention to Modernist texts from other cultures and other languages as well. Poems by T.S. Eliot, W.C. Williams, Langston Hughes, Robert Frost, Pablo Neruda, Hilda Doolittle, Charles Baudelaire, and others. May be repeated for credit with permission of instructor if content differs.  
S. Tapscott
21L.488 Contemporary Literature
Prereq: One subject in Literature
U (Spring)
3-0-9 units. HASS-H
Can be repeated for credit.

Study of key themes and techniques in prose, poetry, and drama since the 1970s. Recent topics include postmodernism, globalization, new British and Irish writing, and literature and development. May be repeated for credit with permission of instructor if content differs.

N. Montfort

21L.489 Interactive Narrative
Same subject as 21W.765, CMS.618
Subject meets with CMS.845
Prereq: None
U (Fall)
3-0-9 units. HASS-A

See description under subject 21W.765.

N. Montfort

21L.490 Introduction to the Classics of Russian Literature
Same subject as 21G.077
Subject meets with 21G.618
Prereq: None
U (Spring)
3-0-9 units. HASS-H

See description under subject 21G.077.

M. Khotimsky

21L.006 American Literature
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H

Studies the national literature of the United States since the early 19th century. Considers a range of texts - including, novels, essays, films, and electronic media - and their efforts to define the notion of American identity. Readings usually include works by such authors as Nathaniel Hawthorne, Henry David Thoreau, Frederick Douglass, Emily Dickinson, Flannery O'Connor, William Faulkner, Sherman Alexie, and Toni Morrison. Enrollment limited.

W. Kelley

21L.501 The American Novel
Prereq: Permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Can be repeated for credit.

Works by major American novelists, beginning with the late 18th century and concluding with a contemporary novelist. Major emphasis on reading novels as literary texts, but attention paid to historical, intellectual, and political contexts as well. Syllabus varies from term to term, but many of the following writers are represented: Rowson, Hawthorne, Melville, Twain, Wharton, James, and Toni Morrison. Previously taught topics include The American Revolution and Makeovers (i.e. adaptations and reinterpretation of novels traditionally considered as American “Classics”). May be repeated for credit with instructor's permission so long as the content differs.

J. Terrones

21L.504 Race and Identity in American Literature
Same subject as WGS.140
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
Can be repeated for credit.

Questions posed by the literature of the Americas about the relationship of race and gender to authorship, audience, culture, ethnicity, and aesthetics. Social conditions and literary histories that shape the politics of identity in American literature. Specific focus varies each term. Previously taught topics include Immigrant Stories, African American Literature, and Asian American Literature. May be repeated for credit with permission of instructor if the content differs.

J. Terrones
21L.512 American Authors
Prereq: One subject in Literature and permission of instructor
U (Fall)
3-0-9 units. HASS-H
Can be repeated for credit.
Examines in detail the works of several American authors selected according to a theme, period, genre, or set of issues. Through close readings of poetry, novels, or plays, subject addresses such issues as literary influence, cultural diversity, and the writer's career. Previously taught topics include American Women Writers, American Autobiography, American Political Writing, and American Short Fiction. Approved for credit in Women's and Gender Studies when content meets the requirements for subjects in that program. May be repeated for credit with instructor's permission so long as the content differs.
J. Terrones

International Literatures

21L.007 World Literatures
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
Introduces students to a coherent set of textual and visual materials drawn from different geographical regions, languages, artistic genres, and historical periods. The focus may vary but usually cuts across national boundaries. Includes non-English works read in translation and examines different kinds of writing, both fiction and nonfiction. Pays special attention to such issues as identity formation, cultural contact, exploration, and exile. Previously taught topics include contemporary writing from Africa and South Asia, the impact of the discovery of the New World, and Caribbean literature. Enrollment limited.
Staff

21L.020[J] Globalization: The Good, the Bad and the In-Between
Same subject as WGS.145[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
Examines the cultural paradoxes of contemporary globalization. Studies the cultural, artistic, social and political impact of globalization across international borders. Students analyze contending definitions of globalization and principal agents of change, and why some of them engender backlash; identify the agents, costs and benefits of global networks; and explore how world citizens preserve cultural specificity. Case studies on global health, human trafficking and labor migration illuminate the shaping influence of contemporary globalization on gender, race, ethnicity, and class. Develops cultural literacy through analysis of fiction and film. Enrollment limited.
M. Resnick

21L.522[J] International Women's Voices
Same subject as 21G.022[J], WGS.141[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Introduces students to a variety of fictional works by contemporary women writers. International perspective emphasizes the extent to which each author's work reflects her distinct cultural heritage and to what extent, if any, there is an identifiable female voice that transcends national boundaries. Uses a variety of interpretive perspectives, including sociohistorical, psychoanalytic, and feminist criticism, to examine texts. Authors include Mariama Ba, Isabel Allende, Anita Desai, Maxine Hong Kingston, Toni Morrison, Doris Lessing, Alifa Riyaat, Yang Jiang, Nawal Al-Saadawi, and Sawako Ariyoshi. Taught in English.
M. Resnick
21L.580 Translations
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A

Students study theories of translation, compare examples of multiple renderings of the same work, and work on translation projects. Supplementary assignments focus on adaptation of works from one genre to another, and on transmission of information from one mode to another (visual to verbal changes, American Sign Language, etc.). Students write essays about relative theories of translation and about comparisons of variant versions, and also work on translation projects of their own in workshop-format. Includes texts such as the King James Bible, and writers such as Walter Benjamin, George Steiner, Wislawa Szymborska, Czeslaw Milosz, Pablo Neruda, Gabriela Mistral, Rainer Maria Rilke, William Gass, and Robert Pinsky. Limited to 18.
S. Tapscott

21L.590 The Spanish Incubator
Prereq: None
U (IAP)
3-3-3 units. HASS-E

Students travel to Spain to explore the country’s influence on our understanding of contemporary culture, from its role as the crucible of the international avant-garde, to its genesis of political art and writing, to its Civil War that ignited the artistic passion of authors around the world, to the exuberant liberation after 40 years of dictatorship. Readings include Hemingway, Lorca, Orwell, Neruda, memoirs of Americans of the Abraham Lincoln Brigade, Spanish poetry of the war and repression that followed, and the films of Saura and Almodovar. Films, readings, field trips to museums, and cultural events enable students to understand the full context in which today’s vibrant Spanish democracy emerged. Contact Literature about travel fee and possible funding opportunities. Enrollment limited. Application required; contact Literature Headquarters for details.
M. Resnick

21L.591 Literary London
Prereq: None
U (IAP)
3-3-3 units. HASS-E

Based in London, explores the specific locations, history and artistic institutions that have made London a world cultural hub, deepening students’ knowledge gained on site through guided readings, theater performances, visits to homes associated with major authors, guest experts, and independent “author mapping” projects with reports back to the class. Sharpens students’ understanding of the complexities of international exchange and identity formation in a global age. Contact Literature about travel fee and possible funding opportunities. Enrollment limited. Application required; contact Literature Headquarters for details.
D. Henderson

21L.601[J] Old English and Beowulf
Same subject as 24.916[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Intensive introduction to Old English (also called Anglo-Saxon), the ancestor of modern English that was spoken in England ca. 600-1100. In the first half of the term, students use short prose texts to study the basics of Old English grammar. They go on to read short poems, and conclude by tackling portions of the epic Beowulf in the last third of the term. Assessment based upon translation work, daily vocabulary quizzes, and three exams. Limited to 16.
A. Bahr

21L.607 Greek I
Prereq: None
U (Fall; first half of term)
3-0-3 units

Introduces rudiments of ancient Greek - the language of Plato, Sophocles, Thucydides, and Euclid, and the basis for that of the New Testament - to students with little or no prior knowledge of the subject. Aimed at laying a foundation to begin reading ancient and/or medieval texts. Greek I and Greek II may be combined (after completion of both) to count as a single HASS-H. Limited to 20.
S. Frampton
**21L.608 Greek II**
Prereq: 21L.607 or permission of instructor
U (Fall; second half of term)
3-0-3 units
Introductory Greek subject for students with some prior knowledge of basic grammar and vocabulary. Intended to refresh and enrich ability to read ancient and/or medieval literary and historical texts. May be taken independently of Greek I with permission of instructor. Greek I and Greek II may be combined (after completion of both) to count as a single HASS-H. Limited to 20.
S. Frampton

**21L.609 Greek Readings**
Prereq: 21L.608 or permission of instructor
U (Spring; first half of term)
2-0-4 units
Can be repeated for credit.
Introduction to reading ancient Greek literature in the original language. Provides a bridge between the study of Greek grammar and the reading of Greek authors. Improves knowledge of the language through careful examination of literary texts, both prose and poetry. Builds proficiency in reading Greek and develops appreciation for basic features of style and genre. Texts vary from term to term. May be repeated once for credit if content differs. 21L.609 and 21L.610, or two terms of 21L.609, may be combined by petition (after completion of both) to count as a single HASS-H.
S. Frampton

**21L.610 Advanced Greek Readings**
Prereq: 21L.609 or (placement exam and permission of instructor)
U (Spring; first half of term)
2-0-4 units
Can be repeated for credit.
Building on 21L.609, develops the ability to read and analyze ancient Greek literary texts, both prose and poetry. Focuses on increasing fluency in reading comprehension and recognition of stylistic, generic, and grammatical features. Texts vary from term to term. May be repeated once for credit if content differs. 21L.610 and 21L.609, or two terms of 21L.610, may be combined by petition (after completion of both) to count as a single HASS-H.
S. Frampton

**21L.611 Latin I**
Prereq: None
U (Spring; first half of term)
3-0-3 units
Introduces rudiments of Latin to students with little or no prior knowledge of the subject. Aimed at laying a foundation to begin reading ancient and/or medieval literary and historical texts. Latin I and Latin II may be combined by petition (after completion of both) to count as a single HASS-H. Limited to 20.
Staff

**21L.612 Latin II**
Prereq: 21L.611 or permission of instructor
U (Spring; second half of term)
3-0-3 units
Introductory Latin subject for students with some prior knowledge of basic grammar and vocabulary. Intended to refresh and enrich ability to read ancient and/or medieval literary and historical texts. May be taken independently of Latin I with permission of instructor. Latin I and Latin II may be combined by petition (after completion of both) to count as a single HASS-H. Limited to 20.
Staff

**21L.613 Latin Readings**
Prereq: 21L.611 or permission of instructor
U (Fall; first half of term)
2-0-4 units
Can be repeated for credit.
Introduction to reading Latin literature in the original language. Provides a bridge between the study of Latin grammar and the reading of Latin authors. Improves knowledge of the language through careful examination of literary texts, focusing on prose and poetry in alternate years. Builds proficiency in reading Latin and develops appreciation for basic features of style and genre. Texts vary from term to term. May be repeated once for credit if content differs. 21L.613 and 21L.614, or two terms of 21L.613, may be combined by petition (after completion of both) to count as a single HASS-H.
S. Frampton
21L.614 Advanced Latin Readings
Prereq: 21L.613 or (placement exam and permission of instructor)
U (Fall; first half of term)
2-0-4 units
Can be repeated for credit.

Building on 21L.613, develops the ability to read and analyze Latin literary texts, focusing on prose and poetry in alternate years. Increases fluency in reading comprehension and recognition of stylistic, generic, and grammatical features. Texts vary from term to term. May be repeated once for credit if content differs. 21L.613 and 21L.614, or two terms of 21L.614, may be combined by petition (after completion of both) to count as a single HASS-H.
S. Frampton

21L.636[J] Introduction to Contemporary Hispanic Literature and Film
Same subject as 21G.716[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Studies important 20th- and 21st-century texts and films from both Spain and Latin America. Readings include short stories, theater, the novel, and poetry, as well as some non-fiction. Students acquire skills necessary for a serious examination of literacy and cultural issues in the Spanish-speaking world. Conducted entirely in Spanish. Emphasis on active participation of students in class discussion.
M. Resnick

21L.637[J] Introduction to Hispanic Culture
Same subject as 21G.717[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Studies the major social, political, and aesthetic modes which have shaped Spanish civilization. Coordinates the study of literature, film, art, and architecture with the historical evolution of Spain. Readings and discussions focus on such topics as: the coexistence of Christians, Moors, and Jews; Imperial Spain; the First and Second Republics; and the contemporary period as background for the emergence of distinctively Spanish literary and artistic movements. Taught in Spanish. Limited to 18.
M. Resnick

21L.638[J] Literature and Social Conflict: Perspectives on the Hispanic World
Same subject as 21G.738[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Considers how major literary texts illuminate principal issues in the evolution of modern Spanish society. Emphasizes the treatment of such major questions as the exile of liberals in 1820, the concept of progress, the place of religion, urbanization, rural conservatism and changing gender roles, and the Spanish Civil War. Authors include Perez Galdos, Pardo Bazan, Unamuno, Ortega y Gasset, Salinas, Lorca, La Pasionaria, and Falcon. Taught in Spanish.
J. Terrones

Same subject as 21G.739[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Studies new paradigms of cultural exchange that have shaped Latin America in the 20th and 21st centuries. Examines how globalization is rapidly changing the identity of peoples and cultures in Spanish-speaking nations. Spotlights debates about human rights. Materials studied include film, fiction, essay, architectural archives, music and art. Students complete a research project about a specific aspect of Hispanic culture that has been shaped by contemporary forces in the global economy. Taught in Spanish with required readings and writing in Spanish.
M. Resnick
**Seminars**

**21L.640[] The New Spain: 1977-Present**
Same subject as 21G.740[]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H

Deals with the vast changes in Spanish social, political and cultural life that have taken place since the death of Franco. Topics include new freedom from censorship, the re-emergence of strong movements for regional autonomy (the Basque region and Catalonia), the new cinema including Almodovar and Saura, educational reforms instituted by the socialist government, and the fiction of Carme Riera and Terenci Moix. Special emphasis on the emergence of mass media as a vehicle for expression in Spain. Considers the changes wrought by Spain’s acceptance into the European Community. Materials include magazines, newspapers, films, fiction, and Amando de Miguel’s *Los Españoles*. Taught in Spanish.

*M. Resnick*

**21L.701 Literary Methods**
Prereq: Two subjects in Literature
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Can be repeated for credit.

Introduces practice and theory of literary criticism. Seminar focuses on topics such as the history of critical methods and techniques, and the continuity of certain subjects in literary history. Instruction and practice in oral and written communication. Previously taught topics include Virginia Woolf’s Shakespeare, Theory and Use of Figurative Language, and *Text, Context, Subtext, Pretext*. Approved for credit in the Women’s and Gender Studies when content meets requirements for subjects in that program. May be repeated for credit with permission of instructor if content differs. Limited to 12.

*W. Kelley*

**21L.702 Studies in Fiction**
Prereq: Two subjects in Literature
U (Spring)
3-0-9 units. HASS-H

Can be repeated for credit.

Intensive study of a range of texts by a single author or by a limited group of authors whose achievements are mutually illuminating. Some attention to narrative theory and biographical and cultural backgrounds. Instruction and practice in oral and written communication. Previously taught topics include Stowe, Twain, and the Transformation of 19th-century America, and Joyce and the Legacy of Modernism. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. May be repeated for credit with permission of instructor if content differs. Limited to 12.

*J. Buzard*

**21L.703 Studies in Drama**
Prereq: Two subjects in Literature
U (Spring)
3-0-9 units. HASS-H

Can be repeated for credit.

Intensive study of an important topic or period in drama. Close analysis of major plays, enriched by critical readings and attention to historical and theatrical contexts. Instruction and practice in oral and written communication through student presentations and research essays. Previously taught topics include: Renaissance Drama; Shakespeare with his Contemporaries; Oscar Wilde; and Stoppard and Company. May be repeated for credit with permission of instructor if content differs. Limited to 12.

*S. Raman*

**21L.704 Studies in Poetry**
Prereq: Two subjects in Literature
U (Fall)
3-0-9 units. HASS-H

Can be repeated for credit.

Intensive study of a body of poetry, raising questions of form, authorship, poetic influence, social context, and literary tradition. Instruction and practice in oral and written communication. Previously taught topics include: Does poetry Matter?, Poetry and the Science of Mind; Songs, Sonnets and the Story of English; Virgil, Spenser, Milton; and The Image: Poetry, Photography, and Technologies of Vision. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. May be repeated for credit with permission of instructor if content differs. Limited to 12.

*N. Jackson*
21L.705 Major Authors
Prereq: Two subjects in Literature
U (Fall)
3-0-9 units. HASS-H
Can be repeated for credit.

Close study of a limited group of writers. Instruction and practice in oral and written communication. Previously taught topics include John Milton and his Age, Chaucer, Herman Melville, Toni Morrison, and Oscar Wilde and the ‘90s. Approved for credit in Women's and Gender Studies when content meets the requirements for subjects in that program. May be repeated for credit with permission of instructor if content differs. Limited to 12.

M. Fuller

21L.706 Studies in Film
Subject meets with CMS.830
Prereq: (21L.011 and one subject in Literature or Comparative Media Studies) or permission of instructor
U (Fall, Spring)
3-3-6 units. HASS-H
Can be repeated for credit.

Intensive study of films from particular periods, genres, or directors. Instruction and practice in oral and written communication provided. Previous topics include Global Horror Film, Film Remixes, Film Narrative, and Heroic Cinema. Students taking graduate version complete different assignments. May be repeated for credit with permission of instructor if content differs. Limited to 12.

P. Donaldson, E. Brinkema

21L.707 Problems in Cultural Interpretation
Prereq: Two subjects in Literature or permission of instructor
U (Fall, Spring)
3-0-9 units. HASS-H
Can be repeated for credit.

Studies the relation between imaginative texts and the culture surrounding them. Emphasizes ways in which imaginative works absorb, reflect, and conflict with reigning attitudes and world views. Instruction and practice in oral and written communication. Previously taught topics include Women Reading/Women Writing; Poetry, Passion, and the Self; and Race, Religion and Identity in Early Modern America. Approved for credit in Women's and Gender Studies when content meets the requirements for subjects in that program. May be repeated for credit with permission of instructor if content differs. Limited to 12.

L. Lipkowitz

21L.709 Studies in Literary History
Prereq: Two subjects in Literature or History
U (Spring)
3-0-9 units. HASS-H
Can be repeated for credit.

Close examination of the literature of a particular historical period. Instruction and practice in oral and written communication. Syllabi vary. Previous topics include Britons Abroad in the 18th Century; Modernism: From Nietzsche to Fellini; and Make it New: Manifestos and the Invention of the Modern. May be repeated for credit with permission of instructor if content differs. Limited to 12.

W. Kelley

21L.715 Media in Cultural Context
Subject meets with CMS.871
Prereq: Two subjects in Literature or Comparative Media Studies or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
Can be repeated for credit.

Seminar uses case studies to examine specific media or media configurations and the larger social, cultural, economic, political, or technological contexts within which they operate. Organized around recurring themes in media history, as well as specific genres, movements, media, or historical moments. Previously taught topics include Gendered Genres: Horror and Maternal Melodramas; Comics, Cartoons, and Graphic Storytelling; and Exploring Children's Culture. Students taking graduate version complete additional assignments. Approved for credit in Women's and Gender Studies when content meets the requirements for subjects in that program. May be repeated for credit with permission of instructor if content differs. Limited to 12.

M. Marks

Special Subjects, Research, and Thesis

21L.900 Independent Study
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Open to qualified students who wish to pursue an independent study with members of the Literature faculty. Normal maximum is 6 units, though exceptional 9-unit projects are occasionally approved. May be repeated for credit with permission of instructor.

Staff
21L.901 Independent Study
Prereq: Permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
Units arranged [P/D/F]
Can be repeated for credit.

Open to qualified students who wish to pursue an independent study with members of the Literature faculty. Normal maximum is 6 units, though exceptional 9-unit projects are occasionally approved. May be repeated for credit with permission of instructor.
Staff

21L.S88 Special Subject in Literature
Prereq: Permission of instructor
U (IAP)
Units arranged
Can be repeated for credit.

Covers topics in Literature that are not provided in the regular subject offerings. Units vary depending on the number of class meetings, readings and assignments. May be repeated for credit if the subjects are different.
S. Frampton

21L.S89 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics in Literature that are not provided in the regular subject offerings. Units vary depending on the number of class meetings, readings and assignments. May be repeated for credit if the subjects are different.
Staff

21L.S90 Special Subject in Literature
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Covers topics in Literature that are not provided in the regular subject offerings. Units vary depending on the number of class meetings, readings and assignments. May be repeated for credit if the subjects are different.
Staff

21L.S91 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics in Literature that are not provided in the regular subject offerings. Units vary depending on the number of class meetings, readings and assignments. May be repeated for credit if the subjects are different.
Staff

21L.S92 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics in Literature that are not provided in the regular subject offerings. Units vary depending on the number of class meetings, readings and assignments. May be repeated for credit if the subjects are different.
Staff

21L.S93 Special Subject in Literature
Prereq: Permission of instructor
U (IAP)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Covers topics in Literature that are not provided in the regular subject offerings. Units vary depending on the number of class meetings, readings and assignments. May be repeated for credit if the subjects are different.
Staff

21L.S94 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Covers topics in Literature that are not provided in the regular subject offerings. Units vary depending on the number of class meetings, readings and assignments. May be repeated for credit if the subjects are different.
Staff
21L.S95 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Covers topics in Literature that are not provided in the regular subject offerings. Units vary depending on the number of class meetings, readings and assignments. May be repeated for credit if the subjects are different.
Staff

21L.S96 Special Subject in Film and Media
Prereq: Two subjects in Film and Media and permission of the director of Comparative Media Studies
U (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Open to qualified students who wish to pursue special projects with film and media studies faculty. Individual or small group projects encouraged. Usually limited to 6 credits. May be repeated for credit with additional permission of the instructor.
Staff

21L.S97 Special Subject in Film and Media
Prereq: Two subjects in Film and Media and permission of director of Comparative Media Studies
U (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Open to qualified students who wish to pursue special projects with film and media studies faculty. Individual or small group projects encouraged. Usually limited to 6 credits. May be repeated for credit with additional permission of the instructor.
Staff

21L.THT Literature Pre-Thesis Tutorial
Prereq: None
U (Fall)
1-0-5 units
Can be repeated for credit.

Definition of and early-stage work on thesis project leading to 21L.THU. Taken during the first term of the student’s two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Required for students in Course 21L when the thesis is a degree requirement.
Staff

21L.THU Literature Thesis
Prereq: 21L.THT
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Completion of work on the senior major thesis under supervision of a faculty tutor. Includes oral presentation of thesis progress early in the term, assembling and revising the final text, and meeting at the close with a committee of faculty evaluators to discuss the successes and limitations of the project. Required for students in Course 21L when the thesis is a degree requirement.
S. Raman

21L.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program. Consult with Section UROP Coordinator

21L.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Individual participation in an ongoing research project. For students in the Undergraduate Research Opportunities Program. Consult with Section UROP Coordinator
Managerial Economics

15.000 Explorations in Management
Prereq: None
U (Fall)
2-0-1 units

Broad introduction to the various aspects of management including analytics, accounting and finance, operations, marketing, entrepreneurship and leadership, organizations, economics, systems dynamics, and negotiation and communication. Introduces the field of management through a variety of experiences as well as discussions led by faculty or industry experts. Also reviews the three undergraduate majors offered by Sloan as well as careers in management. Subject can count toward the 9-unit discovery-focused credit limit for first year students.

J. Orlin

15.002 Sloan Innovation Period Requirement
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]

Units assigned to MBA students upon completion of the Sloan Innovation Period requirement. MBAs only.

Consult D. Gormley

15.003 Analytics Tools
Prereq: None
G (Fall, IAP, Spring, Summer)
2-0-1 units

Units assigned to Master of Business Analytics students upon completion of the Analytics Tools requirement. Restricted to Master of Business Analytics students.

Consult D. Gormley

15.010 Economic Analysis for Business Decisions
Prereq: None
G (Fall)
4-0-5 units
Credit cannot also be received for 15.011, 15.0111

Introduces principles of microeconomics as a framework for making more informed managerial decisions. Discusses the supply and demand paradigm with applications to digital marketplaces, innovation, sources of market power, and strategic pricing. Provides an introduction to game theory to study competition and cooperation both within and between firms. Restricted to first-year Sloan MBA students.

J. Doyle

15.011 Economic Analysis for Business Decisions
Subject meets with 15.0111
Prereq: None
G (Fall)
4-0-5 units
Credit cannot also be received for 15.010

Introduces principles of microeconomics as a framework for making more informed managerial decisions. Discusses the supply and demand paradigm with applications to digital marketplaces, innovation, sources of market power, and strategic pricing. Provides an introduction to game theory to study competition and cooperation both within and between firms. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details. Intended for non-Sloan graduate students.

J. Doyle

15.0111 Economic Analysis for Business Decisions
Subject meets with 15.011
Prereq: None
U (Fall)
4-0-5 units
Credit cannot also be received for 15.010

Introduces principles of microeconomics as a framework for making more informed managerial decisions. Discusses the supply and demand paradigm with applications to digital marketplaces, innovation, sources of market power, and strategic pricing. Provides an introduction to game theory to study competition and cooperation both within and between firms. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
15.012 Applied Macro- and International Economics
Prereq: None
G (Fall)
3-0-6 units

Uses case studies to investigate the macroeconomic environment in which firms operate. Subject develops the basic tools of macro and international economics: monetary and fiscal policy, growth theory and exchange rates. Discusses recent emerging market and financial crises, examining their causes, how best to address them, and how to prevent them from recurring in the future. Evaluates different strategies of economic development, including an understanding of growth and development and the role of debt and foreign aid.
R. Rigobon

15.013 Industrial Economics for Strategic Decisions
Prereq: 15.010 or 15.011
G (Fall)
3-0-6 units

Applies principles of industrial economics most relevant for corporate strategy to analysis of particular industries. Topics include market structure and its determinants; rational strategic behavior in small numbers situations; strategies for price and nonprice competition; dynamic pricing, output, and advertising decisions; entry and entry deterrence; competition with network externalities; investments under uncertainty; R&D and patent licensing; and the growth and evolution of industries.
R. Pindyck

15.014 Applied Macro- and International Economics II
Prereq: 15.012 or 15.015
G (Spring; second half of term)
4-0-2 units

Establishes understanding of the development processes of societies and economies. Studies several dimensions of sustainability (environmental, social, political, institutional, economy, organizational, relational, and personal) and the balance among them. Explores the basics of governmental intervention, focusing on areas such as the judicial system, environment, social security, and health. Builds skills to determine what type of policy is most appropriate. Considers implications of new technologies on the financial sector: internationalization of currencies, mobile payment systems, and cryptocurrencies. Discusses the institutional framework to ensure choices are sustainable across all dimensions and applications.
R. Rigobon

15.015 Macro and International Economics
Prereq: Permission of instructor
G (Fall; first half of term)
Not offered regularly; consult department
2-0-4 units

Focuses on the policy and economic environment of firms. Subject divided in two parts: study of the closed economy and how monetary and fiscal policy interacts with employment, GNP, inflation, and interest rates; and study of the open economy with discussion of recent financial and currency crises in developed and emerging markets. Restricted to Sloan Fellows.
A. Cavallo

15.017[J] Engineering, Economics and Regulation for Energy Access in Developing Countries
Same subject as 6.934[J]
Prereq: None
G (Spring)
3-0-9 units

Examines the technical, economic, political and social trade-offs inherent in designing energy solutions that can ensure universal access to electricity - as well as modern technologies for heating and cooking - in developing countries. Presents the characteristic features of the power sectors in these countries and how they need specific technical, financial and regulatory approaches. Focuses on the identification and design of viable business models that can attract the large volume of private investment needed to achieve universal energy access. Covers adequate power sector regulation and computer-aided electrification planning techniques in detail. Students make use of these models and discuss practical case examples.
I. Perez-Arriaga, R. Stoner
15.020 Economics of Energy, Innovation, and Sustainability
Prereq: 14.01 or 15.011
G (Fall)
4-0-8 units
Credit cannot also be received for 14.43[J], 15.0201[J]
Covers energy and environmental market organization and regulation. Explores economic challenges and solutions to transforming energy markets to be more efficient, accessible, affordable, and sustainable. Applies core economic concepts - consumer choice, firm profit maximization, and strategic behavior - to understand when energy and environmental markets work well and when they fail. They also conduct data-driven economic analysis on the trade-offs of real and proposed policy interventions. Topics include renewable generation sources for electricity, energy access in emerging markets, efficiency programs and fuel efficiency standards, transitioning transportation to alternative fuels, measuring damages and adaptation to climate change, and the effect of energy and environmental policy on innovation. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
J. Li

15.021[J] Real Estate Economics
Same subject as 11.433[J]
Prereq: 14.01, 15.010, or 15.011
G (Fall)
4-0-8 units
See description under subject 11.433[J].
W. C. Wheaton

Same subject as 12.848[J]
Subject meets with 12.348[J], 15.026[J]
Prereq: (Calculus II (GIR), 5.60, and (14.01 or 15.010)) or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
Introduces scientific, economic, and ecological issues underlying the threat of global climate change, and the institutions engaged in negotiating an international response. Develops an integrated approach to analysis of climate change processes, and assessment of proposed policy measures, drawing on research and model development within the MIT Joint Program on the Science and Policy of Global Change. Graduate students are expected to explore the topic in greater depth through reading and individual research.
R. G. Prinn

15.024 Applied Economics for Managers
Prereq: Permission of instructor
G (Summer)
3-0-6 units
Credit cannot also be received for 15.722
Develops facility with concepts, language and tools of microeconomics. Primary focus on the analysis of markets, strategic interactions among firms and game theory as applied to firms. Emphasizes integration of theory, data, and judgment in the analysis of a wide range of corporate decisions, both between and within firms. Restricted to Sloan Fellow MBAs.
T. Suri
15.025 Game Theory for Strategic Advantage
Subject meets with 15.0251
Prereq: 14.01, 15.010, 15.011, or 15.024
G (Spring)
3-0-6 units
Develops and applies principles of game theory relevant to
managers' strategic decisions. Topics include how to reason about
strategies and opponents; strategic commitment and negotiations;
reputation and seemingly irrational actions; bidding in auctions;
and the design of auctions, contests and markets. Applications to
a variety of business decisions that arise in different industries,
both within and outside the firm. Meets with 15.0251 when offered
concurrently. Expectations and evaluation criteria differ for students
taking graduate version; consult syllabus or instructor for specific
details.
G. Cisternas

15.0251 Game Theory for Strategic Advantage
Subject meets with 15.025
Prereq: 14.01 or 15.0111
U (Spring)
3-0-6 units
Develops and applies principles of game theory relevant to
managers' strategic decisions. Topics include how to reason about
strategies and opponents; strategic commitment and negotiations;
reputation and seemingly irrational actions; bidding in auctions;
and the design of auctions, contests and markets. Applications to
a variety of business decisions that arise in different industries,
both within and outside the firm. Meets with 15.025 when offered
concurrently. Expectations and evaluation criteria differ for students
taking graduate version; consult syllabus or instructor for specific
details.
G. Cisternas

Same subject as 12.348[J]
Subject meets with 12.848[J], 15.023[J]
Prereq: (Calculus II (GIR), 5.60, and 14.01) or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-6 units
Introduces scientific, economic, and ecological issues underlying
the threat of global climate change, and the institutions engaged
in negotiating an international response. Develops an integrated
approach to analysis of climate change processes, and assessment
of proposed policy measures, drawing on research and model
development within the MIT Joint Program on the Science and Policy
of Global Change. Graduate students are expected to explore the
topic in greater depth through reading and individual research.
12.340 recommended.
R. G. Prinn

15.027 Opportunities in Developing Economies
Prereq: None
G (Fall; second half of term)
3-0-3 units
Investigates the role of the private sector in developing economies,
highlighting how solving market failures can improve overall
welfare. Covers constraints faced by firms in developing economies:
contract enforcement, corruption, political risk, human rights, IP and
infrastructure. Uses case studies to discuss successful firms and
innovative solutions to these constraints, including public-private
partnerships, the role of technology, the role of finance and impact
investing.
T. Suri

15.032[J] Engineering, Economics and Regulation of the Electric
Power Sector
Same subject as 6.695[J], IDS.505[J]
Subject meets with IDS.064
Prereq: 14.01, 22.081[J], IDS.060[J], or permission of instructor
G (Spring)
3-0-9 units
See description under subject IDS.505[J].
I. Perez-Arriaga
15.034 Econometrics for Managers: Correlation & Causality in a Big Data World
Subject meets with 15.0341
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4-0-5 units

Enables students to evaluate the quality of evidence supported by data, and to implement an empirical toolkit that provides credible answers to questions in finance, marketing, human resources, strategy, and general business planning. Reviews big-data tools designed to discover useful correlations. Introduces econometrics as a framework to go beyond correlations to causality, including an in-depth understanding of regression modelling including instrumental-variables estimation. Students apply these tools in classroom exercises, problem sets, and projects. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

J. Doyle

15.0341 Econometrics for Managers: Correlation and Causality in a Big Data World
Subject meets with 15.034
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4-0-5 units

Enables students to evaluate the quality of evidence supported by data, and to implement an empirical toolkit that provides credible answers to questions in finance, marketing, human resources, strategy, and general business planning. Reviews big-data tools designed to discover useful correlations. Introduces econometrics as a framework to go beyond correlations to causality, including an in-depth understanding of regression modelling including instrumental-variables estimation. Students apply these tools in classroom exercises, problem sets, and projects. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

J. Doyle

15.037[J] Energy Economics and Policy
Same subject as 14.444[J]
Prereq: 14.01 or 15.0111
U (Spring)
4-0-8 units

See description under subject 14.444[J]. Limited to 60.

C. Knittel

Same subject as 14.444[J]
Prereq: 14.01 or 15.0111
G (Spring)
4-0-8 units
Credit cannot also be received for 14.444[J], 15.037[J]

See description under subject 14.444[J]. Limited to 60.

C. Knittel

15.039[J] Economics of Incentives: Theory and Applications (New)
Same subject as 14.26[J]
Subject meets with 14.260
Prereq: 14.01
U (Spring)
4-0-8 units. HASS-S

See description under subject 14.26[J]. Limited to 60.

R. Gibbons

Operations Research/Statistics

15.053 Optimization Methods in Business Analytics
Prereq: 1.00, 1.000, 6.0001, or permission of instructor
U (Spring)
4-0-8 units. REST

Introduces optimization methods with a focus on modeling, solution techniques, and analysis. Covers linear programming, network optimization, integer programming, nonlinear programming, and heuristics. Applications to logistics, manufacturing, statistics, machine learning, transportation, game theory, marketing, project management, and finance. Includes a project in which student teams select and solve an optimization problem (possibly a large-scale problem) of practical interest.

J. Orlin

15.054[J] The Airline Industry
Same subject as 1.232[J], 16.71[J]
Prereq: None
G (Fall)
3-0-9 units

See description under subject 16.71[J].

P. P. Belobaba, H. Balakrishnan, A. I. Barnett, R. J. Hansman, T. A. Kochan
15.060 Data, Models, and Decisions
Prereq: Permission of instructor
G (Fall, Summer)
3-0-6 units
Credit cannot also be received for 15.730
Introduces students to the basic tools in using data to make informed management decisions. Covers basic topics in data analytics, including introductory probability, decision analysis, basic statistics, regression, simulation, linear and discrete optimization, and introductory machine learning. Spreadsheet exercises, cases, and examples drawn from marketing, finance, operations management, and other management functions. Restricted to first-year Sloan master’s students.
J. Vielma, R. Freund, G. Perakis

15.062[J] Data Mining: Finding the Models and Predictions that Create Value
Same subject as IDS.145[J]
Subject meets with 15.0621
Prereq: 15.060, 15.075[J], or permission of instructor
G (Fall; second half of term)
2-0-4 units
Introduction to data mining, data science, and machine learning, methods that assist in recognizing patterns, developing models and predictive analytics, and making intelligent use of massive amounts of data collected via the internet, e-commerce, electronic banking, point-of-sale devices, bar-code readers, medical databases, and other sources. Topics include logistic regression, association rules, tree-structured classification and regression, cluster analysis, discriminant analysis, and neural network methods. Presents examples of successful applications in credit ratings, fraud detection, marketing, customer relationship management, investments, and synthetic clinical trials. Introduces data-mining software focusing on R. Term project required. Meets with 15.062[J] when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
R. E. Welsch

15.0621 Data Mining: Finding the Models and Predictions that Create Value
Subject meets with 15.062[J], IDS.145[J]
Prereq: 15.075[J] or permission of instructor
U (Fall; second half of term)
2-0-4 units
Introduction to data mining, data science, and machine learning, methods that assist in recognizing patterns, developing models and predictive analytics, and making intelligent use of massive amounts of data collected via the internet, e-commerce, electronic banking, point-of-sale devices, bar-code readers, medical databases, and other sources. Topics include logistic regression, association rules, tree-structured classification and regression, cluster analysis, discriminant analysis, and neural network methods. Presents examples of successful applications in credit ratings, fraud detection, marketing, customer relationship management, investments, and synthetic clinical trials. Introduces data-mining software focusing on R. Term project required. Meets with 15.062[J] when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
R. E. Welsch

15.066[J] System Optimization and Analysis for Operations
Same subject as 2.851[J]
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 units
Introduction to mathematical modeling, optimization, and simulation, as applied to manufacturing and operations. Specific methods include linear programming, network flow problems, integer and nonlinear programming, discrete-event simulation, heuristics and computer applications for manufacturing processes, operations and systems. Restricted to Leaders for Global Operations students.
Staff

15.068 Statistical Consulting
Prereq: 15.060
G (Spring)
3-0-6 units
Addresses statistical issues as a consultant would face them: deciphering the client’s question; finding appropriate data; performing a viable analysis; and presenting the results in compelling ways. Real-life cases and examples.
A. I. Barnett
15.070[J] Discrete Probability and Stochastic Processes
Same subject as 6.265[J]
Prereq: 6.431, 6.436[J], 18.100A, 18.100B, or 18.100Q
G (Spring)
3-0-9 units
Provides an introduction to tools used for probabilistic reasoning in the context of discrete systems and processes. Tools such as the probabilistic method, first and second moment method, martingales, concentration and correlation inequalities, theory of random graphs, weak convergence, random walks and Brownian motion, branching processes, Markov chains, Markov random fields, correlation decay method, isoperimetry, coupling, influences and other basic tools of modern research in probability will be presented. Algorithmic aspects and connections to statistics and machine learning will be emphasized.
G. Bresler, D. Gamarnik, E. Mossel, Y. Polyanskiy

15.071 The Analytics Edge
Prereq: 15.060
G (Fall, Spring)
4-0-8 units
Credit cannot also be received for 15.071
Examines how data analytics is used to transform businesses and industries, using examples and case studies in e-commerce, healthcare, social media, high technology, sports, the internet, and beyond. Demonstrates the use of analytics methods such as linear regression, logistic regression, classification trees, random forests, text analytics, social network analysis, time series modeling, clustering, and optimization. Uses R programming language. Includes team projects. Meets with 15.071 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
R. Freund

15.0711 The Analytics Edge
Prereq: 15.053 and 15.0791
U (Spring)
4-0-8 units
Credit cannot also be received for 15.071
Examines how data analytics is used to transform businesses and industries, using examples and case studies in e-commerce, healthcare, social media, high technology, sports, the internet, and beyond. Demonstrates the use of analytics methods such as linear regression, logistic regression, classification trees, random forests, text analytics, social network analysis, time series modeling, clustering, and optimization. Uses R programming language. Includes team projects. Meets with 15.071 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
R. Freund

Same subject as 1.203[J], IDS.700[J]
Prereq: 6.041B or 18.600
G (Fall)
3-0-9 units
A vigorous use of probabilistic models to approximate real-life situations in Finance, Operations Management, Economics, and Operations Research. Emphasis on how to develop a suitable probabilistic model in a given setting and, merging probability with statistics, and on how to validate a proposed model against empirical evidence. Extensive treatment of Monte Carlo simulation for modeling random processes when analytic solutions are unattainable.
A. Barnett

15.0741 Predictive Data Analytics and Statistical Modeling
Prereq: 6.041B
U (Spring)
Not offered regularly; consult department
4-0-5 units
Provides a brief review of statistics and regression drawn from advanced topics, such as bootstrap resampling, variable selection, data and regression diagnostics, visualization, and Bayesian and robust methods. Covers data-mining and machine learning, including classification, logistic regression, and clustering. Culminates with time series analysis and forecasting, design of experiments, analysis of variance, and process control. Uses statistical computing systems based on application add-ins and stand-alone packages. Case studies involve finance, management science, consulting, risk management, and engineering systems. Term project required.
R. E. Welsch
15.075[J] Statistical Thinking and Data Analysis
Same subject as IDS.013[J]
Prereq: 6.041B or 15.0791
U (Spring)
3-1-8 units. Institute LAB
Credit cannot also be received for 18.650[J], 18.6501, IDS.014[J]

Introduces a rigorous treatment of statistical data analysis while helping students develop a strong intuition for the strengths and limitations of various methods. Topics include statistical sampling and uncertainty, estimation, hypothesis testing, linear regression, classification, analysis of variation, and elements of data mining. Involves empirical use of hypothesis testing and other statistical methodologies in several domains, including the assessment of A-B experiments on the web and the identification of genes correlated with diseases.

R. Mazumder

15.077[J] Statistical Learning and Data Mining
Same subject as IDS.147[J]
Prereq: None
G (Spring)
4-0-8 units
Advanced introduction to theory and application of statistics, data mining and machine learning using techniques from management science, marketing, finance, consulting, engineering systems, and bioinformatics. Covers bootstrap theory of estimation, testing, nonparametric statistics, analysis of variance, experimental design, categorical data analysis, regression analysis, MCMC, EM, Gibbs sampling, and Bayesian methods. Focuses on data mining, supervised learning, and multivariate analysis. Topics chosen from logistic regression; principal components and dimension reduction; discrimination and classification analysis, trees (CART), partial least squares, nearest neighbors, regularized methods, support vector machines, boosting and bagging, clustering, independent component analysis, and nonparametric regression. Uses statistics software R and MATLAB. Some background in statistics or instructor permission required. Includes term project.

R. E. Welsch

15.079 Introduction to Applied Probability
Prereq: Calculus I (GIR)
G (Fall)
Not offered regularly; consult department
4-0-8 units
Credit cannot also be received for 6.041, 6.431, 15.0791, 18.600

Presents probability from the perspective of applied mathematics, with strong emphasis on an intuitive overview of key theorems and continuing demonstrations of their usefulness. Covers the laws of probability and numerous important discrete and continuous random variables, both individually and in combination. Introduces simulation. Draws applications from economics, finance, engineering, marketing, public policy, operations management, and operations research. Meets with 15.0791 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

A. Barnett, R. Larson

15.0791 Introduction to Applied Probability
Prereq: Calculus I (GIR)
U (Fall)
4-0-8 units. REST
Credit cannot also be received for 6.041, 6.431, 15.079, 18.600

Presents probability from the perspective of applied mathematics, with strong emphasis on an intuitive overview of key theorems and continuing demonstrations of their usefulness. Covers the laws of probability and numerous important discrete and continuous random variables, both individually and in combination. Introduces simulation. Draws applications from economics, finance, engineering, marketing, public policy, operations management, and operations research. Meets with 15.079 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

A. Barnett, R. Larson

15.081[J] Introduction to Mathematical Programming
Same subject as 6.251[J]
Prereq: 18.06
G (Fall)
4-0-8 units

See description under subject 6.251[J].

J. N. Tsitsiklis, D. Bertsimas
15.083 Integer Programming and Combinatorial Optimization
Prereq: 6.251[J] or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units
In-depth treatment of the modern theory of integer programming and combinatorial optimization, emphasizing geometry, duality, and algorithms. Topics include formulating problems in integer variables, enhancement of formulations, ideal formulations, integer programming duality, linear and semidefinite relaxations, lattices and their applications, the geometry of integer programming, primal methods, cutting plane methods, connections with algebraic geometry, computational complexity, approximation algorithms, heuristic and enumerative algorithms, mixed integer programming and solutions of large-scale problems.
D. J. Bertsimas, A. S. Schulz

15.084[J] Nonlinear Optimization
Same subject as 6.252[J]
Prereq: 18.06 and (18.100A, 18.100B, or 18.100Q)
G (Spring)
4-0-8 units
See description under subject 6.252[J].
R. M. Freund, P. Parrilo, G. Perakis

15.085[J] Fundamentals of Probability
Same subject as 6.436[J]
Prereq: Calculus II (GIR)
G (Fall)
4-0-8 units
See description under subject 6.436[J].
J. N. Tsitsiklis, D. Gamarnik

15.086 Engineering Probability
Prereq: Calculus I (GIR) and permission of instructor
G (Summer; first half of term)
2-0-4 units
Introduction to applied probability. Makes real-life problems central to the pedagogy and aims for an intuitive understanding of probability as well as mastery of key probabilistic concepts and methods. Preference to first-year Leaders for Global Operations students.
Staff

15.087 Engineering Statistics and Data Science
Prereq: Calculus II (GIR), 15.086, 18.06, and permission of instructor
G (Summer)
4-0-8 units
Develops ideas for making principled decisions and recommendations based on data, providing an introduction to statistical inference and statistical learning. Covers data displays and summary statistics for quantitative and qualitative data, the law of large numbers for means and empirical distributions, the normal distribution and the central limit theorem, confidence intervals, statistical hypothesis tests for the population mean and differences between population means, simple and multiple regression with quantitative data, model selection, the bias-variance tradeoff, logistic regression for binary outcomes, CART, random forests, gradient boosting, and deep learning. The statistical programming language R is used for in-class demonstrations and for out-of-class assignments. Preference to first-year Leaders for Global Operations students. No required textbook.
Staff

15.089 Analytics Capstone
Prereq: None
G (IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Practical application of business analytics problems within a real company. Teams of 1-2 students, matched with company projects, visit companies to define project and scope. In class, students refine and improve on projects and devise methods for solving problems for their select companies. Mentors are assigned to each team. The culmination of the program is summer, on-site, practical training. Restricted to Master of Business Analytics students.
D. Bertsimas, C. Simone
15.093[J] Optimization Methods
Same subject as 6.255[J], IDS.200[J]
Subject meets with 6.215
Prereq: 18.06
G (Fall)
4-0-8 units
Introduces the principal algorithms for linear, network, discrete, robust, nonlinear, and dynamic optimization. Emphasizes methodology and the underlying mathematical structures. Topics include the simplex method, network flow methods, branch and bound and cutting plane methods for discrete optimization, optimality conditions for nonlinear optimization, interior point methods for convex optimization, Newton’s method, heuristic methods, and dynamic programming and optimal control methods. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
D. Bertsimas, P. Parrilo

15.094[J] Robust Modeling, Optimization, and Computation
Same subject as 1.142[J]
Prereq: 18.06 or permission of instructor
G (Spring)
4-0-8 units
Introduces modern robust optimization, including theory, applications, and computation. Presents formulations and their connection to probability, information and risk theory for conic optimization (linear, second-order, and semidefinite cones) and integer optimization. Application domains include analysis and optimization of stochastic networks, optimal mechanism design, network information theory, transportation, pattern classification, structural and engineering design, and financial engineering. Students formulate and solve a problem aligned with their interests in a final project.
D. Bertsimas

15.095 Machine Learning Under a Modern Optimization Lens
Prereq: 6.251[J], 15.093[J], or permission of instructor
G (Fall)
3-1-8 units
Develops algorithms for central problems in machine learning from a modern optimization perspective. Topics include sparse, convex, robust and median regression; an algorithmic framework for regression; optimal classification and regression trees, and their relationship with neural networks; how to transform predictive algorithms to prescriptive algorithms; optimal prescriptive trees; and robust classification. Also covers design of experiments, missing data imputations, mixture of Gaussian models, exact bootstrap, and sparse matrix estimation, including principal component analysis, factor analysis, inverse co-variance matrix estimation, and matrix completion.
D. Bertsimas

15.096 Prediction: Machine Learning and Statistics
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units
Gives a practical background and theoretical foundation to machine learning algorithms and Bayesian analysis. Includes an overview of the top ten algorithms in data mining. Covers frameworks for knowledge discovery, a unified view of support vector machines, AdaBoost and regression based on regularized risk minimization; generalization bounds from statistical learning theory based on covering numbers, VC dimension, and the margin theory; as well as basic Bayesian analysis and notes on the history of machine learning and statistics.
C. Rudin

15.097 Seminar in Statistics and Data Analysis
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Group study of current topics related to statistics and data analysis.
C. Rudin

15.098 Seminar in Applied Probability and Stochastic Processes
Prereq: 6.431
G (Fall)
Not offered regularly; consult department
2-0-4 units
Can be repeated for credit.
Doctoral student seminar covering current topics in applied probability and stochastic processes.
D. Gamarnik, D. Shah
15.099 Seminar in Operations Research
Prereq: 6.251[J]
G (Fall, Spring)
Units arranged
Can be repeated for credit.

Doctoral student seminar covering current topics related to operations research.
D. Bertsimas, R. Freund, J. Orlin, G. Perakis

Health Care Management

15.124[J] Evaluating a Biomedical Business Concept
Same subject as HST.973[J]
Prereq: None
G (Fall)
3-0-6 units
See description under subject HST.973[J]. Enrollment limited.
R. J. Cohen

15.128[J] Revolutionary Ventures: How to Invent and Deploy Transformative Technologies
Same subject as 9.455[J], 20.454[J], MAS.883[J]
Prereq: Permission of instructor
G (Fall)
2-0-7 units
See description under subject MAS.883[J].
E. Boyden, J. Bonsen, J. Jacobson

15.132[J] Medicine for Managers and Entrepreneurs Proseminar
Same subject as HST.972[J]
Prereq: None
G (Spring)
3-0-6 units
Provides students with basic business-oriented clinical and technological knowledge related to health, healthcare and medicine through engagements with clinical and industry experts. Each session focuses on a specific field of medicine. Speakers include a basic science and/or clinical expert and a CEO or other senior executive involved in cutting-edge innovation in each area.
R. J. Cohen

15.136[J] Principles and Practice of Drug Development
Same subject as 7.547[J], 10.547[J], HST.920[J], IDS.620[J]
Prereq: Permission of instructor
G (Fall)
3-0-6 units
Description and critical assessment of the major issues and stages of developing a pharmaceutical or biopharmaceutical. Drug discovery, preclinical development, clinical investigation, manufacturing and regulatory issues considered for small and large molecules. Economic and financial considerations of the drug development process. Multidisciplinary perspective from faculty in clinical; life; and management sciences; as well as industry guests.
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

15.137[J] Case Studies and Strategies in Drug Discovery and Development
Same subject as 7.549[J], 20.486[J], HST.916[J]
Prereq: None
G (Spring)
2-0-4 units
See description under subject 20.486[J].
A. W. Wood

15.141[J] Economics of Health Care Industries
Same subject as HST.918[J]
Prereq: None
G (Spring; first half of term)
3-0-3 units
Considers health economics issues from a business perspective, including differences between health care and other industries, the role of health insurance, regulatory issues and incentives for innovation, data analytics to measure value, strategic issues in pricing and marketing, use of e-commerce and information technology, personalized/stratified medicines, and formation and management of various alliances. Explores US and global health institutions. Visiting speakers from academia, government, NGOs, and industry.
J. Doyle
Global Economics Management

15.216 Central Banks, Monetary Policy and Global Financial Markets
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-6 units

Explores the role of central banks and monetary policy in the global economy and the effects of their policies on countries, companies and global financial markets. Reviews the decision-making process and policy implementation, and provides conceptual tools for analyzing and predicting central bank decisions and assessing their likely impact. Covers monetary policy, bank regulation and crisis management, drawing on the experience of the Federal Reserve, the ECB and other central banks in advanced and emerging market economies.

A. Orphanides

15.218 Global Economic Challenges and Opportunities
Prereq: None
G (Spring)
3-0-6 units

Analyzes the causes, effects and policy responses to recent major global economic issues. Studies financial crises, beginning with historical examples and building up to develop the tools to assess current vulnerabilities in countries around the world. Focuses on current economic debates in the headlines so topics vary each year. Possible topics include globalization, currency wars, monetary and fiscal policy, unsustainable debt, aging populations, inequality and poverty, oil and commodity markets, international institutions, and financial contagion. Some background or coursework in international economics recommended.

K. Forbes

Same subject as 11.267[J]
Prereq: None
G (Spring)
3-0-9 units
Credit cannot also be received for 11.167[J], 14.47[J], 15.2191[J], 17.399[J]

Focuses on the ways economics and politics influence the fate of energy technologies, business models, and policies around the world. Extends fundamental concepts in the social sciences to case studies and simulations that illustrate how corporate, government, and individual decisions shape energy and environmental outcomes. In a final project, students apply the concepts in order to assess the prospects for an energy innovation to scale and advance sustainability goals in a particular regional market. Recommended prerequisite: 14.01. Meets with 15.219[J] when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

V. Karplus

Same subject as 11.167[J], 14.47[J], 17.399[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Credit cannot also be received for 11.267[J], 15.219[J]

Focuses on the ways economics and politics influence the fate of energy technologies, business models, and policies around the world. Extends fundamental concepts in the social sciences to case studies and simulations that illustrate how corporate, government, and individual decisions shape energy and environmental outcomes. In a final project, students apply the concepts in order to assess the prospects for an energy innovation to scale and advance sustainability goals in a particular regional market. Recommended prerequisite: 14.01. Meets with 15.219[J] when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details. Preference to juniors, seniors, and Energy Minors.

V. Karplus
15.220 New Models for Global Business
Prereq: None
G (Fall; second half of term)
Not offered regularly; consult department
3-0-3 units
Explores international dimensions of strategic management, and equips students to design strategies and structures that work effectively in an increasingly complex world economy. Focuses on a range of industries, from technology-based firms with global roots to emerging market multinationals. Topics include managing and leveraging big data, social and peer-to-peer networks, technology, and talent across national borders to develop capabilities and enhance competitive advantage. Includes a final group project in which students apply class concepts to evaluate strategic options for a startup or established global company of their choice. No final exam.
V. Karplus

15.221 Global Strategy and Organization
Prereq: None
G (Spring; first half of term)
3-0-3 units
Focuses on the international dimensions of strategy and organization, and provides a framework for formulating strategies in an increasingly complex world economy, and for making those strategies work effectively. Topics include the globalization of industries, the continuing role of country factors in competition, organization of multinational enterprises, building global networks, and the changing managerial tasks under conditions of globalization. Restricted to Sloan Fellows in Innovation and Global Leadership.
Staff

15.223 Global Markets, National Policies and the Competitive Advantages of Firms
Prereq: None
G (Fall; second half of term)
3-0-3 units
Examines opportunities and risks firms face in today’s global market. Provides conceptual tools for analyzing how governments and social institutions influence economic competition among firms embedded in different national settings. Public policies and institutions that shape competitive outcomes are examined through cases and analytical readings on different companies and industries operating in both developed and emerging markets. Priority to Sloan Fellows MBAs.
S. Johnson

15.225 Economy and Business in Modern China and India: China Lab and India Lab
Prereq: None
G (Spring)
3-0-9 units
Provides an integrated approach to analyze the economies of China and India through action learning. The classroom portion covers macro issues of China and India, project-related issues and personal and learning reflections. The onsite portion involves working with a host company in China or in India. Students work in teams to tackle a real world business problem with an entrepreneurial Chinese or Indian company and produce a final deliverable for the host company. Students are required to take a mid semester trip during SIP and Spring Break to China or India to work onsite with the host company. Past lab projects have included creating a business plan for fundraising, developing a new market strategy, and crafting financial models; the projects have included both for-profit and NGO projects. Limited to graduate students who participate in China Lab or India Lab.
J. Grant, Y. Huang, M. Jester

15.227 - 15.229 Seminar in International Management
Prereq: None
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Group study of current topics related to international business.
Staff

15.232 Effective Business Models in Frontier Markets
Prereq: None
G (Spring; first half of term)
3-0-3 units
Examines how new approaches to operations, revenue, marketing, finance, and strategy enable improved social outcomes in resource-limited settings across Africa, Latin America, and Asia. Draws on system dynamics, design thinking, and strategic analysis. Explores success and failure in attempts to innovate and scale in product and service delivery. Analysis of novel business models draws on case studies, videos, industry reports, research, and guest speakers. Students present their assessments of innovative base-of-the-pyramid enterprises that aim to do more with less. Students who have not taken at least three management or business classes must apply to the instructor for permission to enroll before the first day of class.
A. Sastry
**15.233 Global Health Lab**
Prereq: None  
G (Spring)  
3-0-9 units

Pairs faculty-mentored student teams with enterprises on the front lines of health care delivery in sub-Saharan Africa and South Asia. Custom-designed projects in strategy, business model innovation, operations, marketing, and technology designed to tackle specific barriers identified by each partnering organization. Interactive cases, practical exercises, and conversations with experts, all designed to support project work before, during, and after an intensive two-week onsite collaboration with entrepreneurs, leaders, staff, and stakeholders. Assignments include a portfolio of host deliverables, a foundational toolkit designed to support each project, and a distillation of learning from the field. Enrolled students must be available to work on site in Africa or South Asia for the entire weeks of SIP and Spring Break. Preference to students who have taken 15.232. Admission by application and interview in the prior November and December. Graduate students only.

A. Sastry

**15.234 Scalable Civic Action (New)**
Same subject as MAS.720
Prereq: None  
G (Fall)  
2-1-3 units

Project-based subject in which students deploy research-based civic, political and organizational engagement tools and analyze their impact and effectiveness. Sample application areas include addressing voter suppression, voter mobilization, and civic group organization. Addresses topics such as randomized controlled testing methods, political campaign techniques, behavioral optimization, and assessment metrics. Students form teams and perform real-world interventions using systems under development in the Media Lab. Open to undergraduates with permission of instructor.

S. Johnson, A. Lippman

**15.235 Blockchain and Money (New)**
Prereq: None  
G (Fall)  
3-0-6 units

Explores blockchain technology’s potential use - by entrepreneurs and incumbents - to change the world of money and finance. Begins with a review of the technology’s initial application, the cryptocurrency Bitcoin, giving students an understanding of the commercial, technical and public policy fundamentals of blockchain technology, distributed ledgers and smart contracts in both open-sourced and private applications. Focuses on current and potential blockchain applications in the financial sector. Includes reviews of potential use cases for payment systems, central banking, venture capital, secondary market trading, trade finance, commercial banking, post-trade possessing, and digital ID. Also explores the markets and regulatory landscape for cryptocurrencies, initial coin offerings, other tokens, and crypto derivatives. Open to undergraduates with permission of instructor.

G. Gensler

**15.248 Israel Lab: Startup Nation’s Entrepreneurship and Innovation Ecosystem**
Prereq: None  
G (Fall, IAP; second half of term)  
3-0-6 units

Practical study of Israel’s innovation and entrepreneurial ecosystem. On-campus component provides context about the country and its social and geopolitical issues as they pertain to business in Israel; REAP Stakeholder Model, entrepreneurship lessons, Israeli business culture, and team dynamics. During IAP, student teams work at the Israeli host organizations in Tel Aviv on complex problems in critical areas, such as big data/analytics, computing technologies, life sciences, robotics, Fintech, and cybersecurity, with an emphasis on early stage ventures and their growth. Provides students an opportunity to engage directly with startup CEOs and venture capitalists. Limited to graduate students and Sloan undergraduates, application required for Sloan undergraduates.

J. Cohen
History, Environment and Ethics

15.268 Choice Points: Thinking about Life and Leadership through Literature
Prereq: None
G (Spring)
3-0-6 units

Explores decision making and leadership. Analyzes the dilemmas and decisions characters face in a selection of plays, stories, and films. Provokes reflection on what constitutes effective and moral reasoning in critical moments of both life and leadership. Restricted to Sloan Fellow MBAs.
Consult J. DiFabio

15.269 Leadership Stories: Literature, Ethics, and Authority
Prereq: None
G (Fall)
3-0-6 units

Explores how we use story to articulate ethical norms. The syllabus consists of short fiction, novels, plays, feature films and some non-fiction. Major topics include leadership and authority, professionalism, the nature of ethical standards, social enterprise, and questions of gender, cultural and individual identity, and work/life balance. Materials vary from year to year, but past readings have included work by Robert Bolt, Michael Frayn, Timothy Mo, Wole Soyinka, H.D. Thoreau, and others; films have included Crouching Tiger, Hidden Dragon, Hotel Rwanda, The Descendants, Motorcycle Diaries, Three Kings, and others. Draws on various professions and national cultures, and is run as a series of moderated discussions, with students centrally engaged in the teaching process.
L. Hafrey

Communication

15.270 Ethical Practice: Leading Through Professionalism, Social Responsibility, and System Design
Prereq: None
G (Spring; second half of term)
3-0-3 units

Introduction to ethics in business, with a focus on business management. Students explore theoretical concepts in business ethics, and cases representing the challenges they will likely face as managers. Opportunity to work with guest faculty as well as business and other professional practitioners. Individual sessions take the form of moderated discussion, with occasional short lectures from instructor.
L. Hafrey

15.276 Communicating with Data
Prereq: None
U (Spring)
3-0-9 units

Credit cannot also be received for 15.286

Equips students with the strategies, tactics, and tools to use quantitative information to inform and persuade others. Emphasizes effective communication skills as the foundation of successful careers. Develops the skills to communicate quantitative information in a business context to drive people and organizations toward better decisions. Focuses heavily on the cycle of practicing, reflecting, and revising. Students receive extensive, personalized feedback from teaching team and classmates.
M. Kazakoff

15.277 Seminar in Communications
Prereq: None
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Group study of current topics related to communication.
J. Yates

15.278 Seminar in Communications
Prereq: None
G (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Group study of current topics related to communication.
J. Yates

15.279 Management Communication for Undergraduates
Prereq: None
U (Fall, Spring)
3-0-9 units

Develops writing, speaking, teamwork, interpersonal, social media, and cross-cultural communication skills necessary for management professionals. Assignments include creating persuasive memos, writing in response to cases, and giving presentations. Major project involves the production of a team report and presentation on a topic of interest to a professional audience.
L. Breslow
15.280 Communication for Leaders
Prereq: Permission of instructor
G (Fall)
3-1-5 units
Credit cannot also be received for 15.710

Students develop and polish communication strategies and methods through discussion, examples, and practice. Emphasizes writing and speaking skills necessary for effective leaders. Includes several oral and written assignments which are integrated with other subjects, and with career development activities, when possible. Schedule and curriculum coordinated with Organizational Processes. Mandatory one hour recitation in small groups. Restricted to first-year Sloan graduate students.

N. Hartman, L. Breslow, V. Healy-Tangney, K. Blackburn, M. Kazakoff, J. Yates, B. Shields

15.281 Advanced Leadership Communication
Prereq: 15.279, 15.280, or permission of instructor
G (Spring)
3-0-6 units

Introduces interactive oral and interpersonal communication skills critical to leaders, including strategies for presenting to a hostile audience, running effective and productive meetings, active listening, and contributing to group decision-making. Includes team-run classes on chosen communication topics, and an individual analysis of leadership qualities and characteristics. Students deliver an oral presentation and an executive summary, both aimed at a business audience.

N. Hartman, K. Blackburn, B. Shields, J. Yates, V. Healy-Tangney

15.282 EnActing Leadership: Shakespeare and Performance
Prereq: None
G (Spring)
3-0-6 units

Uses Shakespeare to challenge students’ views of leadership and provide them with a deeper understanding of their performance as a leader. While performing shortened versions of Shakespeare’s plays, students consider the serious questions they raise about the nature of leadership, power, and ambition, and explore their own leadership presence. Uses acting to strengthen speaking ability and personal presence.

C. Kelly

15.283 Social Media Management: Persuasion in Networked Culture
Prereq: None
G (Spring)
3-0-6 units

Explores how organizations and leaders can maximize the business value of social media platforms. Provides a framework and best practices for social media management, enhances understanding of strategic communication within the social media context, and improves social media communication skills. Assignments include case analysis, weekly content creation, and a final group project on social media strategy and content.

B. Shields

15.284 Strategic Leadership Communication
Prereq: None
G (Fall; partial term)
3-0-3 units

Introduces the essentials of how individuals and organizations develop and implement effective communication strategies, focusing on persuasion, audience analysis, communicator credibility, message construction, and delivery. Includes oral presentations and writing assignments with feedback to help students improve their communication effectiveness. Provides instruction to create communication strategies, develop and present clearly organized and powerful presentations, expand personal oral delivery and writing styles, and enhance presentations through effective visual aids. Restricted to Sloan Fellow MBAs.

N. Hartman, L. Breslow

15.286 Communicating with Data
Prereq: None
G (Spring; first half of term)
3-0-3 units
Credit cannot also be received for 15.276

Focuses on the strategic and tactical use of data to move others to take (the correct) action. Sharpens communication skills via practice and real-world examples. Students spend significant time writing, speaking and designing visuals for a professional audience. Intended for students who expect to communicate quantitative information with non-experts inside and outside of their organizations, as well as students seeking to improve communication skills in general. Recommended prerequisite: 15.280 or 15.284.

M. Kazakoff
15.289 Doctoral Seminar: Communication Skills for Academics  
Prereq: Permission of instructor  
G (Spring)  
3-0-3 units  
Focuses on the communication skills needed for a career in academia. Topics include writing for academic journals, preparing and delivering conference papers and job talks, creating your professional presence on social media, peer reviewing for journals and conferences, and teaching. Participants are expected to work on a written project and deliver an oral presentation based on their current research. Limited to 20; priority to Sloan doctoral students who have completed their first year.  
J. Yates, L. Breslow

Work and Organizational Studies

15.301 People, Teams, and Organizations Laboratory  
Prereq: None  
U (Fall)  
3-3-9 units. Institute LAB  
Surveys individual and social psychology and organization theory interpreted in the context of the managerial environment. Laboratory involves projects of an applied nature in behavioral science. Emphasizes use of behavioral science research methods to test hypotheses concerning decision-making, group behavior, and organizational behavior. Instruction and practice in communication includes report writing, team projects, and oral and visual presentation. 12 units may be applied to the General Institute Laboratory Requirement. Shares lectures with 15.310.  
J. Carroll, P. Osterman

15.304 Being Effective: Power and Influence  
Prereq: None  
G (Spring)  
3-0-6 units  
Discusses how to map power and interest patterns in organizations, how to understand your own interests and objectives, and how to operate effectively in organizational environments. Provides frameworks as well as a range of practical tools to address these goals. Utilizes a wide range of material drawn from the business and public worlds.  
P. Osterman

15.305 Leadership and Management  
Prereq: Permission of instructor  
U (Fall)  
3-0-6 units  
Explores leadership from the military perspective taught by professors of military science from the Army, Navy and Air Force. Survey of basic principles for successfully managing and leading people, particularly in public service and the military. Develops skills in topics such as oral and written communication techniques, planning, team building, motivation, ethics, decision-making, and managing change. Relies heavily on interactive experiential classes with case studies, student presentations, role plays, and discussion. Also appropriate for non-management science majors.  
S. Ott

15.307 Leadership and Ethics  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
2-0-0 units  
Foundations, pillars, principles and mantras of outstanding leadership introduced through in-class discussions and case studies presented by senior industry leaders (LGO and non-LGO alumni). Alumni also share their personal leadership experiences with the class. Leaders for Global Operations students only.  
Staff

15.309 Leadership Lessons Learned from the Military  
Prereq: None  
G (IAP)  
2-0-1 units  
Prepared and taught by veterans in various Sloan programs, under the supervision of MIT Sloan faculty. Focuses on the nature of military leadership and its relevance to the civilian professional and organizational experience.  
D. Ancona, L. Hafrey

15.310 People, Teams, and Organizations  
Prereq: None  
G (Fall)  
2-1-6 units  
Surveys social psychology and organization theory as interpreted in the context of the managerial environment. Covers a number of diverse topics, including motivation and reward systems, social influence, groups and teams, leadership, power, organizational design and culture, and networks and communication patterns. Similar in content to 15.311; shares lectures with 15.301. Preference to non-Course 15 students.  
J. Carroll, P. Osterman
15.311 Organizational Processes
Prereq: Permission of instructor
G (Fall)
2-3-4 units
Enhances students’ ability to take effective action in complex organizational settings by providing the analytic tools needed to analyze, manage, and lead the organizations of the future. Emphasizes the importance of the organizational context in influencing which individual styles and skills are effective. Employs a wide variety of learning tools, from experiential learning to the more conventional discussion of written cases. Centers on three complementary perspectives on organizations: the strategic design, political, and cultural "lenses" on organizations. Major team project to analyze an actual organizational change, with oral and written reports. Restricted to first-year Sloan master’s students.
_E. Kelly, K. Kellogg, C. Turco_

15.312 Organizational Processes for Business Analytics
Prereq: None
U (Fall)
3-0-9 units
Develops appreciation for organizational dynamics and competence in navigating social networks, working in a team, demystifying rewards and incentives, leveraging the crowd, understanding change initiatives, and making sound decisions. Provides instruction and practice in written and oral communication through presentations, and interpersonal and group exercises.
_R. Reagans, L. Breslow_

15.316 Building and Leading Effective Teams
Prereq: None
G (Summer)
3-1-0 units
An intensive one-week introduction to leadership, teams, and learning communities. Introduction of concepts and use of a variety of experiential exercises to develop individual and team skills and develop supportive relationships within the Fellows class. Restricted to first-year Leaders for Global Operations students.
_J. S. Carroll_

15.317 Leadership and Organizational Change
Prereq: None
G (Spring, Summer; second half of term)
Units arranged
Can be repeated for credit.
Course spans the entire two-year Leaders for Global Operations (LGO) program, with a focus on leadership that blends theory and practice. During their first summer in the program, students reflect on exemplary leaders' stories in cases, the arts, journalism, philosophy, and social science, and evaluate their own previous leadership experience. During the succeeding four semesters, they apply the lessons they have learned in class to their off-campus internship and other activities at Sloan, and intensively review that experience as they reach the end of the program. Classes take the form of moderated discussion, with the expectation that students will participate fully in each session; students also submit short, written deliverables throughout the program.
_L. Hafrey_

15.318 Discovering Your Leadership Signature
Prereq: None
G (Fall; second half of term)
3-0-6 units
Credit cannot also be received for 15.739
Provides the tools to better understand an individual’s unique way of leading, i.e., one’s leadership signature. Involves intensive self-assessment and interactive exercises aimed to identify the leadership patterns that help and hinder one’s ability to make change happen. Focusses on identifying core leadership strengths and weaknesses, immunity to change, and developing one’s leadership signature. Explores alternative leadership approaches in order to determine capabilities to emulate and plan changes in behavior moving forward. Readings from psychology, family systems, developmental psychology, and leadership literature augment analyses.
_D. Ancona_
15.320 Strategic Organizational Design
Prereq: None
G (Spring)
3-0-6 units

Focuses on effective organizational design in both traditional and innovative organizations, with special emphasis on innovative organizational forms that can provide strategic advantage. Topics include when to use functional, divisional, or matrix organizations; how IT creates new organizational possibilities; examples of innovative organizational possibilities, such as democratic decision-making, crowd-based organizations, and other forms of collective intelligence. Team projects include inventing new possibilities for real organizations.
T. Malone

15.321 Improvisational Leadership: In-the-Moment Leadership Skills
Prereq: None
G (Fall, Spring; second half of term)
3-0-3 units

Designed to provide a practical understanding of the skills of improvisation and their application to leadership. Examines the essential elements of successful leadership, including creativity, emotional intelligence, adaptability, and the capacity to develop effective influence strategies and build strong teams. Cultivates students’ ability to respond to the unexpected with confidence and agility. Each class offers a highly experiential learning laboratory where students practice a wide variety of improvised business scenarios, interactive exercises, and simulations.
D. Giardella

15.322 Leading Organizations
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall; first half of term)
3-0-3 units
Credit cannot also be received for 15.716

Analyzes through lectures, discussions, and class exercises, the human processes underlying organizational behavior. Restricted to Sloan Fellow MBAs.
J. Van Maanen

15.323 Leading from the Middle
Prereq: None
G (Spring; first half of term)
2-0-1 units
Students and Leaders for Global Operations (LGO) alumni develop and present case studies that focus on the challenges and opportunities of leading from positions in the middle of an organization. Restricted to Leaders for Global Operations program students.
L. Hafrey

15.324 Practical leadership
Prereq: None
G (Spring; second half of term)
3-0-3 units
Strengthens leadership capacities through reflection, practice and feedback. Students use readings, role plays, experiential exercises, self-reflection, and reviews of their own videos, as well as focused coaching and feedback, to optimize their own leadership capabilities. Focuses on individual leadership growth. Culminates with submission of a written summary of students’ reflections and experiences around leadership from throughout the term.
P. Bentley

15.325 Seminar in Leadership I
Prereq: None
G (Fall; second half of term)
2-0-1 units
Provides students opportunities to meet senior executives of private and public institutions, and discuss key management issues from the perspective of top management. Students prepare detailed briefings identifying and analyzing important management issues facing these organizations. Restricted to Sloan Fellow MBAs.
Consult Staff

15.326 Seminar in Leadership II
Prereq: 15.325
G (Spring)
2-0-1 units
Continuation of 15.325, providing students opportunities to meet senior executives of private and public institutions, including current or former policymakers, and discuss challenges associated with the management of country and global affairs. Restricted to Sloan Fellow MBAs.
Staff
15.328 Seminar in Organizational Studies
Prereq: None
G (Summer)
Units arranged
Can be repeated for credit.
Group study of current topics related to organizational studies.
Consult D. G. Ancona

15.329 Seminar in Organizational Studies
Prereq: None
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Group study of current topics related to organizational studies.
Consult D. G. Ancona

15.339 Developing Leadership Capabilities
Prereq: None
G (IAP)
2-0-4 units
Focuses on the key leadership capabilities needed in today's increasingly decentralized organizations: sensemaking, relating, visioning, and inventing. Through conceptual discussions, small group exercises, and self-reflection in a workshop setting, students examine a model of leadership, assess their leadership strengths and weaknesses, articulate their values and aspirations, and practice developing leadership capabilities in interaction with class members.
D. Ancona, T. Malone, W. Orlikowski

15.341 Individuals, Groups, and Organizations
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Covers classic and contemporary theories and research related to individuals, groups, and organizations. Designed primarily for doctoral students in the Sloan School of Management who wish to familiarize themselves with research by psychologists, sociologists, and management scholars in the area commonly known as micro organizational behavior. Topics may include motivation, decision making, negotiation, power, influence, group dynamics, and leadership.
J. Curhan

15.342 Organizations and Environments
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Provides an introduction to research in "organizations and environments," an interdisciplinary domain of inquiry drawing primarily from sociology, and secondarily from economics, psychology, and political science. Seeks to understand organizational processes and outcomes in the surrounding economic, cultural, and institutional context in which they are situated. Also provides an introduction to the main groups that together form the Behavioral Policy Sciences (BPS) area of MIT/ Sloan, including economic sociology, organization studies, work and employment, strategic management, global management, and technology, innovation, and entrepreneurship. Consists of four modules taught by faculty from each of the four BPS groups, as well as integrative sessions taught by the main instructor. Preference to first-year doctoral students in BPS.
R. Reagans

15.345 Doctoral Proseminar in Behavioral and Policy Sciences
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-0-4 units
Can be repeated for credit.
A professional seminar for doctoral students to report on their research, work on their thesis proposals, and practice their job talks. Also addresses general professional issues such as publishing, searching for jobs, the academic career, etc.
J. Carroll

15.347 Doctoral Seminar in Research Methods I
Subject meets with 21A.809
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Introduces the process of social research, emphasizing the conceptualization of research choices to ensure validity, relevance, and discovery. Includes research design and techniques of data collection as well as issues in the understanding, analysis, and interpretation of data.
M. Amengual
15.348 Doctoral Seminar in Research Methods II
Prereq: 15.347 or permission of instructor
G (Fall)
3-0-6 units
Builds on 15.347 to examine contemporary social research methods in depth. Focuses on making students familiar with the most important quantitative methods (e.g., logit/probit models, models for ordinal and nominal outcomes, count models, event history models).
E. J. Castilla

15.349[J] Qualitative Research Methods
Same subject as 21A.819[J]
Prereq: Permission of instructor
G (Spring)
3-6-3 units
See description under subject 21A.819[J].
S. Silbey

Technology, Innovation and Entrepreneurship

15.350 Managing Technological Innovation and Entrepreneurship
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-6 units
Focuses on the challenges inherent in attempting to take advantage of both incremental innovation and more radical or breakthrough changes in products, processes and services. Highlights the importance of innovation to both new ventures and to large established firms and explores the organizational, economic and strategic problems that must be tackled to ensure innovation is a long term source of competitive advantage. Discussions and class presentations cover non-technical as well as technology-based innovation. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
Staff

15.351[J] Introduction to Making
Same subject as 2.351[J]
Prereq: Permission of instructor
G (Fall, Spring)
3-0-3 units
Provides basic skills and knowledge with a set of core maker technologies that form a broad foundation for creating prototypes. Fosters an understanding of how to make the abstract concrete. Includes a large experiential component that builds skills in the various elements of making. Enrollment limited; application required.
M. Culpepper, M. Cameron, A. Jay

15.356 Product and Service Development in the Internet Age
Prereq: None
G (Spring; second half of term)
4-0-5 units
Explains both the theory behind novel innovation development methods, and how they can be profitably used in practice. Covers lead user searches, internet-based crowdsourcing, design by customers using innovation toolkits, and more. Includes visits from industry experts who present cases that illustrate the art required to implement each method.
E. A. von Hippel

15.357 Economics of Ideas, Innovation and Entrepreneurship
Prereq: None
G (Fall)
3-0-6 units
Advanced subject in the economics of technological change. Covers the micro-foundations of the knowledge production function (including the role of creativity and the impact of Science), the impact of institutions and strategic interaction on the commercialization of new technology, and the diffusion and welfare impact of ideas and technology. Includes a mixture and explicit comparisons of both theoretical and empirical research. Students should have adequate preparation in microeconomic theory and econometrics. Primarily for PhD students.
P. Azoulay, S. Stern
15.358 Software and Platform Entrepreneurship
Prereq: 15.900 or 15.902
G (Spring)
3-0-6 units
Considers key strategic concepts, especially the distinction between being a product versus a services company, as well as a product versus a platform strategy. Reviews how software became a business (from early developments in services to the emergence of standardized products), and the transition to software as a service, and cloud computing. Studies critical techniques for managing sales and marketing, as well as product development and project management for software products. Examines how the business differs for various platforms - including new and traditional enterprise software, social media, internet video, and mobile competitors - as well as for entrepreneurs competing in these markets. Student teams help teach some weekly sessions and analyze emerging companies and sectors in team projects.
M. A. Cusumano, I. Sayeed

15.359[J] Engineering Innovation: Moving Ideas to Impact
Same subject as 6.901[J]
Prereq: None
U (Fall)
3-3-6 units
Provides students the perspective of a Chief Technology Officer of a start-up, large corporation, or a not-for-profit. Details the innovation process, from an idea's inception through impact in the economy, regardless of organizational setting. Explores how solutions are developed to become ready for broader market deployment. Includes testing and development of the problem-solution fit, probing of solutions for robustness, and testing of both technical and operational scaling of proposed solutions. Examines the human aspects of innovation, specifically issues of team building and readiness. Considers the broader system for innovation, including the role of key stakeholders in shaping its success in order to arrive at an impactful solution. Addresses intellectual property, the effect of regulations and social and cultural differences across varied global markets, and the personal skillset necessary to align and manage these issues.
V. Bulovic, F. Murray

15.360 Introduction to Technological Entrepreneurship
Prereq: Permission of instructor
G (Fall)
2-0-1 units
Provides an overview of entrepreneurial knowledge for founding, developing and growing new enterprises, primarily focused on companies with a technological base. Aimed at students who are enthusiastic about possible careers as entrepreneurs or "joiners" in early-stage firms. Weekly lectures and discussions by academic and practitioner faculty in the MIT Entrepreneurship Program and by leaders of related MIT entrepreneurship activities, e.g., Trust Center for MIT Entrepreneurship, Deshpande Center, and Venture Mentoring Service, as well as by successful entrepreneurs and venture capitalists. Includes student Open Mic presentations and discussion of new business ideas, as well as project study of existing young companies. Enrollment in Silicon Valley Study Tour for the following spring term is required. No listeners; restricted to students in Sloan Entrepreneurship and Innovation (EI) MBA track.
E. Roberts

15.361 Executing Strategy for Results
Prereq: None
G (Fall; first half of term)
Not offered regularly; consult department
3-0-6 units
Credit cannot also be received for 15.711
Provides students an alternative to the mechanistic view of strategy execution that reframes an organization as a complex network of teams continuously adjusting to market conditions and to other teams. Introduces the Flexible Execution Model, consisting of seven elements; strategy for execution, shared context, goals 2.0, resource re-allocation, distributed leaders, top leaders, and execution culture that together shape how well an organization executes its strategy. Discusses a set of practical tools, based on research and field-tested, that help leaders achieve their organizations' strategic priorities. Explores novel ways to use data including surveys, Glassdoor reviews, and other sources to measure strategy execution and identify what is and is not working. Preference given to Master of Business Administration students.
D. Sull
15.363[J] Strategic Decision Making in the Life Sciences
Same subject as HST.971[J]
Prereq: None
G (Spring)
3-0-6 units
Surveys key strategic decisions faced by managers, investors and scientists at each stage in the value chain of the life science industry. Aims to develop students' ability to understand and effectively assess these strategic challenges. Focuses on the biotech sector, with additional examples from the pharmaceutical and medical device sectors. Includes case studies, analytical models, and detailed quantitative analysis. Intended for students interested in building a life science company or working in the sector as a manager, consultant, analyst, or investor. Provides analytical background to the industry for biological and biomedical scientists, engineers and physicians with an interest in understanding the commercial dynamics of the life sciences or the commercial potential of their research.

J. Fleming, A. Zarur

15.364 Regional Entrepreneurship Acceleration Leaders (REAL)
Prereq: None
G (Spring)
3-0-6 units
Credit cannot also be received for 15.364
Aimed at students seeking an action-oriented understanding of innovation ecosystems, such as Silicon Valley, Greater Boston, Singapore, Lagos, and other sites across the globe. Provides a framework for analyzing these critical innovation economies. Outlines the design and delivery of policies and programs (e.g., hackathons, accelerators, prizes, tax policy, immigration policy) intended to accelerate innovation-driven entrepreneurship. Takes a stakeholder perspective to examine the role of large corporations, governments, universities, entrepreneurs, and risk capital providers in innovation-driven entrepreneurship. Focuses especially on ecosystem-based opportunities for corporate innovation and entrepreneurship. Meets with 15.364 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

P. Budden, F. Murray

15.366 Energy Ventures
Prereq: 15.910, (10.807[J] or 15.390), and (22.811[J] or 10.579[J])
G (Fall)
3-0-9 units
Project-based approach to innovation and venture creation in the energy sector. Explores how innovation and entrepreneurial concepts apply (or do not apply) to the significant opportunities in the industry. Working in teams, students create new ventures specifically for the energy sector. Lectures guide teams through key elements of their projects. Concurrent enrollment in 15.933 recommended.

T. Hynes, F. O'Sullivan

15.367[J] Healthcare Ventures
Same subject as HST.978[J]
Prereq: None
G (Spring)
3-0-9 units
See description under subject HST.978[J].

M. Gray, Z. Chu
15.368 Disciplined Entrepreneurship Lab
Prereq: None
G (IAP)
1-0-5 units
Project-based course offering the opportunity to experience startup life in a low stakes environment while contributing strategic value to early-stage ventures. Students secure a startup project of their choice or work with a startup pre-selected by the action learning team. Startups represent a range of industries and, while concentrated in the Boston area, may also come from other parts of the US. Students cannot drop course once project commences.
B. Aulet

15.369 Seminar in Corporate Entrepreneurship
Prereq: 15.310 or 15.311
G (Fall)
3-0-6 units
Addresses the practical steps that can be taken to make existing organizations (corporations, non-profits, government, etc.) become more entrepreneurial. Uses a systematic approach to integrate lectures, exercises, guest speakers, and a team project. Application required.
E. Chen, B. Aulet

15.371 Innovation Teams
Same subject as 10.807
Prereq: None
G (Fall)
4-4-4 units
Introduces skills and capabilities for real-world problem solving to take technology from lab to societal impact: technical and functional exploration, opportunity discovery, market understanding, value economics, scale-up, intellectual property, and communicating/working for impact across disciplines. Students work in multidisciplinary teams formed around MIT research breakthroughs, with extensive in-class coaching and guidance from faculty, lab members, and select mentors. Follows a structured approach to innovating in which everything is a variable and the product, technology, and opportunities for new ventures can be seen as an act of synthesis. Teams gather evidence that permits a fact-based iteration across multiple application domains, markets, functionalities, technologies, and products, leading to a recommendation that maps a space of opportunity and includes actionable next steps to evolve the market and technology.
L. Perez-Breva, D. Hart

15.372 Experimental Innovation Lab
Prereq: None
G (Fall)
Not offered regularly; consult department
3-3-3 units
Develops the skills needed to run randomized experiments (from design through analysis) in business settings in order to help firms innovate and shape their strategy. Provides foundational knowledge related to the basic structure of a good experiment, analysis methods, randomization, and reasons why even well-planned experiments may fail. Working in small teams, students design, run, and present the results of randomized trials with partner companies. Application required.
D. Sull, N. Thompson

15.373 Venture Engineering
Same subject as 2.912, 3.085
Prereq: None
U (Spring)
3-0-9 units
Provides an integrated approach to the development and growth of new innovative ventures. Intended for students who seek to leverage their engineering and science background through innovation-driven entrepreneurship. Emphasizes the concept that innovation-driven entrepreneurs must make a set of interdependent choices under conditions of high uncertainty, and demonstrates that venture engineering involves reducing uncertainty through a structured process of experimental learning and staged commitments. Provides deep understanding of the core technical, customer, and strategic choices and challenges facing start-up innovators, and a synthetic framework for the development and implementation of ventures in dynamic environments.
S. Stern, E. Fitzgerald

15.374 Innovation-Driven Advantage
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-6-3 units
Challenges students to understand what it means for an organization to manage innovation. Subject has four parts: the sources of innovation (from the research lab, to local innovation ecosystems, to open innovation); motivating technical or and/creative professionals (incentives, structure, and culture); organizing the innovation process (from the study of product development processes to R&D portfolios to building an experimental capacity). Includes a team semester-long project. Restricted to MIT Sloan Fellow MBAs.
P. Azoulay
15.375[J] Development Ventures
Same subject as EC.731[J], MAS.665[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject MAS.665[J].
J. Bonsen, A. Pentland, C. Breazeal

15.376[J] Media Ventures
Same subject as MAS.664[J]
Prereq: None
G (Spring)
3-0-6 units
Can be repeated for credit.
See description under subject MAS.664[J].
A. Pentland, J. Bonsen

15.378 Building an Entrepreneurial Venture: Advanced Tools and Techniques
Prereq: Permission of instructor
G (Fall, Spring)
3-1-8 units
Credit cannot also be received for 15.378
Intensive, project-based subject intended for startup teams already working on building a new, high-impact venture. Applies advanced entrepreneurial techniques to build and iterate a venture in a time-compressed manner. Includes weekly coaching sessions with instructors and peers, as well as highly interactive and customized sessions that provide practical, in-depth coverage on key topics in entrepreneurship. Topics include venture creation, primary market research, product development, market adoption, team and culture, and scaling processes with constrained resources. Meets with 15.3781 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details. Application required; consult instructor. No listeners.
C. Chase, K. Arnold, J. Baum

15.3781 Building an Entrepreneurial Venture: Advanced Tools and Techniques
Prereq: 15.3901 or permission of instructor
U (Fall)
Not offered regularly; consult department
3-1-8 units
Credit cannot also be received for 15.378
Intensive, project-based subject intended for startup teams already working on building a new, high-impact venture. Applies advanced entrepreneurial techniques to build and iterate a venture in a time-compressed manner. Includes weekly coaching sessions with instructors and peers, as well as highly interactive and customized sessions that provide practical, in-depth coverage on key topics in entrepreneurship. Topics include venture creation, primary market research, product development, market adoption, team and culture, and scaling processes with constrained resources. Meets with 15.378 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details. Application required; consult instructor. No listeners.
C. Chase, K. Arnold, J. Baum

15.385 Innovating for Impact
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall; first half of term)
3-0-3 units
Provides a structured approach to innovation and entrepreneurship that creates business value while solving social and environmental problems. Covers physical domains of sustainability, e.g., waste, water, food, energy, and mobility, as well as social and human capital domains, such as health and education. Students explore case studies of critical decisions made in the early stages of an enterprise that help determine its impact. Considers perspective and tools applicable to the startup context or to new lines of business in existing enterprises.
J. Jay
15.386 Leading in Ambiguity: Steering Through Strategic Inflection Points
Prereq: None
G (Fall, Spring; second half of term)
3-0-3 units
Develops the skills required to think and lead at the senior, enterprise level of an organization. CEOs and senior leaders from a wide variety of organizations, both public and private, profit and non-profit, large and small, present complex real-life situations. Students are asked to take a position about how they might approach each situation, perhaps using management frameworks they have studied previously. Executives then discuss what they did, or are doing, and reflect on their own journeys as enterprise-level leaders. No listeners.
C. Chilton

15.387 Entrepreneurial Sales
Prereq: None
G (Fall, Spring)
3-0-9 units
Instruction provided in basics of technology sales - making a sales call, designing sales compensation plans, and hiring, managing, and firing sales representatives. Also discusses negotiating large sales transactions, managing international sales organizations, integrating sales teams in acquisitions, and selecting the best go to market model for a company. Considers what comprises a 'startup sales toolkit.'
L. Shipley, K. Arnold, J. Schuchart

15.389 Global Entrepreneurship Lab
Prereq: None
G (Fall, IAP)
3-1-8 units
Experiential study of the climate for innovation and determinants of entrepreneurial success. Students work in teams of four with the top management of a company to address a real world business challenge, gaining insight as to how companies build, run, and scale a new enterprise. Focuses primarily on start-ups operating in emerging markets. Restricted to graduate students.
S. Johnson, M. Jester

15.390 New Enterprises
Prereq: None
G (Fall, Spring)
2-2-8 units
Credit cannot also be received for 15.3901
Covers the process of identifying and quantifying market opportunities, then conceptualizing, planning, and starting a new, technology-based enterprise. Topics include opportunity assessment, the value proposition, the entrepreneur, legal issues, entrepreneurial ethics, the business plan, the founding team, seeking customers and raising funds. Students develop detailed business plans for a start-up. Intended for students who want to start their own business, further develop an existing business, be a member of a management team in a new enterprise, or better understand the entrepreneur and the entrepreneurial process. Meets with 15.3901 when offered concurrently.
B. Aulet, C. Catalini, W. Sanchez

15.3901 New Enterprises
Prereq: None
U (Fall, Spring)
2-2-8 units
Credit cannot also be received for 15.390
Covers the process of identifying and quantifying market opportunities, then conceptualizing, planning, and starting a new, technology-based enterprise. Topics include opportunity assessment, the value proposition, the entrepreneur, legal issues, entrepreneurial ethics, the business plan, the founding team, seeking customers and raising funds. Students develop detailed business plans for a start-up. Intended for students who want to start their own business, further develop an existing business, be a member of a management team in a new enterprise, or better understand the entrepreneur and the entrepreneurial process. Meets with 15.390 when offered concurrently. Students taking graduate version complete additional assignments.
B. Aulet, C. Catalini, W. Sanchez

15.392 Scaling Entrepreneurial Ventures
Prereq: 10.807[J] or 15.390
G (Spring; first half of term)
3-0-3 units
Surveys the personal, institutional and operational challenges involved in scaling an entrepreneurial venture. Discusses both effective and ineffective solutions. Addresses topics such as leadership, culture, operations, governance, and human resources. Includes case studies, site visits, movies, simulations and guest speakers.
E. Cohen, B. Halligan
15.393 The Nuts and Bolts of New Ventures
Prereq: None
G (IAP)
1-0-2 units

Designed to foster an understanding of how to start a new venture (for-profit and social/development). Details the process from an idea’s inception to the development of a successful new venture to deliver products and services enabled by the idea. Explores customer identification, the business/economic models, financial projections, legal and operational issues, and financing alternatives and sources. All sessions taught by persons who have actually launched or have been involved in successful ventures.

J. Hadzima

15.394 Entrepreneurial Founding and Teams
Prereq: None
G (Spring)
3-0-6 units
Credit cannot also be received for 15.394

Explores key organizational and strategic decisions in founding and building a new venture. Through a series of cases, readings, and activities, students examine the trade-offs and consequences of early founder decisions: whom to include in the founding team, how to allocate equity among co-founders, how to determine founder roles, how to hire and motivate early-employees, and whether to involve external investors. Aims to equip students with tools and frameworks to help them understand the implications of early decisions, and to build enduring resources that enable the venture to execute even if the original plan changes substantially. Meets with 15.394 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

K. Hickey, E. Scott

15.3941 Entrepreneurial Founding and Teams
Prereq: None
U (Spring)
3-0-6 units
Credit cannot also be received for 15.394

Explores key organizational and strategic decisions in founding and building a new venture. Through a series of cases, readings, and activities, students examine the trade-offs and consequences of early founder decisions: whom to include in the founding team, how to allocate equity among co-founders, how to determine founder roles, how to hire and motivate early-employees, and whether to involve external investors. Aims to equip students with tools and frameworks to help them understand the implications of early decisions, and to build enduring resources that enable the venture to execute even if the original plan changes substantially. Meets with 15.394 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

K. Hickey, E. Scott

15.395 Entrepreneurship Without Borders
Prereq: None
G (Fall; first half of term)
Not offered regularly; consult department
3-0-3 units

Examines opportunities and problems for entrepreneurs globally, including Europe, Latin America, and Asia. Covers linkages between the business environment, the institutional framework, and new venture creation. Special focus on blockchain technology. In addition to discussing a range of global entrepreneurial situations, student groups pick one particular cluster on which to focus and to understand what further development would entail. Classroom interactions based primarily on case studies.

S. Johnson

15.396 Seminar in Entrepreneurship
Prereq: None
G (Spring)
Not offered regularly; consult department
Units arranged

Group study of current topics related to entrepreneurship.

W. Aulet
15.397 Seminar in Entrepreneurship
Prereq: None
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Group study of current topics related to high-tech entrepreneurship.
*Staff*

15.398 Corporations at the Crossroads: The CEO Perspective
Prereq: None
G (Spring)
2-0-4 units

Focuses on the role of the CEO and the need, as leader, to successfully navigate crossroads (often created by new technologies). Provides a unique opportunity for students to interact with some of the world’s leading CEOs who are invited to participate in each class. The CEOs offer advice and answer questions related to topics such as the responsibilities of the CEO, corporate strategy, career learnings, and advice.
*P. Kurzina*

15.399 Entrepreneurship Lab
Prereq: None
G (Fall, Spring)
2-9-1 units

Credit cannot also be received for 15.399

Project-based subject, in which teams of students from MIT and Harvard work with startups on problems of strategic importance to the venture. Popular sectors include software, hardware, robotics, clean technology, and life sciences. Meets with 15.399 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details. In addition to the regular MIT registration process, students should register at the subject website one month before start of term to facilitate formation of student teams and matching of teams with startup companies.
*C. Catalini, J. Dougherty*

15.3991 Entrepreneurship Lab
Prereq: None
U (Fall, Spring)
2-9-1 units

Credit cannot also be received for 15.399

Project-based subject, in which teams of students from MIT and Harvard work with startups on problems of strategic importance to the venture. Popular sectors include software, hardware, robotics, clean technology, and life sciences. Meets with 15.399 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details. In addition to the regular MIT registration process, students should register at the subject website one month before start of term to facilitate formation of student teams and matching of teams with startup companies.
*C. Catalini, J. Dougherty*

Finance

15.401 Managerial Finance
Prereq: None
G (Fall, Spring)
4-0-5 units

Introduction to finance from the perspective of businesspeople and finance professionals. Designed to build effective decision-making skills based on sound financial knowledge, focusing on areas such as day-to-day operational issues, launching a startup, or negotiating option bonuses. Provides a firm grounding in the modern financial analysis underlying any decision, through three core themes: determining the value of a project, deciding how to finance a project, and managing its risk. Students also hone their ability to negotiate skillfully and speak intelligently about finance. Meets with 15.417 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
*Consult K. Nixon*
15.402 Corporate Finance
Prereq: 15.401
G (Fall, Spring)
3-0-6 units
Credit cannot also be received for 15.418
Provides instruction in the tools and techniques of corporate financial management, from the perspective of the CFO. Primarily uses case studies to present the financial tools needed to make value-enhancing business decisions: how to decide which projects to invest in, how to finance those investments, and how to manage the cash flows of the firm. Topics include capital budgeting, investment decisions and valuation; working capital management, security issues; dividend policy; optimal capital structure; and real options analysis. Meets with 15.418 when offered concurrently.
A. Malenko, C. Palmer

15.403 Introduction to the Practice of Finance
Prereq: None
G (Fall)
2-0-1 units
Explores various elements of the finance industry, from private equity to public policy, FinTech to social impact, investment banking to investment management, corporate finance to venture capital. Students engage with industry professionals about the challenges they face and how their part of the industry is changing. They also network with peers to discover the challenges and rewards associated with various careers, and explore how coursework connects with industry practice. Restricted to first year MBA students in the Finance Track.
Staff

15.414 Financial Management
Prereq: 15.511
G (Fall)
3-0-6 units
Credit cannot also be received for 15.724
Provides a rigorous introduction to corporate finance and capital markets, with an emphasis on applications vital to corporate managers. Exposes students to the major financial decisions made by leaders within a firm and to the ways the firm interacts with investors, with a focus on valuation. Topics include project and company valuation, measuring risk and return, stock pricing, corporate financing policy, the cost of capital, and risk management. Presents a broad overview of both theory and practice. Restricted to Sloan Fellow MBAs.
Staff

15.415 Finance Theory
Prereq: None
G (Summer)
6-0-9 units
Core theory of capital markets and corporate finance. Topics include functions and operations of capital markets, analysis of consumption-investment decisions of investors, valuation theory, financial securities, risk analysis, portfolio theory, pricing models of risky assets, theory of efficient markets, as well as investment, financing and risk management decisions of firms. Provides a theoretical foundation of finance and its applications. Restricted to students in the Master of Finance Program.
L. Kogan, J. Wang

15.417 Laboratory in Investments
Prereq: None
U (Spring)
3-3-9 units. Institute LAB
Provides a firm grounding in modern financial analysis: determining the value of a decision, deciding how to finance a project, and assessing its risk. Lab component introduces modern quantitative finance practices and methods used by investment managers. Through team projects, students develop and test asset-pricing models and investment strategies using real-world market data. Provides instruction in writing and speaking from a financial perspective.
P. Mende

15.418 Laboratory in Corporate Finance
Prereq: None. Coreq: 15.501
U (Fall)
4-2-9 units. Institute LAB
Credit cannot also be received for 15.402
Provides instruction in the tools and techniques of corporate financial management, from the perspective of the CFO. Covers capital budgeting, investment decisions and valuation; working capital management, security issues; dividend policy; optimal capital structure; and real options analysis. Lab component puts theory into practice through hands-on projects - students either conduct an event study and analyze its impact on firm capital market value, or conduct a merger model between two firms of their choosing. Emphasizes use of research databases to test hypotheses. Provides instruction in writing and speaking from a financial perspective. Meets with 15.402 when offered concurrently.
S. Myers
15.425 Corporate Finance
Prereq: 15.415
G (Fall)
3-0-6 units

Foundational, applied course providing instruction in the tools and techniques of corporate financial management from the perspective of the CFO. Case studies present the financial tools needed to make value-enhancing business decisions: how to decide which projects to invest in, how to finance those investments, and how to manage the cash flows of the firm. Topics include capital budgeting, investment decisions and valuation; working capital management, security issues; dividend policy; optimal capital structure; and real options analysis. Restricted to students in the Master of Finance Program.
D. Thesmar

15.426[J] Real Estate Finance and Investment
Same subject as 11.431[J]
Prereq: Permission of instructor
G (Fall)
4-0-8 units

See description under subject 11.431[J]. Limited to graduate students.
D. Geltner

15.427[J] Real Estate Capital Markets
Same subject as 11.432[J]
Prereq: 11.431[J] and (15.402 or 15.414)
G (Spring; first half of term)
2-0-4 units

See description under subject 11.432[J].
D. Geltner

15.428[J] Tools for Analysis: Design for Real Estate and Infrastructure Development
Same subject as 11.434[J], IDS.720[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units

See description under subject 11.434[J].
D. Geltner, R. de Neufville

15.429[J] Securitization of Mortgages and Other Assets
Same subject as 11.353[J]
Prereq: 11.431[J], 15.401, or permission of instructor
G (Spring)
3-0-6 units

Investigates the economics and finance of securitization. Considers the basic mechanics of structuring deals for various asset-backed securities. Investigates the pricing of pooled assets, using Monte Carlo and other option pricing techniques, as well as various trading strategies used in these markets.
W. Torous

15.431 Entrepreneurial Finance and Venture Capital
Prereq: 15.402, 15.414, or 15.415
G (Fall)
3-0-6 units
Credit cannot also be received for 15.4311, 15.719

Examines the elements of entrepreneurial finance, focusing on technology-based start-up ventures, and the early stages of company development. Addresses key questions which challenge all entrepreneurs: how much money can and should be raised; when should it be raised and from whom; what is a reasonable valuation of a company; and how funding, employment contracts and exit decisions should be structured. Aims to prepare students for these decisions, both as entrepreneurs and venture capitalists. In-depth analysis of the structure of the private equity industry. Meets with 15.431 when offered concurrently. Expectations and evaluation criteria for graduate students will differ from those of undergraduates; consult syllabus or instructor for specific details.
M. Rhodes-Kropf, A. Schoar

15.4311 Entrepreneurial Finance and Venture Capital
Prereq: None
U (Fall, Spring)
3-0-6 units
Credit cannot also be received for 15.431, 15.719

Examines the elements of entrepreneurial finance, focusing on technology-based start-up ventures, and the early stages of company development. Addresses key questions which challenge all entrepreneurs: how much money can and should be raised; when should it be raised and from whom; what is a reasonable valuation of a company; and how funding, employment contracts and exit decisions should be structured. Aims to prepare students for these decisions, both as entrepreneurs and venture capitalists. In-depth analysis of the structure of the private equity industry. Meets with 15.431 when offered concurrently. Expectations and evaluation criteria for graduate students will differ from those of undergraduates; consult syllabus or instructor for specific details.
Staff
15.433 Financial Markets
Subject meets with 15.4331
Prereq: 15.401, 15.414, or 15.415
G (Fall)
3-0-6 units

Provides students with a solid understanding of key financial markets and the empirical skills and tools used to support decision making. Employs an in-depth, empirically-driven exploration of markets, including equity, fixed income, and derivatives. Students apply real-world financial data to test and understand financial models, focusing on key risk factors and risk management concerns in these markets, along with the quantitative tools used to analyze risk. Discusses major institutions and players involved in each market, the evolution of the markets, and issues such as liquidity. Meets with 15.4331 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

Staff

15.4331 Financial Markets
Subject meets with 15.433
Prereq: 15.417
U (Fall)
3-0-6 units

Provides students with a solid understanding of key financial markets and the empirical skills and tools used to support decision making. Employs an in-depth, empirically-driven exploration of markets, including equity, fixed income, and derivatives. Students apply real-world financial data to test and understand financial models, focusing on key risk factors and risk management concerns in these markets, along with the quantitative tools used to analyze risk. Discusses major institutions and players involved in each market, the evolution of the markets, and issues such as liquidity. Meets with 15.433 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details. Preference to Course 15 students.

Staff

15.434 Advanced Corporate Finance
Prereq: 15.402, 15.414, or 15.415
G (Fall)
3-0-6 units
Credit cannot also be received for 15.4341

In-depth application of tools and techniques of corporate financial management. Provides exposure to unique situations faced by modern CFOs that demand a higher level of acumen. Covers complex valuations, static and dynamic capital structure, risk management, and real options. Also considers security design, restructuring, bankruptcy, project financing, corporate control and governance, dividend policy, and international finance issues. Meets with 15.4341 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

Staff

15.4341 Advanced Corporate Finance
Prereq: 15.418
U (Fall)
3-0-6 units
Credit cannot also be received for 15.434

In-depth application of tools and techniques of corporate financial management. Provides exposure to unique situations faced by modern CFOs that demand a higher level of acumen. Covers complex valuations, static and dynamic capital structure, risk management, and real options. Also considers security design, restructuring, bankruptcy, project financing, corporate control and governance, dividend policy, and international finance issues. Meets with 15.434 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.

Staff
15.436 Corporate Financial Strategy
Prereq: 15.402 or 15.414
G (Fall, Spring)
3-0-6 units
Case-based subject that bridges theory and practice in corporate finance, exploring the connection between finance and strategy. Covers a range of transactions and financial engineering steps used by companies to pursue their strategic goals, such as carve-outs, spin-offs and related tools to break up and refocus business assets; special purpose vehicles to raise non-traditional capital and reconfigure corporate assets and operations; diversification as a financial strategy; companies with control setups, such as dual class shares; security issuance decisions; and recapitalizations and strategic use of debt leverage. Students work in study groups to complete regular homework assignments and prepare for class discussion. 15.434 recommended.
N. Gregory

15.437 Options and Futures Markets
Prereq: 15.401, 15.414, or 15.415
G (Spring)
3-0-6 units
Credit cannot also be received for 15.437
Students develop the economic intuition and technical skills necessary to understand how to use derivatives for investment and risk management purposes, and how to hedge and price them. Topics include determinants of forward and futures prices, hedging and synthetic asset creation with futures, uses of options in investment strategies, relation between bets and calls, option valuation using binomial trees and Monte Carlo simulation, advanced hedging techniques, exotic options, and applications to corporate securities and other financial instruments. Meets with 15.437 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
D. Lucas

15.4371 Options and Futures Markets
Prereq: 15.417
U (Spring)
3-0-6 units
Credit cannot also be received for 15.437
Students develop the economic intuition and technical skills necessary to understand how to use derivatives for investment and risk management purposes, and how to hedge and price them. Topics include determinants of forward and futures prices, hedging and synthetic asset creation with futures, uses of options in investment strategies, relation between puts and calls, option valuation using binomial trees and Monte Carlo simulation, advanced hedging techniques, exotic options, and applications to corporate securities and other financial instruments. Meets with 15.437 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
D. Lucas

15.438 Fixed Income Securities and Derivatives
Prereq: 15.401, 15.414, or 15.415
G (Spring)
3-0-6 units
Develops an overall familiarity with fixed income markets and instruments, and a sophisticated understanding of tools for valuation, and for quantifying, hedging, and speculating on risk. Topics include duration; convexity; modern approaches to modeling the yield curve; interest rate forwards, futures, swaps and options; credit risk and credit derivatives; mortgages; securitization; and public policy and regulation. 15.437 strongly recommended.
D. Lucas

15.439 Investment Management
Prereq: 15.401, 15.414, or 15.415
G (Spring)
3-0-6 units
Focuses on implementing successful investment strategies - blending academic finance with the practice of investment management employed by the world’s most sophisticated (quantitative) investors. Covers the dynamics of behavioral finance and their effects on markets; investment strategies in current use, and how to build and test your own quantitative strategies; portfolio construction and trading, considering transaction costs, risk management, and efficient trade execution; and current trends and regulatory changes. Includes guest lecturers. Requires an understanding of basic statistical and financial concepts.
M. Rothman
15.444 International Corporate Finance  
Prereq: 15.402, 15.414, or 15.415  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-6 units  
Addresses issues relating to valuation, risk management, financing and contractual design for firms operating in international markets, providing exposure to emerging markets. Students analyze how risk and cash flows should be evaluated in environments with varying levels of risk, such as currency fluctuation, sovereign default, weak property rights, etc. Discusses how certain types of risk can be eliminated or managed through the appropriate design of financial contracts, and how institutional differences across countries shape the structure and efficacy of private equity contracts. Other topics include firm policy and international tax regimes, microfinance, and valuing social return. Concludes with a discussion on the impact of global financial crises on firm financial policy.  
Staff

15.445 Mergers, Acquisitions and Private Equity  
Prereq: 15.515 or 15.516; Coreq: 15.402, 15.414, or 15.415  
G (Spring)  
3-0-6 units  
Credit cannot also be received for 15.4451  
Uses case studies to explore the financial aspects of a wide range of corporate mergers and buyout transactions: classic stock and cash mergers; minority squeeze-outs; company sale process and auction design; hostile takeover law and strategy; the structuring, financing and valuation of leveraged buyouts; the structure, history and returns of private equity buyout funds; publicly traded private equity firms; and more. Includes guest lectures on the practices and tools used in private equity and M&A. Students participate in group work, both in and out of class, including a full-term project involving the mock sale of a company. Meets with 15.445 when offered concurrently. Expectations and evaluation criteria for graduate students will differ from those of undergraduates; consult syllabus or instructor for specific details.  
N. Gregory

15.447 International Capital Markets  
Prereq: 15.401, 15.414, or 15.415  
G (Spring)  
3-0-6 units  
Provides a strategic framework for current and future finance leaders - with domestic or multinational startups, established companies, investment banks or asset management firms - for investing and operating in international capital markets. Includes currency markets; measuring and managing exchange rate exposure; exchange rate determination and forecasting; international financial instruments and institutions; international trading strategies; and the dynamics of global financial crises. Incorporates real-world events into interactive discussions.  
J. Parker

15.448-15.449 Seminar in Finance  
Prereq: None  
G (Fall)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Group study of current topics related to finance.  
Staff
15.450 Analytics of Finance
Prereq: 15.401, 15.414, or 15.415
G (Spring)
5-0-7 units
Credit cannot also be received for 15.457

Increased data availability and complexity creates the need for finance professionals who can work with data and can separate insights from noise. Introduces a set of modern analytical tools that specifically target finance applications. Exposure to statistical inference; financial time series; event study analysis; basic machine learning techniques for forecasting and working with big data. Aims to build operational models, take them to the data, and use real world data to build models for financial and macro forecasting, quantitative trading, and dynamic risk management. Looks behind the curtain of some fintech innovations, such as Kensho's "financial answer machine" and big-data lending platforms. (Note: 15.457 is a more advanced version of 15.450. Students with solid background in statistics and proficient in programming are encouraged to take 15.457.)

H. Chen

15.451 Proseminar in Capital Markets/Investment Management
Prereq: 15.401, 15.414, or 15.415
G (Fall)
2-0-4 units

Provides a unique opportunity to tackle original research problems in capital market analysis and investment management that have been posed by leading experts from the financial community. Students are assigned to teams, and each team is assigned one such problem. Teams present their solutions at a seminar which is attended by representatives of the sponsoring organization and open to the entire MIT community. Not open to students from other institutions.

M. Kritzman

15.452 Proseminar in Corporate Finance/Investment Banking
Prereq: 15.402, 15.414, or 15.415
G (Fall)
3-0-3 units

Action learning experience provides an opportunity to bring theory into practice by tackling problems provided by executives in corporate finance or investment banking. Students work in multidisciplinary teams (combining MFin, MBA, and Sloan Fellows) to analyze and problem-solve, culminating in reports which the teams present in a group setting for evaluation and feedback. Tests and hones skills at capturing the core of a real-world finance problem and developing a creative and insightful solution that is sensitive to the full context. Students build key communication skills, presenting difficult concepts clearly, concisely, and persuasively. Not open to students from other institutions.

Staff

15.453 Finance Research Practicum
Prereq: 15.401, 15.414, or 15.415
G (IAP, Spring; first half of term)
3-0-6 units

Bridges theory and practice, providing students with an immersive research and analysis experience during IAP followed by a classroom segment in the first half of spring term. Students work with leading industry practitioners and a diverse cross-section of students on collaborative teams, focusing on topical, real-world finance research questions posed by the practitioners. Teams then deliver a nuanced analysis and report findings, gaining insight and coaching from the experts. Practitioners represent a range of financial institutions, including investment management, hedge funds, private equity, venture capital, risk, and consulting. Examples of project topics include equity and fixed income research, trading, risk analysis, venture capital valuation, private equity due diligence, and fundamental industry analysis. Application required; restricted to MIT students.

G. Rao

15.454 Financial Mathematics
Prereq: None
G (Summer)
3-0-3 units

Covers fundamental mathematics essential for the study of modern finance: probability, stochastic processes, linear algebra, statistics, optimization, and basic programming in R. Restricted to students in the Master of Finance Program.

Staff
15.455 Advanced Mathematical Methods for Financial Engineering
Prereq: None
G (Summer)
3-0-3 units
Covers advanced mathematical topics essential for financial engineering and quantitative finance: linear algebra, optimization, probability, stochastic processes, statistics, and basic programming in R. Covers topics at a more advanced level and at a faster pace than 15.454. Restricted to students in the Master of Finance Program.

P. Mende

15.456 Financial Engineering
Prereq: 15.401, 15.414, or 15.415
G (Fall)
4-0-5 units
Exposes students to the cutting edge of financial engineering. Includes a deep immersion into 'how things work,' where students develop and test sophisticated computational models and solve highly complex financial problems. Covers stochastic modeling, dynamic optimization, stochastic calculus and Monte Carlo simulation through topics such as dynamic asset pricing and investment management, market equilibrium and portfolio choice with frictions and constraints, and risk management. Assumes solid undergraduate-level background in calculus, probability, statistics, and programming and includes a substantial coding component. Students are encouraged but not required to use R for coursework.

L. Kogan, J. Wang

15.457 Advanced Analytics of Finance
Prereq: 15.401, 15.414, or 15.415
G (Spring)
5-0-7 units
Credit cannot also be received for 15.450
Introduces a set of modern analytical tools that specifically target finance applications. Provides exposure to statistical inference, financial time series, event study analysis, and basic machine learning techniques for forecasting and working with big data. Aims to build operational models, take them to the data, and use real world data to build models for financial and macro forecasting, quantitative trading, and dynamic risk management. In-depth exploration of fintech innovations, such as Kensho's "financial answer machine" and big-data lending platforms. 15.457 is a more advanced version of 15.450. Students with solid background in statistics and proficiency in programming are encouraged to register for 15.457.

H. Chen

15.458 Financial Data Science and Computing I
Prereq: 15.401, 15.414, or 15.415
G (Fall; first half of term)
3-0-3 units
First in a two-course sequence that covers methods of managing and extracting information from financial data. Topics include the basics of statistical inference and hypothesis testing, regression models, and time series modeling applied to financial data. Studies major sources of financial data, raw data cleaning, data visualization and communication. Emphasizes computer implementations (in R) throughout.

P. Mende

15.459 Financial Data Science and Computing II
Prereq: 15.458 or permission of instructor
G (Fall; second half of term)
3-0-3 units
Building on 15.458, provides an overview of data technologies, financial data architecture and design, data management tools, web scraping, and how to work with "Big Data" and textual data. Students use R, SQL, Bloomberg, Access, Excel, and other tools to develop data-driven analysis and applications.

P. Mende

15.466 Functional and Strategic Finance
Prereq: 15.433 or 15.437
G (Spring)
3-0-6 units
Ideal for students pursuing careers in financial-services, banking, the public-sector (central banks, ministries of finance) and academics. Applies finance science and financial engineering tools and theory to the design and management of global financial institutions, markets, and the financial system to better understand the dynamics of institutional change and financial product/service design. Focuses on foundational analytical tools students will rely upon throughout their careers - derivative pricing and risk measurement; portfolio analysis and risk accounting; and performance measurement to analyze and implement concepts and new product ideas. Examines the needs of government as user, producer and overseer of the financial system, and how tools are applied to measure and manage risks in financial crises (e.g., 1973-1975 vs. 2007-2009). A high comfort level working through rigorous mathematical analyses is recommended. Preference to MBA and MFin students.

R. Merton
15.467 Asset Management, Lifecycle Investing, and Retirement Finance
Prereq: 15.433
G (Spring)
3-0-6 units
Built for students focused on financial services careers - professional asset management, financial product design, trading, sales, consulting, or regulatory oversight of the financial industry. Applies finance science and financial engineering tools and theory to asset management, lifecycle investing, and retirement finance. Focuses on foundational analytical tools students will rely upon throughout their careers - derivative pricing and risk measurement, portfolio analysis and risk accounting, and performance measurement to analyze and implement concepts and new product ideas. Students should be familiar with basic portfolio-selection theory, CAPM, options, futures, swaps and other derivative securities. Preference to MBA and MFin students.
R. Merton

15.470[J] Asset Pricing
Same subject as 14.416[J]
Prereq: None
G (Fall)
4-0-8 units
L. Kogan, L. Schmidt

15.471[J] Corporate Finance
Same subject as 14.441[J]
Prereq: None
G (Spring)
3-0-9 units
Provides an introduction to the basic theoretical and empirical contributions in corporate finance. Exposes students to the key methodological tools in modern corporate finance. Covers capital structure, corporate governance, agency problems, incomplete financial contracting, the market for corporate control, product market corporate finance interactions, corporate reorganization and bankruptcy, banking, and other selected topics. Primarily for doctoral students in finance, economics, and accounting.
A. Schoar, D. Thesmar

15.472[J] Advanced Asset Pricing
Same subject as 14.442[J]
Prereq: None
G (Fall)
3-0-9 units
Focuses on solution, evaluation, and estimation of theories of asset prices and financial markets and their macro- and micro-economic foundations. Discusses theory and econometric methods, the state of the literature, and recent developments. Covers topics such as cross-sectional and time-series models, consumption-based models, financial institutions, household finance, housing, behavioral finance, and financial crises. Students complete a term paper and presentation. Primarily for doctoral students in finance, economics, and accounting.
D. Greenwald

15.473[J] Advanced Corporate Finance
Same subject as 14.440[J]
Prereq: None
G (Spring)
3-0-9 units
This course builds on 15.471[J] and considers further topics that are at the frontier of corporate finance research. Topics covered include: structural estimation of corporate finance models, financial intermediation, corporate taxation, aggregate effects of financing frictions, corporate finance with irrational managers or irrational investors and entrepreneurial finance (young firm dynamics, venture capital and private equity). Primarily for doctoral students in finance, economics, and accounting.
D. Thesmar, A. Schoar

15.474[J] Current Topics in Finance
Same subject as 14.448[J]
Prereq: None
G (Spring)
3-0-9 units
Covers a series of advanced topics in finance. Topics are selected at the discretion of the instructors, in line with their current research. Provides a rapid overview of the literature, an in-depth presentation of selected contributions, and a list of potential research topics. Primarily for doctoral students in accounting, economics, and finance.
A. Malenko, C. Palmer, L. Schmidt, A. Verdelhan
15.475[J] Current Research in Financial Economics

Same subject as 14.449[J]
Prereq: Permission of instructor
G (Fall, Spring)
3-0-3 units

Advanced seminar intended for PhD students in finance. Covers advanced topics - methodological, theoretical, and empirical - and focuses on training students to produce advanced research in finance. Critically reviews the contributions, method of analysis, and presentation of evidence of existing research through reading, presentation, and observation, with the goal of highlighting potential dissertation projects. Topics and papers vary by term, following the latest research in academia. Restricted to doctoral students.

Staff

15.480[J] Science and Business of Biotechnology

Same subject as 7.546[J], 20.586[J]
Prereq: None. Coreq: 15.401; permission of instructor
G (Spring)
3-0-6 units

Covers the new types of drugs and other therapeutics in current practice and under development, the financing and business structures of early-stage biotechnology companies, and the evaluation of their risk/reward profiles. Includes a series of live case studies with industry leaders of both established and emerging biotechnology companies as guest speakers, focusing on the underlying science and engineering as well as core financing and business issues. Students must possess a basic background in cellular and molecular biology.

A. Lo, H. Lodish

15.481[J] Financial Market Dynamics and Human Behavior

Same subject as 6.935[J]
Prereq: 15.401, 15.414, or 15.415
G (Spring)
4-0-5 units

Gives students a complete understanding of financial markets. Draws on the latest research in psychology, evolutionary biology, and artificial intelligence, as well as in financial economics, to provide new perspectives and insights into the role that human behavior plays in the business environment and the dynamics of financial markets and institutions. Incorporates practical applications from financial markets, the hedge fund industry, private equity, government regulation, and political economy. Students use ideas from this new perspective to formulate original hypotheses regarding real-world challenges involving investment and business strategies, risk management, financial crises, and corporate ethics.

A. Lo

15.482 Healthcare Finance

Prereq: 15.401, 15.414, 15.415, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-6 units

Financial tools and techniques may one day help unlock solutions to some of humanity's most significant healthcare challenges. Covers the role of finance in the healthcare industry; specifically, the application of novel financing methods and business structures to facilitate drug discovery, clinical development, and greater patient access to high-cost therapies. Topics include basic financial analysis for the life-sciences professional; risks and returns in the biotech and pharmaceutical industries; the mechanics of biotech startup financing; capital budgeting for pharmaceutical companies; and applications of financial engineering in modern healthcare investment strategies and institutions. Develops a systemic framework for problem-solving when daunting business issues stand in the way of progress in healthcare.

A. Lo

15.483 Consumer Finance: Markets, Product Design, and FinTech

Prereq: 15.401, 15.414, or 15.415
G (Spring; first half of term)
3-0-3 units

Provides a solid understanding of consumer decision-making and how new products and services are developed, especially given the rapid pace of innovation and regulatory change, to help students succeed in consumer finance today. Covers rational and behavioral aspects of consumer financial decision making; current household financial products and competitive landscape in credit, investment, and advising markets; consumer financial product innovations and regulatory issues; securitization, and the development of financial products derived from consumer debt (e.g., mortgages, credit card receivables, and student loans). A combination of case studies, guest speakers and group discussion provide real-world insight and interactivity, while special review sessions help hone technical skills.

J. Parker

15.493 Practice of Finance: Perspectives on Investment Management

Prereq: 15.402, 15.414, or 15.415
G (Fall, Spring; second half of term)
3-0-3 units

Provides an overview of the investment management industry and an introduction to business fundamentals and valuation. Students read company analyst reports, write papers analyzing various companies, and complete an in-depth company analysis as a final paper. Includes presentations by outside speakers in the investment management industry. Class attendance is mandatory.

J. Shames
15.496 Practice of Finance: Data Technologies for Quantitative Finance
Prereq: 15.401, 15.414, or 15.415
G (Fall)
Not offered regularly; consult department
4-0-5 units
Introduces students to financial market data and to data architecture and design, with applications to asset pricing, quantitative investment strategies, algorithmic trading, portfolio management, and risk management. Studies how data relationships are structured and how to use modern tools and technologies to manipulate, manage, and analyze large-scale financial data sets. Uses real-world data, applications, and cases to illustrate principles and provide practical experience.
P. Mende

15.497 FinTech Ventures
Prereq: None
G (Fall)
3-0-6 units
Designed for entrepreneurial types interested in the FinTech space, this course presents a unique opportunity to work through the nuts and bolts of developing, investing in or acquiring a FinTech startup. Bring your idea and/or team, or find both at class and develop your plan for the final “Demo Day” in front of a group of investors. In each class a new speaker (entrepreneurs, legal experts, venture capitalists) is welcomed who addresses relevant topics, while students present progress reports and receive advice and feedback. Students with an interest in being part of a FinTech startup, regardless of background (legal, financial, computer science, operations, etc.) should apply, individually or as part of a team. JD students from Harvard Law School and technical students from MIT are encouraged to apply. Enrollment by application only. Consult R. Kissinger

15.499 Practice of Finance: Social Impact Investing
Prereq: 15.401, 15.414, or 15.415
G (Spring; second half of term)
2-0-4 units
Provides an introduction to social impact investing - an investment approach intentionally seeking to create both financial return and positive social impact that is actively measured. Aims to provide a solid analytical framework for evaluating the spectrum of social impact investments. Students will gain experience in structuring different types of investments, and critically compare and contrast these investments with traditional mainstream investments, with a view to understanding structural constraints.
G. Rao

Accounting

15.501 Corporate Financial Accounting
Prereq: None
U (Fall, Spring)
3-0-9 units
Credit cannot also be received for 15.516
Preparation and analysis of financial statements. Focuses on why financial statements take the form they do, and how they can be used in evaluating corporate performance and solvency and in valuation of corporate securities. Introduces concepts from finance and economics (e.g., cash flow discounting and valuation) and explains their relation to, and use in, accounting. Students taking the graduate version complete additional assignments. Permission of Sloan Educational Services required for all cross-registrants. Staff

15.511 Financial Accounting
Prereq: Permission of instructor
G (Summer)
3-0-6 units
Credit cannot also be received for 15.515, 15.720
Introduces concepts of corporate financial accounting and reporting of information widely used in making investment decisions, corporate and managerial performance assessment, and valuation of firms. Students perform economics-based analysis of accounting information from the viewpoint of the user (especially senior managers) rather than the preparer (the accountant). Restricted to Sloan Fellow MBAs.
J. Weber

15.515 Financial Accounting
Prereq: Permission of instructor
G (Fall)
4-0-5 units
Credit cannot also be received for 15.511, 15.720
An intensive introduction to the interpretation of financial information. Adopts a decision-maker perspective of accounting by emphasizing the relation between accounting data and the underlying economic events generating them. Class sessions are a mixture of lecture and case discussion. Assignments include textbook problems, analysis of financial statements, and cases. Restricted to first-year Sloan master’s students.
J. Core, R. Verdi
15.516 Corporate Financial Accounting
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-0-9 units
Credit cannot also be received for 15.501
See description under subject 15.501. If subject is oversubscribed, priority is given to Course 15 students.

15.518 Taxes and Business Strategy
Prereq: 15.501, 15.511, 15.515, or 15.516
G (Spring)
3-0-6 units
Credit cannot also be received for 15.518
Provides conceptual framework for thinking about taxation and decision-making. Topics include taxation of various investments and types of compensation; retirement planning; considerations for choosing organizational form when starting a business; methods of merging, acquiring, divesting business entities; international tax planning strategies; and high wealth planning and estate tax. Applies current debates on tax policy options and recent tax law changes to class discussions. Intended to show how taxes affect individual investment as well as business decisions. Meets with 15.5181 when offered concurrently. Expectations and evaluation criteria for graduate students will differ from those of undergraduates; consult syllabus or instructor for specific details.
M. Hanlon

15.5181 Taxes and Business Strategy
Prereq: 15.501
U (Spring)
3-0-6 units
Credit cannot also be received for 15.518
Provides conceptual framework for thinking about taxation and decision-making. Topics include taxation of various investments and types of compensation; retirement planning; considerations for choosing organizational form when starting a business; methods of merging, acquiring, divesting business entities; international tax planning strategies; and high wealth planning and estate tax. Applies current debates on tax policy options and recent tax law changes to class discussions. Intended to show how taxes affect individual investment as well as business decisions. Meets with 15.518 when offered concurrently. Expectations and evaluation criteria for graduate students will differ from those of undergraduates; consult syllabus or instructor for specific details.
M. Hanlon

15.521 Accounting Information for Decision Makers
Prereq: None
G (Fall, Spring; first half of term)
3-0-3 units
Focuses on how organizations use granular-level information from their accounting systems on a day-to-day basis for two purposes – making decisions and evaluating those decisions after the fact. Presents a practical set of accounting-based concepts, tools and techniques to help organizations operate more effectively and create lasting value. Helps prepare students for work in general management, consulting, operations, marketing, private equity, startups, or non-profits.
C. Noe

15.522 Security Design and Corporate Financing
Prereq: 15.401, (15.402 or 15.414), and (15.433 or 15.434)
G (Spring)
Not offered regularly; consult department
3-0-6 units
Examines how corporations choose securities and markets to finance themselves. These are decisions which the firm must make after it has determined its financial policies including capital structure and dividend policy. Subject discusses recent trends in corporate financing including globalization, secularization, and transformation. Explores new securities and institutional factors, particularly tax and accounting factors that affect their design.
P. Asquith

15.535 Business Analysis Using Financial Statements
Prereq: 15.501, 15.511, 15.515, or 15.516; Coreq: 15.401, 15.414, 15.415, or 15.417
G (Fall, Spring)
3-0-6 units
Focuses on the strategic, financial, and accounting analysis of a company by means of historical financial statement data. Also studies financial statement forecasting along with a specific application of forecasting - valuation. Concepts are applied to a number of decision-making contexts, including securities analysis, credit analysis, merger analysis, and company performance assessment.
C. Noe
15.539 Doctoral Seminar in Accounting
Prereq: 15.515
G (Fall, Spring)
Units arranged
Can be repeated for credit.

Designed primarily for doctoral students in accounting and related fields. The reading list consists of accounting research papers. Objective is to introduce research topics, methodologies, and developments in accounting, and train students to do independent research.

J. Weber

Information Technologies

15.561 Information Technology Essentials
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-6 units

Examines technology concepts and trends underlying current and future uses of information technology (IT) in business. Emphasis on networks and distributed computing, including the web. Other topics include hardware and operating systems, software development tools and processes, relational databases, security and cryptography, enterprise applications, and electronic commerce. Exposure to web, database, and graphical user interface (GUI) tools. Primarily for Sloan master’s students with limited IT background.

T. W. Malone

15.564 IT Essentials II: Advanced Technologies for Digital Business in the Knowledge Economy
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-6 units

Technologies and concepts for next generation knowledge management and web e-business, including semantic web and web services. Business applications for use in the next two to seven years, including: e-commerce, marketing, finance, trust/security, health/biomedical, mobile. Strategic impacts and entrepreneurial opportunities. Core skills for identifying and evaluating technologies and their business potential, and for managing innovative IT-dependent projects. Overall emphasis on business process automation and e-services.

S. Madnick

Same subject as IDS.345[J]
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-6 units

Examines the evolution from Web 2.0, with its emphasis on interactivity through online collaboration and sharing among users (primarily through social networking sites, wikis and communication tools), to Web 3.0, which focuses on high proactivity, transforming the Web into a database, and the leveraging of artificial intelligence technologies, such as the Semantic Web. Introduces Management 3.0 and the range of new Web technologies, applications, and business opportunities and challenges that it supports. Addresses topics such as big data, cloud computing, and cybersecurity. Includes case studies, industry and academic speakers, discussion of basic principles, and a team project.

S. Madnick

15.567 The Economics of Information: Strategy, Structure and Pricing
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall; first half of term)
3-0-3 units

Analysis of the underlying economics of information with business implications. Studies effects of digitization and technology on business strategy and organizational structure. Examines pricing, bundling, and versioning of digital goods, including music, video, software, and communication services. Considers the economic and managerial implications of data-driven decision-making, search, platform competition, targeted advertising, personalization, privacy, network externalities, and artificial intelligence. Readings on fundamental economic principles provide context for industry speakers and case discussions.

E. Brynjolfsson
15.569 Leadership Lab: Leading Sustainable Systems  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall, IAP)  
6-0-9 units
Addresses key sustainability challenges faced by business and society. Explores alternative ways to view organizations that draw attention to cross-boundary interdependencies and help leaders at all levels develop their capacity to collaborate for systemic change. Develops skills to help students surface and reflect on mental models and practices that keep organizations stuck in unproductive system dynamics. Weaves together theory, experiential practices, guest speakers, and action learning projects that enable teams of students to work with organizations on systemic change initiatives.  
P. Senge, W. Orlikowski

15.570 Digital Marketing and Social Media Analytics  
Prereq: 15.809, 15.814, or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall; second half of term)  
3-0-3 units
Provides a detailed, applied perspective on the theory and practice of digital marketing and social media analytics in the age of big data. Covers concepts such as the difference between earned and paid media, predictive modeling for ad targeting and customer relationship management, measuring and managing product virality, viral product design, native advertising, and engaging the multichannel experience. Stresses the theory and practice of randomized experimentation, AB testing and the importance of causal inference for marketing strategy. Combines lectures, case studies, and guest speakers with relevant industry experience that speak directly to the topics at hand.  
S. Aral

15.571 Enterprise Transformations in the Digital Economy  
Prereq: None  
G (Spring)  
3-0-6 units
Designed to help students understand how the digital economy forces companies to rethink their business strategies - and architect their processes, products, and information. Explores how firms use technology to create new value propositions and new organizational designs. Includes case studies about large enterprises using IT to transform how they do business; guest executives from those enterprises respond to student discussions. Student teams present to company executives the results of their debates on the options available for applying technology in ways that cut costs, enhance products, and engage customers. 
J. W. Ross

15.572 Analytics Lab: Action Learning Seminar on Analytics, Machine Learning, and the Digital Economy  
Prereq: Permission of instructor  
G (Fall)  
2-0-7 units
Student teams design and deliver a project based on the use of analytics, machine learning, large data sets, or other digital innovations to create or transform a business or other organization. Teams may be paired up with an organization or propose their own ideas and sites for the project. Culminates with presentation of results to an audience that includes IT experts, entrepreneurs, and executives.  
S. Aral, E. Brynjolfsson

15.575 Economics of Information and Information Technology  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units
Builds upon relevant economic theories and methodologies to analyze the changes in organizations and markets enabled by digital technologies. Examines information economics, labor economics, industrial organization and price theory, growth theory, intangible asset valuation, incomplete contracts theory, and design of empirical studies. Extensive reading and discussion of research literature explores the application of these theories to business issues with relevant guest speakers. Students will complete a final research paper and presentation. Primarily for doctoral students.  
E. Brynjolfsson

15.576 Research Seminar in Information Technology and Organizations: Social Perspectives  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units
Examines the assumptions, concepts, theories, and methodologies that inform research into the social aspects of technology. Extensive reading and discussion of research literature aimed at exploring the multiple social phenomena surrounding the development, implementation, use and implications of information technology in organizations. Primarily for doctoral students.  
W. J. Orlikowski
15.579 Seminar in Information Technology
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
Units arranged
Can be repeated for credit.

Group study of current topics related to information technology.
S. Aral, S. E. Madnick, T. W. Malone

15.579-15.580 Seminar in Information Technology
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit.

Group study of current topics related to information technology.
S. E. Madnick, T. W. Malone, W. Orlikowski

15.599 Workshop in Digitization
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
2-0-4 units
Can be repeated for credit.

Presentations by faculty, doctoral students, and guest speakers of ongoing research relating to current issues in digitization, technology and the changing economics of work, as well as discussions of key research papers in the field. Specific topics determined by the interest of participants and by new and important directions in digitization, information technology and information economics. Background readings, regular assignments and active participation by students expected. Preference to doctoral students.
E. Brynjolfsson

Law

15.615 Essential Law for Business
Prereq: None
G (Fall, Spring)
3-0-6 units

Provides a solid grounding in what managers need to know about how law shapes opportunities and risks for the businesses they manage and their own careers. Enhances leadership skills for navigating critical law-sensitive junctures that managers encounter in young and mature companies. Explores the legal frameworks of organizing a new venture; contracts and deals; litigation and liability; employment and changing jobs; regulation and criminal sanctions; complex transactions, including public and private mergers and acquisitions; finance and private equity; distress, reorganization, and bankruptcy; and effective use of IP and cutting-edge technologies. No prior knowledge of law expected.
J. Akula, L. Rodrigues

15.616 Basic Business Law, Tilted Towards Key Emerging Issues
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-6 units

Broad-gauged introduction to business law designed to prepare managers to exercise judgment and leadership when confronting key law-sensitive issues of importance to their organizations and their own careers. Topics include contracts, liability, employment, changing jobs, intellectual property, business disputes, bankruptcy and reorganization, acquisitions, regulatory compliance, and corporate crime. The distinctive feature of 15.616 is an additional focus on newly-emerging, law-sensitive issues of key significance to business. Those topics vary from year to year; some recent examples include doing business in the BRIC nations, and the legal framework of social media.
J. Akula
15.617 Deals, Finance, and the Law
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-6 units
Credit cannot also be received for 15.6171
Addresses law-sensitive issues arising in the overlapping contexts of complex deals and financial services and products. Covers financial services regulation, employment and job changes, and civil and criminal accountability. Develops managerial skills for handling law-sensitive situations at individual and organizational levels. Meets with 15.6171 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
J. Akula

15.6171 Deals, Finance, and the Law
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-6 units
Credit cannot also be received for 15.617
Addresses law-sensitive issues arising in the overlapping contexts of complex deals and financial services and products. Covers financial services regulation, employment and job changes, and civil and criminal accountability. Develops managerial skills for handling law-sensitive situations at individual and organizational levels. Meets with 15.6171 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
J. Akula

15.618 Entrepreneurship, Innovation, Startups and the Law
Prereq: None
G (Fall, Spring)
2-0-4 units
Credit cannot also be received for 15.6181
The legal framework of entrepreneurship and innovation. Key lawsensitive junctures in launching and growing a startup: assembling a team, organizing a business entity, ownership and compensation, early financing, managing contracts and employees, business distress and winding down, and selling a company. Cutting-edge technologies and intellectual property rights. Designed for those who may start or work in such ventures; or are engaged in research with potential for commercial or social impact; or are otherwise attempting to advance an innovation from idea to impact. No prior knowledge of law expected. Meets with 15.6181 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version.
J. Akula

15.6181 Entrepreneurship, Innovation, Startups and the Law
Prereq: None
U (Fall)
2-0-4 units
Credit cannot also be received for 15.618
The legal framework of entrepreneurship and innovation. Key law-sensitive junctures in launching and growing a startup: assembling a team, organizing a business entity, ownership and compensation, early financing, managing contracts and employees, business distress and winding down, and selling a company. Cutting-edge technologies and intellectual property rights. Designed for those who may start or work in such ventures; or are engaged in research with potential for commercial or social impact; or are otherwise attempting to advance an innovation from idea to impact. No prior knowledge of law expected. Meets with 15.6181 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version.
J. Akula

15.620 Patent Law Fundamentals
Prereq: None
G (IAP)
1-0-2 units
Intensive introduction to the basic provisions of US patent law, emphasizing the requirements for patentability and the process of applying for a patent. Topics include requirements of utility, novelty, and non-obviousness; eligible subject matter; applying for a patent, including patent searches and the language of patent claims; infringement, defenses, and remedies; comparison of patents with other forms of intellectual property (copyrights, trade secrets, and trademarks). Reading materials include key sections of the US patent statute (Title 35, US Code) and related judicial decisions.
J. Meldman
15.621 Your Career and the Law: Key Junctures, Opportunities and Risks (New)
Prereq: None
G (Fall; second half of term)
2-0-4 units

Explores legal opportunities and risks in employment from the perspectives of both employees and managers. Special attention to issues faced by tech-savvy employees and tech-intensive ventures; employees starting competing ventures; compensation and equity arrangements; the challenges of the gig economy; employee privacy; and discrimination, gender and other inclusion-related issues in the workplace. Led by former practicing attorneys, focuses on how employment law issues play out in the real world. Utilizes realistic scenarios and documents, such as offer letters and non-competition and invention assignment agreements. No prior knowledge of law expected.

J. Akula, L. Rodriques

15.622 Digital Technology and the Law (New)
Prereq: None
G (Spring)
2-0-4 units

Focuses on how law impacts the development, application and commercialization of cutting-edge digital technologies. Looks closely at law-sensitive current developments in artificial intelligence and machine learning as used in decision support and robotics, big data and analytics, blockchain and fintech, the internet and social media, privacy and cybersecurity, and intellectual property rights in new technologies. Special attention paid to the perspectives of those planning careers tied to cutting-edge skills or their own innovations; commercial and social entrepreneurs bringing innovations from ideas to impact; and managers integrating these technologies into their business models, strategies, and organizations.

J. Akula, L. Rodriques

15.647-15.649 Seminar in Law
Prereq: None
G (Fall)
Units arranged
Can be repeated for credit.

Group study of current topics related to law.

J. L. Akula

15.655[J] Law, Technology, and Public Policy
Same subject as IDS.435[J]
Prereq: None
G (Fall)
3-0-9 units

See description under subject IDS.435[J]. Permission of instructor required for freshmen and sophomores.

N. Ashford, C. Caldart

15.657[J] Technology, Globalization, and Sustainable Development
Same subject as 1.813[J], 11.466[J], IDS.437[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

See description under subject IDS.437[J].

N. Ashford

Industrial Relations and Human Resource Management

15.660 Strategic Human Resource Management
Prereq: 15.311
G (Spring)
Not offered regularly; consult department
3-0-6 units

Design and execution of human resource management strategies. Two central themes: How to think systematically and strategically about aspects of managing the organization's human assets, and what really needs to be done to implement these policies and to achieve competitive advantage. Adopts the perspective of a general manager and addresses human resource topics (including reward systems, performance management, high-performance human resource systems, training and development, recruitment, retention, equal employment opportunity laws, work-force diversity, and union-management relationships) from a strategic perspective.

E. J. Castilla

15.661 Building Successful Careers and Organizations
Prereq: None
G (Spring; first half of term)
3-0-3 units

Designed to help students learn more about their strengths, and how they can utilize these strengths to manage their career. Draws on the latest research and practices, experiential exercises, and cases studies, and includes guest speakers. Covers the most important aspects of talent (and career) management. No listeners.

E. Castilla
15.662[J] Managing Sustainable Businesses for People and Profits
Same subject as 11.383[J]
Prereq: None
G (Spring)
3-3-3 units
Examines opportunities and challenges involved in building and growing businesses that achieve high financial performance and provide good jobs and careers to employees. Students engage participants in the MITx online course title Shaping the Future of Work to learn about the expectations and employment experiences of workers across the world. Through readings, cases, simulations and class visits from industry leaders, explores the underlying principles and business practices that help to secure that alignment between business health and societal well-being.
T. Kochan, B. Dyer

15.663[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 1.811[J], 11.630[J], IDS.540[J]
Subject meets with 1.801[J], 11.021[J], 17.393[J], IDS.060[J]
Prereq: None
G (Spring)
3-0-9 units
See description under subject IDS.540[J].
N. Ashford, C. Caldart

15.665 Power and Negotiation
Prereq: Permission of instructor
G (Fall, Spring)
3-0-6 units
Credit cannot also be received for 15.672, 15.6721, 15.673, 15.6731, 15.712
Provides understanding of the theory and processes of negotiation as practiced in a variety of settings. Designed for relevance to the broad spectrum of bargaining problems faced by the manager and professional. Allows students an opportunity to develop negotiation skills experientially and to understand negotiation in useful analytical frameworks. Emphasizes simulations, exercises, role playing, and cases.
J. Curhan

15.667 Negotiation and Conflict Management
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
Applies negotiation theory strategies and styles to problems managers and professionals commonly encounter in the workplace. Emphasizes sources of power in negotiation, self-assessment of personal negotiating strengths/weaknesses, and practice in negotiations via role-plays and simulations of common workplace conflicts. Covers conflict management as a direct party and as a manager helping others resolve their conflicts through mediation, investigation, arbitration, and helping the system itself to change as a result of a dispute. Special cases include bullying, harassment, dealing with difficult people, cross-cultural negotiations, and collective actions.
T. Kochan

15.668 People and Organizations
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-6 units
Examines the historical evolution and current human and organizational contexts in which scientists, engineers and other professionals work. Outlines major challenges facing the management profession. Uses interactive exercises, simulations and problems to develop critical skills in negotiations, teamwork, and leadership. Focuses on practical application of these skills in a professional context. Introduces concepts and tools to analyze work and leadership experiences in internships, school activities, and fieldwork. Preference to Management minors and other undergraduates not majoring in Management Science.
T. Kochan, P. Osterman

15.669 Strategies for People Analytics
Prereq: 15.311 or permission of instructor
G (Spring; second half of term)
3-0-3 units
Focuses on the strategies used to successfully design and implement people analytics in one's organization. Draws on the latest company practices, research projects, and case studies - all with the goal of helping students deepen their understanding of how people analytics can be applied in the real world. Covers the most important aspects of human resource management and people analytics. Demonstrates how to apply those basic tools and principles when hiring, evaluating and rewarding performance, managing careers, and implementing organizational change. No listeners.
E. Castilla
15.671 U-Lab: Transforming Self, Business and Society
Prereq: None
G (Fall; first half of term)
3-0-3 units
Experiential opportunity to practice new leadership skills, such as deep listening, being present (mindfulness), and generative dialogue. In weekly coaching circles, each student has one full session to present their current leadership edge and receive feedback from peer coaches. Includes an additional action learning project.
O. Scharmer

15.672 Negotiation Analysis
Subject meets with 15.6721, 15.673, 15.6731
Prereq: Permission of instructor
G (IAP)
1-0-2 units
Credit cannot also be received for 15.665, 15.712
Presents analytical frameworks and strategies to handle a variety of negotiation situations. Includes simulations, games, videos, lectures, discussion, and multiple opportunities to practice and hone negotiation, communication, and influence skills with extensive personalized feedback. Intended for students with a broad spectrum of backgrounds and experience levels. Six-unit version includes additional class time and outside work. Expectations and evaluation criteria differ for students taking graduate version. Limited to 80 via lottery; consult class website for information and deadlines.
J. Curhan

15.6721 Negotiation Analysis
Subject meets with 15.672, 15.673, 15.6731
Prereq: Permission of instructor
U (IAP)
1-0-2 units
Credit cannot also be received for 15.665, 15.712
Presents analytical frameworks and strategies to handle a variety of negotiation situations. Includes simulations, games, videos, lectures, discussion, and multiple opportunities to practice and hone negotiation, communication, and influence skills with extensive personalized feedback. Intended for students with a broad spectrum of backgrounds and experience levels. Six-unit version includes additional class time and outside work. Expectations and evaluation criteria differ for students taking graduate version. Limited to 80 via lottery; consult class website for information and deadlines.
J. Curhan

15.673 Negotiation Analysis
Subject meets with 15.672, 15.6721, 15.6731
Prereq: Permission of instructor
G (IAP)
2-0-4 units
Credit cannot also be received for 15.665, 15.712
Presents analytical frameworks and strategies to handle a variety of negotiation situations. Includes simulations, games, videos, lectures, discussion, and multiple opportunities to practice and hone negotiation, communication, and influence skills with extensive personalized feedback. Intended for students with a broad spectrum of backgrounds and experience levels. Six-unit version includes additional class time and outside work. Expectations and evaluation criteria differ for students taking graduate version. Limited to 80 via lottery; consult class website for information and deadlines.
J. Curhan

15.6731 Negotiation Analysis
Subject meets with 15.672, 15.6721, 15.673
Prereq: Permission of instructor
U (IAP)
2-0-4 units
Credit cannot also be received for 15.665, 15.712
Presents analytical frameworks and strategies to handle a variety of negotiation situations. Includes simulations, games, videos, lectures, discussion, and multiple opportunities to practice and hone negotiation, communication, and influence skills with extensive personalized feedback. Intended for students with a broad spectrum of backgrounds and experience levels. Six-unit version includes additional class time and outside work. Expectations and evaluation criteria differ for students taking graduate version. Limited to 80 via lottery; consult class website for information and deadlines.
J. Curhan

15.674[J] Leading Creative Teams
Same subject as 6.928[J], 16.990[J]
Prereq: None
G (Fall, Spring)
3-0-6 units
See description under subject 6.928[J].
D. Nino, J. Schindall

2019–2020 MIT Subject Descriptions | 531
15.675 Negotiation Seminar
Prereq: None
G (IAP)
3-0-3 units
Provides understanding of the theory and processes of negotiation as practiced in a variety of settings. Designed for relevance to the broad spectrum of bargaining problems faced by the manager and professional. Allows students an opportunity to develop negotiation skills experientially and to understand negotiation in useful analytical frameworks. Emphasizes simulations, exercises, role playing, and cases. Restricted to Sloan Fellow MBAs.
J. Curhan

15.676 Work, Employment, and Industrial Relations Theory
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
2-0-7 units
Historical evolution and assessment of different theories and disciplinary perspectives used in research on work, employment, and industrial relations. Introduces doctoral students to the field and explores where their research interests fit within the broader field. First part compares the normative assumptions, theories, and methodologies used by economists, historians, sociologists, psychologists, political scientists, and legal scholars from the latter nineteenth century to the present. Final portion explores strategies for advancing research on topics of current interest to participants.
T. Kochan, P. Osterman, E. Castilla, O. Sharone, M. Amengual

15.677[J] Urban Labor Markets and Employment Policy
Same subject as 11.427[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Discusses the broader trends in the labor market, how urban labor markets function, public and private training policy, other labor market programs, the link between labor market policy and economic development, and the organization of work within firms.
P. Osterman

15.678[J] Political Economy I: Theories of the State and the Economy
Same subject as 14.781[J], 17.100[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
See description under subject 17.100[J].
M. Piore, S. Berger

15.681 From Analytics to Action
Prereq: None
G (Fall, Summer)
3-0-3 units
Develops appreciation for organizational dynamics and competence in navigating social networks, working in a team, demystifying rewards and incentives, leveraging the crowd, understanding change initiatives, and making sound decisions. Restricted to Master of Business Analytics students.
R. Fernandez, T. Kochan, R. Reagans

15.691 Research Seminar in Work, Employment and Industrial Relations
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Discusses important areas for research in work, employment and industrial relations; frameworks for research, research techniques, and methodological problems. Centered mainly on staff research and the thesis research of advanced graduate students and invited guests.
Consult T. A. Kochan

15.698 Seminar in Industrial Relations and Human Resource Management
Prereq: None
G (Fall)
Units arranged
Can be repeated for credit.
Group study of current topics related to industrial relations and human resource management.
Consult P. Osterman

Executive MBA Subjects

15.700 Leadership and Integrative Management
Prereq: Permission of instructor
G (Fall)
3-0-6 units
Investigates the different perspectives a general manager must take, how to integrate those perspectives, and the role of leadership in setting and realizing goals. Students work intensively in teams and with multiple faculty, using a deep dive into the challenges faced by a major global firm operating in complex global markets. Restricted to Executive MBA students.
Consult J. Hising DiFabio
15.701 Innovation-Driven Entrepreneurial Advantage
Prereq: None. Coreq: 15.714; or permission of instructor
G (Spring, Summer)
6-0-6 units
Exposes students to the content, context, and contacts that enable entrepreneurs to design and launch successful stand-alone ventures, ventures inside established corporations, and ventures in partnership with established corporations based on new innovations. Students examine the critical entrepreneurial and innovation challenges facing entrepreneurs inside new and established firms, and develop frameworks that allow them to identify, evaluate, iterate, and integrate their ideas effectively. Case-based discussions complemented by visits to key actors in MIT labs, as well as live case studies with successful entrepreneurs. Specially designed team projects provide practical experience in entrepreneurial strategy, innovation management, and the workings of the MIT entrepreneurial ecosystem. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.702 Leading in a Global Context: Macroeconomics and Global Markets
Prereq: Permission of instructor
G (Fall)
6-0-6 units
Can be repeated for credit.
Intensive module on the global economy, combining the key perspectives of macroeconomics and global economic strategy. Focuses on the policy and economic environment of firms, as well as on the development of a more international market in products, services, and capital, and how this affects trade and industries. Presents insights into national economic strategies for development, and into the evolving rules and institutions governing the international economic order. Develops an actionable appreciation for managers of the international dimensions of economic policy and strategy in an increasingly complex world economy. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.703 Leading with Impact
Prereq: Permission of instructor
G (Spring)
3-3-3 units
Student teams work with the leadership of local not-for-profits to solve a pressing problem faced by that organization. The problems will vary with the organization in question, as will the skills and capabilities students draw on to appropriately address them. Culminates with group reflection on what it means to be a principled innovative leader who improves the world.
Consult J. Hising DiFabio

15.705 Organizations Lab
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Preparation for an organizational change project. Emphasis on applying tools of organizational, operational, and systems analysis in order to effect change. Includes a focus on the challenges and opportunities presented by issues of leadership and organizational behavior. Each student leads a change project in his or her own organization, focusing on fixing a broken or ineffective process. Examples of possible initiatives include a strategic reorientation, organizational restructuring, introduction of a new technology, a worker participation program, etc. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.707 Global Strategy
Prereq: Permission of instructor
G (Fall, Spring)
3-0-3 units
Provides students with the evidence, concepts and models for understanding company performance in a global world and the issues facing executives in the early 21st century. Prepares students to manage effectively in todays interconnected world by understanding this changing environment, principles of global strategy, and the relation between global strategy and organization. Focuses on the specificities of strategy and organization of the multinational company. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.708 Global Organizations Lab
Prereq: Permission of instructor
G (Spring)
6-0-9 units
Helps students discover and develop new and effective ways of managing and working together across national borders; also helps accelerate development of the context awareness and integrative management skills needed to lead in a globalized world. Involves intensive team engagement with a firm where students integrate their understanding of the relevant global and national economic and institutional contexts, industry dynamics, the firm’s strategic position and capabilities, and its management organization and processes to provide the management sponsor with insight and effective recommendations. Includes a week-long site visit for research. Restricted to Executive MBA students.
Consult J. Hising DiFabio
15.709 Key Decisions for Corporate Boards
Prereq: None
G (IAP)
1-0-2 units

Designed to help students understand the fundamental rules and practices of corporate boards in three key areas: the audit committee, the compensation committee, and corporate takeovers. Includes discussion related to case studies, with short lectures at the start and end of each session to highlight the differences and similarities in practices by boards in the US and abroad. Restricted to MIT Executive MBA and Sloan Fellows students.

Consult J. Hising DiFabio

15.711 Executing Strategy for Results
Prereq: None
G (IAP)
1-0-2 units

Credit cannot also be received for 15.361

Condensed version of 15.361 that introduces a comprehensive framework to understand how leaders can execute strategy more effectively. Presents case studies of companies that excel at execution, and a series of practical tools that can be applied immediately to boost performance. Intended for owner-operators and managers in complex organizations (more than 200 employees, multiple functions or units), particularly those competing in volatile markets. Restricted to Executive MBA and Sloan Fellows students.

Consult J. Hising DiFabio

15.712 Negotiation and Influence
Prereq: Permission of instructor
G (Spring)
3-0-3 units

Credit cannot also be received for 15.665, 15.672, 15.6721, 15.673, 15.6731

Provides understanding of the theory and processes of negotiation as practiced in a variety of settings. Designed for relevance to the broad spectrum of bargaining problems faced by the manager and professional. Allows students an opportunity to develop negotiation skills experientially and to understand negotiation in useful analytical frameworks. Emphasizes simulations, exercises, role playing, and cases. Restricted to Executive MBA students.

Consult J. Hising DiFabio

15.713 Principles of Fundamental Analysis
Prereq: None
G (IAP)
1-0-2 units

Defines the role of general managers in the capital markets system and highlights their interactions with such players as equity research analysts, investment bankers, and consultants as they seek to create value by increasing the company's intrinsic value. Covers basic and more advanced topics in finance and financial reporting from a high-level, practical standpoint. Restricted to MIT Executive MBA and Sloan Fellows students.

Consult J. Hising DiFabio

15.714 Competitive Strategy
Prereq: Permission of instructor
G (Spring, Summer)
3-0-6 units

Credit cannot also be received for 15.902

Introduces a variety of modern strategy frameworks and methodologies to develop the skills needed to be a successful manager. Cases and readings explore a range of strategic problems, focusing particularly on the sources of competitive advantage and the interaction between industry structure and organizational capabilities. Emphasizes the perspective of the general manager in ensuring the firm's success. Encourages awareness of both the external (market) and internal (organizational) forces that shape firm performance. Restricted to Executive MBA students.

Consult J. Hising DiFabio

15.715 Entrepreneurial Strategy
Prereq: None
G (IAP)
1-0-2 units

Credit cannot also be received for 15.911

Provides an integrated strategy framework for innovation-based entrepreneurs. Students examine the core strategic choices facing start-up innovators, and discuss a synthetic framework for the development, implementation and scaling of entrepreneurial strategy in dynamic environments over time. Identifies the types of choices that entrepreneurs must make to take advantage of a novel opportunity, and studies the logic of particular strategic commitments and positions that allow entrepreneurs to establish competitive advantage. Restricted to MIT Executive MBA and Sloan Fellows students.

Consult J. Hising DiFabio
15.716 Leading Organizations
Prereq: None
G (Summer)
3-0-6 units
Credit cannot also be received for 15.322
Promotes awareness of and strategies to meet the key challenges leaders face today (and tomorrow). Acquaints students with some of the psychological and sociological dynamics that regularly operate in organizational settings - the less visible but quite powerful "forces" that shape the way employees and managers respond (or don’t respond) to a changing world. Restricted to Executive MBA students. Consult J. Hising DiFabio

15.717 Organizational Processes
Prereq: Permission of instructor
G (Fall)
3-0-6 units
Designed to enhance students' ability to take effective action in complex organizational settings by providing the analytic tools needed to analyze, manage, and lead the organizations of the future. Emphasizes the importance of the organizational context in influencing which individual styles and skills are effective. Employs a wide variety of learning tools, from experiential learning to the more conventional discussion of written cases. Centers on three complementary perspectives on organizations: the strategic design, political, and cultural "lenses" on organizations. Restricted to Executive MBA students. Consult J. Hising DiFabio

15.719 Entrepreneurial Finance
Prereq: None
G (IAP)
1-0-2 units
Credit cannot also be received for 15.431, 15.4311
Addresses key questions that are central to the funding and growth of high-tech start-up firms, such as how to value entrepreneurial firms using different valuation methods, and how to negotiate investor term sheets and convertible notes. Discusses the trade-off between different exit options for start-up firms. Aims to prepare students for these decisions from the perspective of entrepreneurs and venture capitalists. Restricted to MIT Executive MBA and Sloan Fellows students. Consult J. Hising DiFabio

15.720 Financial Accounting
Prereq: Permission of instructor
G (Spring)
3-0-6 units
Credit cannot also be received for 15.511, 15.515
Examines the basic concepts of corporate financial accounting and reporting, and the role of accounting information in investment decisions, corporate and managerial performance assessment, and the valuation of firms. Develops skills for performing an economics-based analysis of accounting information from the viewpoint of the users of accounting information (especially senior managers), rather than the preparer (the accountant). Restricted to Executive MBA students. Consult J. Hising DiFabio

15.722 Applied Economics for Managers
Prereq: Permission of instructor
G (Fall)
3-0-6 units
Credit cannot also be received for 15.024
Develops facility with concepts, language, and analytical tools of economics. Primary focus is on microeconomics. Emphasizes integration of theory, data, and judgment in the analysis of corporate decisions and public policy, and in the assessment of changing US and international business environments. Restricted to Executive MBA students. Consult J. Hising DiFabio

15.723 Advanced Applied Macroeconomics and International Institutions
Prereq: 15.702 or permission of instructor
G (Spring)
3-0-3 units
Topics draw on current macroeconomic issues and events, such as modern monetary and fiscal policy; financial crisis, contagion, and currency crisis; real exchange rates, purchasing power parity, and long run sustainability; sustainable development; targeting and the new monetary policy regime; and Europe and the Euro: optimal exchange areas. Restricted to Executive MBA students. Consult J. Hising DiFabio
15.724 Financial Management
Prereq: Permission of instructor
G (Fall)
3-0-6 units
Credit cannot also be received for 15.414
Provides a rigorous introduction to corporate finance and capital markets, with an emphasis on applications vital to corporate managers. Exposes students to the major financial decisions made by leaders within a firm and to the ways the firm interacts with investors, with a focus on valuation. Topics include project and company valuation, measuring risk and return, stock pricing, corporate financing policy, the cost of capital, and risk management. Presents a broad overview of both theory and practice. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.725 Marketing Strategy for General Managers
Prereq: None
G (IAP)
1-0-2 units
Helps students consider the entire marketing mix in light of the strategy of the firm. Reviews customer-based sources of competitive advantage and discusses how to identify, measure, and leverage them. Introduces a method for comparing alternative selling formats (e.g., brick and mortar vs. electronic), aiming to find the most efficient ways to sell different products to different customers. Discusses the myriad ways in which the firm can grow its sources of competitive advantage. Provides practical experience in using tools to identify, evaluate, and develop marketing strategies; design efficient products and selling formats; and plan the use and development of the firm’s portfolio of resources. Restricted to Executive MBA and Sloan Fellows students.
Consult J. Hising DiFabio

15.726 Pricing
Prereq: None
G (IAP)
1-0-2 units
Credit cannot also be received for 15.818
Focuses on practical pricing tactics. Presents a framework for the steps firms should take when thinking about pricing a new product or improving the pricing performance of an old product. Tools covered include monadic pricing surveys, empirical price elasticity calculations, and conjoint. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.727 The Analytics Edge
Prereq: 15.730 or permission of instructor
G (Spring)
3-0-6 units
Introduces modern analytics methods (data mining and optimization), starting with real-world problems where analytics have made a material difference. Modern data mining methods include clustering, classification, logistic regression, CART, random forest methods, and association rules. Modern optimization methods include robust, adaptive and dynamic optimization. Applications include health care, hospital operations, finance, energy, security, internet, and demand modeling. Uses R programming language for data mining and ROME for robust optimization. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.728 Deals, Finance, and the Law
Prereq: None
G (IAP)
1-0-2 units
Addresses the challenges managers face in connection with two overlapping responsibilities: negotiating and managing complex deals, and arranging financing. Examines mergers and acquisitions and early-stage investments in young companies; commercial finance, financial instruments, and structured products; and how these relationships and structures play out in the context of financial distress. Emphasizes the opportunities and risks the different parties involved confront. Focuses primarily on the US, but also considers how key legal issues are analyzed in a transnational context. Restricted to Executive MBA and Sloan Fellows students.
Consult J. Hising DiFabio

15.730 Data, Models, and Decisions
Prereq: Permission of instructor
G (Spring)
3-0-6 units
Credit cannot also be received for 15.060
Introduces students to fundamental tools in using data to make informed management decisions. Emphasizes the executive perspective: how to leverage best-practice quantitative methods to manage and drive the business. Exercises and cases complemented by perspectives and applications in finance, operations management, healthcare, the Internet, and other functions and industries. Restricted to Executive MBA students.
Consult J. Hising DiFabio
15.731 Risk Management
Prereq: (15.730 and 15.734) or permission of instructor
G (IAP)
1-0-2 units
Provides several core analytical and management concepts, helping students identify, model, think about, analyze, and manage risk. Topics vary; examples include risk measures, the drivers-event-outcomes framework, low-probability high-impact risk events, hedging risk with financial options, real options, risk management in the supply chain, project risk management, modern portfolio management, systemic risk. Restricted to Executive MBA and Sloan Fellows students.
Consult J. Hising DiFabio

15.732 Marketing Management
Prereq: Permission of instructor
G (Fall)
3-0-6 units
Credit cannot also be received for 15.814, 15.8141
Studies the application of a reasoned framework to the selection of target markets and the optimization of marketing decisions. Subject is divided into two parts: a tactical portion that reviews how firms optimize profits in their chosen markets, and a strategic portion that focuses on identifying target markets. Tactical topics include pricing, promotion, channel and product issues. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.734 Introduction to Operations Management
Prereq: Permission of instructor
G (Spring, Summer)
3-0-6 units
Credit cannot also be received for 15.761, 15.7611
Provides concepts, techniques and tools to design, analyze and improve core strategic operational capabilities. Covers a broad range of application domains and industries, such as high-tech, financial services, insurance, automotive, health care, retail, fashion, and manufacturing. Emphasizes the effects of uncertainty in business decision making and the interplay between strategic and financial objectives and operational capabilities. Students play simulation games that demonstrate some of the central concepts. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.735 Product Design
Prereq: None
G (IAP)
1-0-2 units
Presents the modern methods of product development using a systematic innovation approach. Topics include opportunity identification, design thinking, product strategy, identifying customer needs, creativity, concept development, product architecture, industrial design, and green design practice. Restricted to Executive MBA and Sloan Fellows students.
Consult J. Hising DiFabio

15.736 Introduction to System Dynamics
Prereq: Permission of instructor
G (Spring, Summer)
3-0-6 units
Credit cannot also be received for 15.871
Introduces system dynamics modeling for the analysis of business policy and strategy. Provides the skills to visualize an organization in terms of the structures and policies that create dynamics and regulate performance. Uses causal mapping, simulation models, case studies, and management flight simulators to help develop principles of policy design for successful management of complex strategies. Considers the use of systems thinking to promote effective organizational learning. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.737 Advanced System Dynamics
Prereq: 15.736 or permission of instructor
G (IAP)
3-0-0 units
Credit cannot also be received for 15.872
Workshops focus on two models: the dynamics of service quality within a firm; and industry dynamics (particularly investment cycles and bubbles), including the energy and housing markets. Emphasis on formulation, analysis, use, and decision-making. Develops modeling skills. Restricted to Executive MBA and Sloan Fellows students.
Consult J. Hising DiFabio
15.738 Topics in Corporate Finance
Prereq: 15.414 or 15.724
G (IAP)
1-0-2 units
Case studies and lectures introduce financial tools needed to make value-enhancing business decisions. Topics drawn from issues such as advanced valuation analysis, capital structure decisions, debt restructuring, bankruptcy, incentive problems, real options, and valuation of international projects. Restricted to Executive MBA and Sloan Fellows students.
Consult J. Hising DiFabio

15.739 Discovering Your Leadership Signature
Prereq: None
G (IAP)
1-0-2 units
Credit cannot also be received for 15.318
Helps students understand their unique way of leading, i.e., leadership signature. Provides tools for students to determine what kind of leader they are and how to tell their leadership story. Examines leadership identity, drawing on theory from leadership literature, family systems, developmental psychology, personality psychology, and organizational change. Also builds on the four capabilities (4-CAP) model. Includes case studies, reflection, video analysis, and storytelling. Restricted to Executive MBA and Sloan Fellows students.
Consult J. Hising DiFabio

15.740 Strategic Communication for Executives
Prereq: None
G (IAP)
1-0-2 units
Develops communication skills crucial to successful management. Focuses on identifying a range of communication styles, and recognizing how to use them; dealing successfully with challenging or hostile audiences; understanding cross-cultural and global communication issues and differences; and leading and communicating in a crisis situation. Restricted to Executive MBA and Sloan Fellows students.
Consult J. Hising DiFabio

Operations Management

15.761 Introduction to Operations Management
Prereq: 6.041B, 15.060, or permission of instructor
G (Fall, Spring, Summer)
4-0-5 units
Credit cannot also be received for 15.734, 15.7611
Imparts concepts, techniques, and tools to design, analyze, and improve core operational capabilities and apply them to a broad range of domains and industries. Emphasizes the effect of uncertainty in decision-making, as well as the interplay among high-level financial objectives, operational capabilities, and people and organizational issues. Covers topics in capacity analysis, process design, process and business innovation, inventory management, risk pooling, supply chain coordination, sustainable operations, quality management, operational risk management, pricing and revenue management. Underscores how these topics are integrated with different functions of the firm. Case studies and simulation games provide experience in applying central concepts and techniques to solve real-world business challenges. Meets with 15.7611 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
R. Levi, T. Zaman, K. Zheng

15.7611 Introduction to Operations Management
Prereq: 6.041B, 15.0791, or permission of instructor
U (Spring)
4-0-5 units
Credit cannot also be received for 15.734, 15.761
Imparts concepts, techniques, and tools to design, analyze, and improve core operational capabilities and apply them to a broad range of domains and industries. Emphasizes the effect of uncertainty in decision-making, as well as the interplay among high-level financial objectives, operational capabilities, and people and organizational issues. Covers topics in capacity analysis, process design, process and business innovation, inventory management, risk pooling, supply chain coordination, sustainable operations, quality management, operational risk management, pricing and revenue management. Underscores how these topics are integrated with different functions of the firm. Case studies and simulation games provide experience in applying central concepts and techniques to solve real-world business challenges. Meets with 15.7611 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
T. Zaman, K. Zheng
15.762[J] Supply Chain Planning
Same subject as 1.273[J], IDS.735[J]
Prereq: 15.761 or SCM.260[J]
G (Spring; first half of term)
2.0-4 units

Focuses on effective supply chain strategies for companies that operate globally, with emphasis on how to plan and integrate supply chain components into a coordinated system. Students are exposed to concepts and models important in supply chain planning with emphasis on key tradeoffs and phenomena. Introduces and utilizes key tactics such as risk pooling and inventory placement, integrated planning and collaboration, and information sharing. Lectures, computer exercises, and case discussions introduce various models and methods for supply chain analysis and optimization. Recommended for Operations Management concentrators. First half-term subject.

D. Simchi-Levi

15.763[J] Manufacturing System and Supply Chain Design
Same subject as 1.274[J], IDS.736[J]
Prereq: 15.761, 15.778, or SCM.260[J]
G (Spring; second half of term)
2.0-4 units

Focuses on decision making for system design, as it arises in manufacturing systems and supply chains. Students exposed to frameworks and models for structuring the key issues and trade-offs. Presents and discusses new opportunities, issues and concepts introduced by the internet and e-commerce. Introduces various models, methods and software tools for logistics network design, capacity planning and flexibility, make-buy, and integration with product development. Industry applications and cases illustrate concepts and challenges. Recommended for Operations Management concentrators. Second half-term subject.

D. Simchi-Levi

Same subject as 1.271[J], IDS.250[J]
Prereq: 6.436[J] and (6.251[J] or 6.251[J]) or permission of instructor
G (Spring)
3.0-9 units
Can be repeated for credit.

Provides mathematical foundations underlying the theory of operations management. Covers both classic and state-of-the-art results in various application domains, including inventory management, supply chain management and logistics, behavioral operations, healthcare management, service industries, pricing and revenue management, and auctions. Studies a wide range of mathematical and analytical techniques, such as dynamic programming, stochastic orders, principal-agent models and contract design, behavioral and experimental economics, algorithms and approximations, data-driven and learning models, and mechanism design. Also provides practical experience in how to apply the theoretical models to solve OM problems in business settings. Specific topics vary from year to year.

D. Simchi-Levi, N. Trichakis, K. Zheng

15.765[J] Global Supply Chain Management
Same subject as 1.265[J], 2.965[J], SCM.265[J]
Prereq: 15.761, 15.778, SCM.260[J], SCM.261[J], or permission of instructor
G (Spring)
Not offered regularly; consult department
2.0-4 units

Focuses on the planning, processes, and activities of supply chain management for companies involved in international commerce. Students examine the end-to-end processes and operational challenges in managing global supply chains, such as the basics of global trade, international transportation, duty, taxes, trade finance and hedging, currency issues, outsourcing, cultural differences, risks and security, and green supply chains issues. Highly interactive format features student-led discussions, staged debates, and a mock trial. Includes assignments on case studies and sourcing analysis, as well as projects and a final exam.

Staff
15.767 Healthcare Lab: Introduction to Healthcare Delivery in the United States
Prereq: (15.060 and 15.761) or permission of instructor
G (Fall)
Not offered regularly; consult department
4-0-5 units
Credit cannot also be received for 15.777
Focuses on the business challenges and opportunities to deliver high-quality and reasonably-priced health services, mainly in the United States. Provides an opportunity to interact with guest speakers and senior executives from the health sector. Topics include aspects of healthcare delivery operations and how they are affected by healthcare reform policies, alternative payment models, population health perspectives, and social determinants of health. Discussions include examples from the ongoing healthcare-related work of Sloan faculty, as well as the potential for analytics and digitization to impact healthcare delivery. Provides a broad perspective on various career paths, such as consulting, entrepreneurship, delivery system management, and digital innovation development. Student teams work with a provider, supplier or healthcare-related startup organization on an applied project. Includes on-site work during fall and IAP.
A. Quaadgras, J. Jonasson

15.768 Management of Services: Concepts, Design, and Delivery
Prereq: 15.761, 15.778, or permission of instructor
G (Fall)
3-0-6 units
Explores the use of operations tools and perspectives in the service sector, including both for-profit and not-for-profit organizations. Builds on conceptual frameworks and cases from a wide range of service operations, selected from health care, hospitality, internet services, supply chain, transportation, retailing, food service, entertainment, financial services, humanitarian services, government services, and others.
C. Fine, Z. Ton

15.769 Operations Strategy
Prereq: 15.761, 15.778, or permission of instructor
G (Spring)
3-0-6 units
Provides unifying framework for analyzing strategic issues in manufacturing and service operations. Covers decisions in technology, facilities, vertical integration, human resources and other strategic areas. Explores means of competition, such as cost, quality, speed, innovativeness, and how operations companies address growth. Presents students with an approach to make operations decisions in the era of outsourcing and globalization.
T. Roemer, K. Zheng

15.770[J] Logistics Systems
Same subject as 1.260[J], IDS.730[J], SCM.260[J]
Subject meets with SCM.271
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject SCM.260[J].
Y. Sheffi, C. Caplice

15.771[J] Case Studies in Logistics and Supply Chain Management
Same subject as 1.261[J], SCM.261[J]
Prereq: Permission of instructor
G (Spring)
3-0-6 units
See description under subject SCM.261[J].
J. Byrnes

15.772[J] D-Lab: Supply Chains
Same subject as 2.771[J], EC.733[J]
Subject meets with 2.871
Prereq: None
U (Fall)
3-3-6 units
Introduces concepts of supply chain design and planning with a focus on supply chains for products destined to improve quality of life in developing countries. Topics include demand estimation, process analysis and improvement, facility location and capacity planning, inventory management, and supply chain coordination. Also covers issues specific to emerging markets, such as sustainable supply chains, choice of distribution channels, and how to account for the value-adding role of a supply chain. Students conduct D-Lab-based projects on supply chain design or improvement. Students taking graduate version complete additional assignments.
S. C. Graves
15.774 The Analytics of Operations Management
Prereq: None. Coreq: 15.060; or permission of instructor
G (Fall)
3-0-9 units
Introduces core concepts and methods in data-driven modeling that inform and optimize decisions under uncertainty. Teaches modeling and computational skills (R and Julia). Covers topics such as time series forecasting, choice modeling, queuing theory, network models, dynamic programming, mixed-integer programming, stochastic optimization, matching algorithms, multi-armed bandits. Draws on real-world applications from retail, healthcare, logistics, supply chain, social and online networks, sports analytics, social applications, and online learning.
G. Perakis, V. Farias, R. Levi

15.775 Analytics Proseminar
Prereq: None
G (Spring; first half of term)
2-0-1 units
Provides opportunities to meet senior executives serving in top analytics and data science functions within a variety of organizations across industries. Discusses key business analytics issues from the perspective of top management. Students prepare detailed briefings identifying and exploring important analytics issues facing these organizations.
C. Simon

15.777 Healthcare Lab: Introduction to Healthcare Delivery in the United States
Prereq: 15.060 and 15.761
G (Fall, IAP)
4-0-11 units
Credit cannot also be received for 15.767
Focuses on the business challenges and opportunities to deliver high-quality and reasonably-priced health services, mainly in the United States. Provides an opportunity to interact with guest speakers and senior executives from the health sector. Topics include aspects of healthcare delivery operations and how they are affected by healthcare reform policies, alternative payment models, population health perspectives, and social determinants of health. Discussions include examples from the ongoing healthcare-related work of Sloan faculty, as well as the potential for analytics and digitization to impact healthcare delivery. Provides a broad perspective on various career paths, such as consulting, entrepreneurship, delivery system management, and digital innovation development. Student teams work with a provider, supplier or healthcare-related startup organization on an applied project. Includes on-site work during fall and IAP.
A. Quaadgras, J. Jonasson

15.778 Introduction to Operations Management
Prereq: None
G (Summer)
3-0-6 units
Integrated approach to the analysis, design and management of supply networks for products and services. Provides a framework for analysis, design and operation of supply chains (SCs) that relies on fundamental concepts, such as the management of inventory, and operations and logistics planning. Discusses the value of (timely) information and of the need for collaboration and coordination between SC players. Also presents conceptual frameworks that focus on the emergence of a wide range of enabling services that are critical to the survival and growth of this class of system. Includes study and discussion of concepts, examples, and case studies from a wide range of industries. Guest speakers present personal experiences on various aspects of the service industry and supply chains. Restricted to Sloan Fellow MBAs.
V. Farias

15.779 Technology, Design and Entrepreneurship: Operating in Emerging Communities
Subject meets with 15.781
Prereq: Permission of instructor
G (Spring)
3-0-3 units
Designed for students working on solutions for resource-constrained communities. Examines downstream issues surrounding the adoption, distribution, and scaling (via business, non-profit, or public policy channels) of new solutions in an international development context. Focuses on implementing solutions as well as understanding the impact of interventions proposed.
C. Vaishnav, D. Rigos, R. Stoner, C. Fine

15.780 Stochastic Models in Business Analytics
Prereq: 6.041B, 15.0791, or permission of instructor
U (Fall)
3-0-9 units
Introduces core concepts in data-driven stochastic modeling that inform and optimize business decisions under uncertainty. Covers stochastic models and frameworks, such as queuing theory, time series forecasting, network models, dynamic programming, and stochastic optimization. Draws on real-world applications, with several examples from retail, healthcare, logistics, supply chain, social and online networks, and sports analytics.
R. Levi, K. Zheng
15.781 Technology, Design and Entrepreneurship: Operating in Emerging Communities
Subject meets with 15.779
Prereq: Permission of instructor
G (Spring)
2-0-1 units
Designed for students working on solutions for resource-constrained communities. Examines downstream issues surrounding the adoption, distribution, and scaling (via business, non-profit, or public policy channels) of new solutions in an international development context. Focuses on implementing solutions as well as understanding the impact of interventions proposed. Restricted to Tata Fellows.
C. Vaishnav, D. Rigos, R. Stoner, C. Fine

15.783[J] Product Design and Development
Same subject as 2.739[J]
Prereq: 2.009, 15.761, 15.778, 15.814, or permission of instructor
G (Spring)
3-3-6 units
Covers modern tools and methods for product design and development. Includes a cornerstone project in which teams conceive, design and prototype a physical product and/or service. Covers design thinking, product planning, identifying customer needs, concept generation, product architecture, industrial design, concept design, green design methods, and product management. Sloan students register via Sloan course bidding. Engineering students accepted via lottery based on WebSIS pre-registration.
S. Eppinger, M. C. Yang

15.784 Operations Laboratory
Prereq: None. Coreq: 15.761
G (Spring)
2-3-4 units
Provides an interactive learning experience in implementing operations improvement and an opportunity to work on challenging operations problems across industries in the Boston-area, across the United States, and abroad. Teams of 3-5 students use their training and experience to help improve operations in organizations that range from small and medium businesses to multi-national corporations. Teams conduct term-long projects via remote interactions with companies, and travel to work on-site at the client company during the Sloan Innovation Period. Boston-area projects involve periodic visits throughout the term.
T. Kraft

15.785 Digital Product Management
Prereq: None
G (Spring; first half of term)
2-0-4 units
Introduction to product management with an emphasis on its role within technology-driven enterprises. Topics include opportunity discovery, product-technology roadmapping, product development processes, go-to-market strategies, product launch, lifecycle management, and the central role of the product manager in each activity. Exercises and assignments utilize common digital tools, such as storyboarding, wireframe mock-ups, and A/B testing. Intended for students seeking a role in a product management team or to contribute to product management in a new enterprise.
Staff

15.792[J] Global Operations Leadership Seminar
Same subject as 2.890[J], 10.792[J], 16.985[J]
Prereq: None
G (Fall, Spring)
2-0-0 units
Can be repeated for credit.
Integrative forum in which worldwide leaders in business, finance, government, sports, and education share their experiences and insights with students aspiring to run global operations. Students play a large role in managing the seminar. Preference to LGO students.
T. Roemer

15.794 Research Project in Operations
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Designed for Leaders for Global Operations (LGO) students in conjunction with on-site projects at LGO partner companies. Student teams work on faculty-supervised thesis research projects that deal with a specific aspect of operations. Students required to summarize their work in the context of understanding organization, leadership, teamwork, and task management in conjunction with 15.317.
T. Roemer
15.795 Behavioral Decision Theories and Applications
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Introduces fundamental behavioral theories of human decision making and demonstrates how they impact the design of management strategies and policies. Topics include prospect theory, reference-dependence preferences, loss aversion, ambiguity aversion, regret, inter-temporal preferences, social preferences, cognitive hierarchy, bounded rationality, and adaptive learning. Studies these concepts in a wide range of applications, including pricing, supply chain management, social welfare, marketing, contract design, sustainability, and e-commerce. Discusses experimental methodologies to identify and measure various preferences and phenomena, as well as mathematical models to capture them in decision making. Content updated from year to year to include state-of-the-art research.
K. Zheng

15.814 Marketing Innovation
Prereq: None
G (Fall, Spring)
3-0-6 units
Credit cannot also be received for 15.732, 15.8141
Develops the skills necessary to market innovations, including new products, services, concepts, and customer experiences. Covers how to select the right market, target that market effectively, position a product or service for maximum success, and combine analytics, frameworks, and research for maximum potential. Emphasizes both marketing theory and practice: proven solutions to marketing problems, case sessions to illustrate the application of these techniques in various industries, and practice sessions to apply these techniques to real problems.
Consult J. Hauser, J. Zhang

15.799 Workshop in Operations Management
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Presentations by faculty, doctoral students, and guest speakers of ongoing research relating to current issues in operations management, including reports of research projects (proposed or in progress) and informal discussions of recent literature dealing with subjects of special interest to participants. Primarily for doctoral students.
Staff

Marketing

15.809 Introduction to Marketing and Strategy
Prereq: None
G (Summer)
3-0-6 units
Introduces the core strategic framework used to evaluate the attractiveness of different markets. Reviews the methods that firms can use to optimize their profits in the markets that they choose to target. Restricted to Sloan Fellow MBAs.
D. Simester

15.815 Applied Behavioral Economics (New)
Prereq: None
G (Spring; second half of term)
3-0-3 units
Introduction to behavioral economics for future managers, analysts, consultants or advisors to private and public enterprises. Presents basic principles of behavioral economics, and selected applications to marketing, management, finance, and public policy. Focuses on hidden influences, habits, and irrationalities in our behavior. Treats departures from 'rational behavior' as opportunities - for individuals to improve themselves, for companies to solve consumers' problems, for society to create new institutions and policies.
D. Prelec
15.818 Pricing
Prereq: 15.809, 15.814, or permission of instructor
G (Fall; first half of term)
3-0-3 units
Credit cannot also be received for 15.726
Framework for understanding pricing strategies and analytics, with emphasis on entrepreneurial pricing. Topics include economic value analysis, elasticities, customization, complementary products, pricing in platform markets, and anticipating competitive responses.
C. Tucker

15.819 Marketing Analytics
Prereq: 15.809, 15.814, or permission of instructor
G (Spring)
3-0-6 units
Hands-on course, using quantitative data to inform, make, and automate marketing decisions, including growth marketing, product design, pricing and promotions, advertising, and customer retention. Topics include creating metrics, randomized experiments, models for targeting, and analyzing launches. Features lectures, industry examples and guest panels, and data analysis assignments supported by in-class labs. Draws inspiration from the internet industry, but applications span many industries.
D. Eckles

15.821 Listening to the Customer
Prereq: None
G (Spring; first half of term)
3-0-3 units
Introduction to soft consumer research methods, useful for getting quick customer input into decisions on product design and development, strategic positioning, advertising, and branding. Covers interview techniques, observational methods, voice of the customer, focus groups, and analyses suitable for qualitative data. Introduces new information-gathering methods in development at MIT.
D. Prelec

15.822 Strategic Market Measurement
Prereq: None
G (Spring; second half of term)
3-0-3 units
Project subject teaches students how to create, carry out, interpret, and analyze a market research questionnaire. Emphasis on discovering market structure and segmentation, but students can pursue other project applications. Includes a user-oriented treatment of multivariate analysis (factor analysis, multidimensional scaling, conjoint and cluster analysis).
D. Prelec

15.828 Product Management
Prereq: 15.809, 15.814, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units
Practical introduction to the process of product management. Provides opportunities for experiential learning through projects with companies and organizations. Exposes students to state-of-the-art frameworks and tools that bring to market elegant and efficient solutions to strong customer needs. Covers the major phases of product management: opportunity identification (customer insights, interviews and surveys, ideation and brainstorming), design (product strategy and conjoint analysis), testing (concept testing, prototyping and A/B testing), and launch (choice of media and channel).
T. Ke

15.830 Enterprise Management Lab
Prereq: None. Coreq: 15.761, 15.814, or 15.900
G (Fall, IAP)
3-0-3 units
Lays the foundation for the Enterprise Management (EM) Track by developing students’ ability to apply integrated management perspectives and practices through action-learning. Small teams of students deliver quality deliverables by working on projects for large organizations and emergent innovators that integrate marketing, operations, and/or strategy. Students engage with faculty mentors and guest faculty speakers from marketing, strategy, and operations. Promotes a holistic cross-functional approach to addressing business issues. Significant class time allocated to team collaboration on projects. Students must register for both the fall term and IAP. Restricted to MBA students in EM Track.
S. Chatterjee
**15.833 Business-to-Business Marketing**  
Prereq: 15.809, 15.814, or permission of instructor  
G (Fall; second half of term)  
3-0-3 units  
Applies marketing concepts, analyses and tools used in business-to-business (B2B) marketing. Develops an understanding of customer value management and value quantification as a strategy for delivering superior value to targeted business segments while maintaining equitable returns. Focuses on B2B pricing, brand building, web and technology facilitation of the supply chain, and customer relationship management. Underscores sales force management within the context of go-to-market strategy; however, does not address selling per se. Discusses ethical issues and various B2B contexts, such as products and services, for- and non-profits, and domestic and global markets. Emphasizes applications in technology and healthcare domains. Includes value-based pricing project, case studies, applied exercises, and readings.  
*S. Chatterjee*

**15.834 Marketing Strategy**  
Prereq: 15.809, 15.814, or permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring; first half of term)  
4-0-2 units  
Prepares students to formulate the marketing component of overall corporate strategy. Students examine three types of situations: some in which firms leverage their existing competitive advantages; some in which they build new competitive advantages; and some in which a seemingly weaker competitor, such as a start-up, leapfrogs a larger incumbent. Presents material through a combination of cases, lectures, and a group project.  
*B. Wernerfelt*

**15.835 Entrepreneurial Marketing**  
Prereq: None  
G (Spring; second half of term)  
3-0-3 units  
Explores a basic marketing framework in depth as it applies to start-ups. Students then apply this framework to a project.  
*B. Wernerfelt*

**15.838 Research Seminar in Marketing**  
Prereq: None  
G (Fall, Spring)  
3-0-6 units  
Can be repeated for credit.  
Seminar on current marketing literature and current research interests of faculty and students. Topics such as marketing models, consumer behavior, competitive strategy, marketing experimentation, and game theory. Restricted to doctoral students.  
*Consult B. Wernerfelt*

**15.839 Workshop in Marketing**  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Presentations by faculty, doctoral students, and guest speakers of ongoing research relating to current issues in marketing. Topics: reports of research projects (proposed or in progress) and informal discussions of recent literature dealing with subjects of special interest to participants. Restricted to doctoral students.  
*Staff*

**15.840-15.843 Seminar in Marketing**  
Prereq: 15.810  
G (Fall)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  
Group study of current topics related to marketing.  
*Staff*

**15.846 Branding**  
Prereq: 15.810  
G (Spring; second half of term)  
3-0-3 units  
Provides a foundation for building, managing, and defending brands at various stages in the brand life cycle. Introduces the fundamentals of brand architecture and management relevant for B2C and B2B Marketing. Examples from a variety of industries cover topics that include brand co-creation, diffusion, imitation, and authenticity. Explores theory and practice using cases and academic research. Also looks at the development of leadership branding.  
*R. Gosline*
15.847 Consumer Behavior
Prereq: 15.810
G (Spring; second half of term)
3-0-6 units
Examines models of consumer behavior and methods for its analysis and prediction. Focuses on theories developed in marketing, psychology, and other behavioral sciences, and their role in understanding consumer preferences and decision making. Reviews theories in the context of a variety of industry applications. Students apply theories to their own market research projects.
Staff

System Dynamics

15.871 Introduction to System Dynamics
Prereq: Permission of instructor
G (Fall, Spring; first half of term)
3-0-3 units
Credit cannot also be received for 15.736
Introduction to systems thinking and system dynamics modeling applied to strategy, organizational change, and policy design. Students use simulation models, management flight simulators, and case studies to develop conceptual and modeling skills for the design and management of high-performance organizations in a dynamic world. Case studies of successful applications of system dynamics in growth strategy, management of technology, operations, public policy, product development, and others. Principles for effective use of modeling in the real world. Meets with 15.873 first half of term when offered concurrently. Students taking 15.871 complete additional assignments.
D. Keith, H. Rahmandad, J. Sterman

15.872 System Dynamics II
Prereq: 15.871
G (Spring; second half of term)
3-0-3 units
Credit cannot also be received for 15.737
Emphasizes tools and methods needed to apply systems thinking and simulation modeling successfully in diverse real-world settings, including supply chains, forecasting, project management, process improvement, service operations, and platform-based businesses, among others. Uses simulation models, management flight simulators, and case studies to deepen the conceptual and modeling skills introduced in 15.871. Through models and case studies of successful applications students develop proficiency in how to use qualitative and quantitative data to formulate and test models, and how to work effectively with senior executives to implement change successfully. Expectations and evaluation criteria differ for students taking half-term graduate version; consult syllabus or instructor for specific details.
J. D. Sterman, H. Rahmandad, D. Keith

15.873 System Dynamics for Business and Policy (New)
Prereq: None
G (Fall, Spring)
3-0-6 units
Focuses on developing the skills and tools needed to successfully apply systems thinking and simulation modeling in diverse real-world settings, including growth strategy, management of technology, operations, public policy, product development, supply chains, forecasting, project management, process improvement, service operations, and platform-based businesses, among others. Uses simulation models, management flight simulators, and case studies to deepen conceptual and modeling skills beyond what is introduced in 15.871. Exploring case studies of successful applications, students develop proficiency in how to use qualitative and quantitative data to formulate and test models, and how to work effectively with senior executives to successfully implement change. Prepares students for further work in the field. Meets with 15.871 in first half of term when offered concurrently. Students taking 15.871 complete additional assignments.
H. Rahmandad

15.874[J] People and the Planet: Environmental Governance and Science
Same subject as 12.387[J], IDS.063[J]
Prereq: None
Acad Year 2019–2020: U (Fall)
Acad Year 2020–2021: Not offered
3-0-6 units
See description under subject 12.387[J].
N. Selin, S. Solomon, J. Sterman
15.875 Applications of System Dynamics
Prereq: 15.872
G (Spring)
Not offered regularly; consult department
3-0-6 units
Can be repeated for credit.
Explores how system dynamics can help organizations achieve important goals. Student teams pair with clients to tackle a pressing issue framed by the client and its partners. In interactive classroom sessions, and via client engagement, students learn modeling and consulting skills they need to be effective. Focuses on gaining practical insight from system dynamics and its application across a wide range of organizations and challenges. Consult J. D. Sterman

15.878 Capstone Seminar in Sustainability
Prereq: None. Coreq: 15.915
G (Spring; second half of term)
3-0-3 units
Provides an opportunity for students to synthesize their coursework and experiences in sustainability. Explores the institutions and global goals that are driving toward sustainability, and how these interact with the industries that students plan to enter after graduation. In this context, students reflect on their strengths and aspirations, and formulate a strategy to maximize their impact and career success. Guest practitioners provide insight and inspiration throughout the course, drawing on their experience across sectors. J. Jay

15.879 Research Seminar in System Dynamics
Prereq: 15.872 and permission of instructor
G (Fall, Spring)
3-0-9 units
Can be repeated for credit.
Doctoral level seminar in system dynamics modeling, with a focus on social, economic and technical systems. Covers classic works in dynamic modeling from various disciplines and current research problems and papers. Participants critique the theories and models, often including replication, testing, and improvement of various models, and lead class discussion. Topics vary from year to year. Consult D. Keith, J. Sterman

Strategic Management

15.900 Competitive Strategy
Prereq: None
G (Fall, Spring)
3-0-6 units
Credit cannot also be received for 15.9001
Explores a wide range of strategic problems, focusing particularly on the sources of competitive advantage and the interaction between industry structure and organizational capabilities. Introduces a wide variety of modern strategy frameworks and methodologies. Builds upon and integrates material from core topics, such as economics and organizational processes. Meets with 15.9001 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
D. Sull, N. Thompson, A. Kacperczyk

15.9001 Competitive Strategy
Prereq: None
U (Spring; first half of term)
3-0-6 units
Credit cannot also be received for 15.900
Explores a wide range of strategic problems, focusing particularly on the sources of competitive advantage and the interaction between industry structure and organizational capabilities. Introduces a wide variety of modern strategy frameworks and methodologies. Builds upon and integrates material from core topics, such as economics and organizational processes. Meets with 15.900 when offered concurrently. Expectations and evaluation criteria differ for students taking graduate version; consult syllabus or instructor for specific details.
D. Sull, N. Thompson, A. Kacperczyk

15.902 Advanced Strategic Management
Prereq: Permission of instructor
G (Spring; first half of term)
3-0-3 units
Credit cannot also be received for 15.714
Focuses on developing skills and applying frameworks for the conduct of competitive and corporate strategy. Develops tools from earlier core subjects, especially those from strategic marketing, organizational processes, innovation-driven advantage, and economics. Emphasis is placed on the role of strategic commitments, social networks, strategic coherence, and adapting to environmental and technological change. Restricted to MIT Sloan Fellows.
E. Zuckerman
15.903 Managing the Modern Organization: Organizational Economics and Corporate Strategy
Prereq: 15.010 and 15.311
G (Fall, Spring; first half of term)
3-0-3 units
Focuses on how managers build and manage complex organizations to achieve strategic goals. Develops theoretical frameworks that build on 15.010 and 15.311. Applies these frameworks to corporate strategy (i.e., the design and management of the multi-business firm) and extended enterprises (i.e., the design and management of multi-firm structures such as supply chains, alliances, joint ventures, and networks).
R. Gibbons

15.904 Advanced Strategic Management
Prereq: 15.900 or permission of instructor
G (Spring; second half of term)
3-0-3 units
Builds on 15.900 and 15.902 to explore key concepts that have shaped the field of strategic management and strategy consulting over the past several decades. Uses lectures, readings, case studies, and videos to review the evolution of strategy teaching, research, and practice; differences between strategic thinking versus strategic planning; and the sources as well as enduring principles related to competitive advantage. Key themes include the role of platform strategies and services, as well as capabilities, pull mechanisms, economies of scope, and flexibility, with examples from a variety of industries. Develops an understanding of what has made some firms successful in the past as well as what managers can do to compete in an uncertain future.
M. Cusumano

15.905 Technology Strategy
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units
Provides a series of strategic frameworks for managing high-technology businesses. Emphasis on the development and application of conceptual models which clarify the interactions between competition, patterns of technological and market change, and the structure and development of internal firm capabilities.
J. Utterback

15.910 Innovation Strategy
Prereq: None
G (Spring; first half of term)
3-0-3 units
Establishes a solid foundation for students interested in formulating and executing a strategy for developing new-to-the-world products in a technology-intensive business. Clarifies the interactions among competition, patterns of technological and market change, and the development of internal firm capabilities. Topics include “crossing the chasm” with new technologies, appropriating the returns from innovation, platform strategy, and the role of intellectual property and government regulations. Key conceptual frameworks are linked to applications in a variety of industry and case settings.
B. Roin

15.911 Entrepreneurial Strategy
Prereq: None
G (Spring; second half of term)
6-0-3 units
Credit cannot also be received for 15.715
Teaches an integrated strategy framework for start-ups. Provides a deep understanding of the core strategic choices facing innovation-based entrepreneurs, a synthetic framework for the process of choosing and the implementation of entrepreneurial strategy, and the core challenges and approaches for scaling ventures over time. Highlights the process of how to choose an entrepreneurial strategy, the specific choices that matter, how key choices fit together to form an overall entrepreneurial strategy, and the playbook for particular strategies for startups.
S. Stern

15.912 Strategic Management of Innovation and Entrepreneurship
Prereq: 15.910, 15.911, or permission of instructor
G (Spring; second half of term)
Not offered regularly; consult department
3-0-3 units
Provides a series of strategic frameworks for managing high-technology businesses with a particular focus on innovation and entrepreneurship, especially as it builds upon patterns of technological and market change, prior research on product development and new ventures, and the structure and development of organizational capabilities. Includes case analyses and simulations, as well as independent readings drawn from research in technological innovation, entrepreneurial management, and organizational theory.
Staff
15.913 Strategies for Sustainable Business
Prereq: None
G (Spring; first half of term)
Not offered regularly; consult department
3-0-3 units
Develops a pragmatic, action-oriented approach to sustainability: the alignment between healthy businesses, healthy environments, healthy societies, and an economy that meets human needs. In-class simulations and role-playing provide a robust foundation for understanding sustainability challenges. Cases analyze innovative strategies for sustainable businesses and organizations. Class discussions explore how sustainability is changing existing business models and market structures, how to develop sustainable management practices, and how firms can implement those practices successfully.
M. Amengual, J. Jay, J. Sterman

15.914 Competitive Dynamics and Strategy: Winning in Technology Markets
Prereq: 15.872 and (15.369, 15.567, 15.900, or 15.902)
G (Spring)
2-0-7 units
Focuses on competitive strategy in technology-driven markets. Students acquire a portfolio of models of the signature dynamics in these markets and use the models in projects with participating companies to analyze technology markets, formulate competitive strategies, and illuminate the challenges of execution. Addresses issues critical for both established incumbents and new market entrants. Restricted to graduate students.
H. B. Weil

15.915 Laboratory for Sustainable Business
Prereq: None
G (Spring)
3-0-9 units
Develops a pragmatic, action-oriented approach to sustainability: the alignment between healthy businesses, healthy environments, healthy societies, and an economy that meets human needs. In-class simulations and role-playing provide a robust foundation for understanding sustainability challenges. Cases analyze innovative strategies for sustainable businesses and organizations. Class discussions explore how sustainability is changing existing business models and market structures, how to develop sustainable management practices, and how firms can implement those practices successfully. Students apply the concepts, theories, and tools of the course by working with a host organization on a real management project during the semester.
M. Amengual, J. Jay

15.928 The Sociology of Strategy
Prereq: 15.342
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Doctoral seminar in theory building for social scientists interested in economic sociology, organization theory, strategic management, and related fields. Builds skills for developing social scientific theory. Focuses on assessing and developing the relevance of sociological research for key questions in strategy research: what explains the relative performance of firms and the variety of their strategies for achieving performance. Students also develop skills in evaluating academic research in this area. Restricted to doctoral students.
E. Zuckerman

15.929 Identity and Action
Prereq: 15.342
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Doctoral seminar in theory building for social scientists. Primary goal is to build skills for developing social scientific theory. Secondary goals are to review and integrate a broad array of ideas concerning the foundations of identity and its relation to action, and to suggest how such issues relate to a broader set of questions in the social sciences. Students learn that any account of action is based on ascribing desires, beliefs, and opportunities to specific actors, but such actors cannot be easily explained except as a result of action by prior actors. The focus of this course is around developing this paradox and providing a foundation for resolving it. Restricted to doctoral students.
E. Zuckerman

15.933 Strategic Opportunities in Energy
Prereq: 15.900 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall; first half of term)
4-0-2 units
Introduces the energy system in terms of sources and uses, market characteristics, and key metrics. Provides frameworks for understanding the structure and dynamics of the sector and the drivers of the energy future. Opportunities resulting from demand growth, supply challenges, environmental constraints, security of supply, technology breakthroughs, and regulation are analyzed from the perspectives of both established players and entrepreneurs. Student teams engage in projects that evaluate a segment of the energy landscape and develop a strategic prospectus for a new business opportunity.
H. B. Weil
15.941[J] Leadership in Real Estate
Same subject as 11.430[J]
Prereq: None
G (Fall; first half of term)
3-0-3 units

Designed to help students deepen their understanding of leadership and increase self-awareness. They reflect on their leadership styles and create goals and a learning plan to develop their capabilities. They also participate in activities to strengthen their “leadership presence“ - the ability to authentically connect with people’s hearts and minds. Students converse with leaders to learn from their insights, experiences, and advice. Limited to 15.

G. Schuck

15.949 Seminar in Strategy
Prereq: None
G (Fall)
Units arranged
Can be repeated for credit.

Opportunity for group study by graduate students on current topics related to strategy.
Consult E. Zuckerman

Special Subjects

15.S01 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.S02 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.
Staff

15.S03 Special Seminar in Management
Prereq: Permission of instructor
G (IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.
Staff

15.S04 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, Spring, Summer; first half of term)
Units arranged
Can be repeated for credit.

Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.
Staff

15.S05 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer; second half of term)
Units arranged
Can be repeated for credit.

Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.
Staff

15.S06 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer; first half of term)
Units arranged
Can be repeated for credit.

Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.
Staff

15.S07 Special Seminar in Management
Prereq: Permission of instructor
G (IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.
Staff
15.S08 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, IAP, Summer; second half of term)  
Units arranged  
Can be repeated for credit.  
Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.  
_Staff_

15.S09 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged  
Can be repeated for credit.  
Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.  
_Conult Department Headquarters_

15.S10 Special Seminar in Management  
Prereq: Permission of instructor  
G (IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum. Consult Department headquarters.  
_E. Zuckerman Sivan_

15.S11 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, Summer)  
Units arranged  
Can be repeated for credit.  
Opportunity for group study by graduate students on current topics related to management not otherwise included in curriculum.  
_Conult Sloan Educational Services_

Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
_Opt for group study by graduate students on current topics related to management not otherwise included in curriculum._  
Consult Department headquarters.  
_E. Zuckerman Sivan_
15.S18 Special Seminar in Management
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult: Sloan Educational Services

15.S19 Special Seminar in Management
Prereq: Permission of instructor
G (IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

Prereq: Permission of instructor
G (IAP)
Units arranged
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum. Coursework may continue into the following term.
Consult Sloan Educational Services

15.S30 Special Distance Learning Seminar in Management
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit.
Group study through distance learning on current topics related to management.
Consult Sloan Educational Services

15.S31 Special Distance Learning Seminar in Management
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Group study through distance learning on current topics related to management.
Consult Sloan Educational Services

15.S32 Special Distance Learning Seminar in Management
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Group study through distance learning on current topics related to management.
Consult Sloan Educational Services

15.S33 Special Distance Learning Seminar in Management
Prereq: None
G (Spring, Summer)
Units arranged
Can be repeated for credit.
Group study through distance learning on current topics related to management.
Consult Sloan Educational Services

15.S35-15.S38 Special Distance Learning Seminar in Management
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Group study through distance learning on current topics related to management.
Consult Sloan Educational Services

15.S40 Special Seminar in Management
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Staff

15.S41 Special Seminar in Management
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Staff
15.S42 Special Seminar in Management  
Prereq: None  
U (Fall)  
Units arranged  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Staff

15.S43 Special Seminar in Management  
Prereq: None  
U (Fall, Spring; first half of term)  
Units arranged  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Staff

15.S44 Special Seminar in Management  
Prereq: None  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Staff

15.S45 Special Seminar in Management  
Prereq: None  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Staff

15.S46 Special Seminar in Management  
Prereq: None  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Staff

15.S47 Special Seminar in Management  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Consult Undergraduate Program Headquarters

15.S48 Special Seminar in Management  
Prereq: None  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S49 Special Seminar in Management  
Prereq: None  
U (Fall, IAP)  
Units arranged  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S50 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S51 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, Spring; second half of term)  
Units arranged [P/D/F]  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S52 Special Seminar in Management  
Prereq: Permission of instructor  
G (IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S53 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.

Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services
15.S54 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S55 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S56 Special Seminar in Management  
Prereq: Permission of instructor  
G (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S57 Special Seminar in Management  
Prereq: Permission of instructor  
G (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S58 Special Seminar in Management  
Prereq: Permission of instructor  
G (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S59 Special Seminar in Management  
Prereq: Permission of instructor  
G (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S60 Special Seminar in Management  
Prereq: Permission of instructor  
G (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S61 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S62 Special Seminar in Management  
Prereq: Permission of instructor  
G (IAP)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services

15.S63 Special Seminar in Management  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Group study of current topics related to management not otherwise included in curriculum.  
Consult Sloan Educational Services
15.S64 Special Seminar in Management
Prereq: Permission of instructor
G (Fall; first half of term)
Units arranged [P/D/F]
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.S65 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.S66 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.S67 Special Seminar in Management
Prereq: Permission of instructor
G (Spring, Summer; second half of term)
Units arranged
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.S68 Special Seminar in Management
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.S69 Special Seminar in Management
Prereq: Permission of instructor
G (Summer)
Units arranged
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.S70-15.S75 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Group study of current topics related to management not otherwise included in curriculum.
Consult Sloan Educational Services

15.UR Undergraduate Research in Management
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Participation in the work of a research group which includes such activities as independent study of the literature, direct involvement in the group's research (commensurate with the student's skills and preparation), or project work under an individual faculty member possibly extending over more than one term. Admission by arrangement with individual faculty member. Requires written project report.
Staff

15.URG Undergraduate Studies in Management
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Participation in the work of a research group which includes such activities as independent study of the literature, direct involvement in the group's research (commensurate with the student's skills and preparation), or project work under an individual faculty member possibly extending over more than one term. Admission by arrangement with individual faculty member. Requires written project report.
J. S. Carroll
15.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units
See description under subject 2.EPE.
Staff

15.950 Independent Study in Management
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Advanced work, special investigation or application of a management topic, on an individual basis, under faculty supervision. May include readings, conferences, laboratory and fieldwork, and reports. Projects require prior approval, as well as a written proposal and a final report.
M. Hanlon

15.951 Independent Study in Management
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Advanced work, special investigation or application of a management topic, on an individual basis, under faculty supervision. May include readings, conferences, laboratory and fieldwork, and reports. Projects require prior approval, as well as a written proposal and a final report.
M. Hanlon

15.952 Curricular Practical Training
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 units
Can be repeated for credit.
For Course 15 undergraduate students participating in management curriculum-related off-campus internship experiences. Students must have an employment offer from a company or organization and must find a Sloan faculty supervisor before enrolling. Consult Sloan Undergraduate Education Office
M. Hanlon

15.960 Independent Study in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Advanced work, special investigation or application of a management topic, on an individual basis, under faculty supervision. May include readings, conferences, laboratory and fieldwork, and reports. Projects require prior approval, as well as a written proposal and a final report.
Consult Sloan Educational Services

15.961 Independent Study in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Advanced work, special investigation or application of a management topic, on an individual basis, under faculty supervision. May include readings, conferences, laboratory and fieldwork, and reports. Projects require prior approval, as well as a written proposal and a final report.
Consult Sloan Educational Services

15.962 Pre-Thesis Research
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Pre-thesis research conducted under faculty supervision; advance approval of project proposal required. Restricted to PhD students.
Consult H. Ross

15.998 Independent Group Study in Action Learning
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Team-based opportunities for application management tools, under faculty supervision, on dynamic projects that provide a wide array of operational challenges facing organizations around the world. May include travel to on-site locales. Projects require prior approval, as well as a written proposal and a final report.
Consult T. Walor
15.999 Internship
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Students participate in an off-campus internship experience and apply topics of management and/or culture to their experience. Requirements include mandatory attendance at one workshop and a written deliverable. Students must have a formal offer letter from host employer/organization prior to enrolling. Restricted to MIT Sloan students who wish to intern in an area related to their field of study. Additional restrictions may apply.

Consult Sloan Educational Services

15.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Research and writing of thesis; to be arranged by the student with supervising committee.

Consult Sloan Educational Services
3.001 Introduction to Materials Science and Engineering
Prereq: None
U (Spring)
2-0-1 units

Provides a broad introduction to topics in materials science and the curricula in the Department of Materials Science and Engineering's core subjects. Lectures emphasize conceptual and visual examples of materials phenomena and engineering, interspersed with guest speakers from both inside and outside academia to show possible career paths. Subject can count toward the 9-unit discovery-focused credit limit for first year students. Preference to first-year students.  
F. M. Ross

3.003 Principles of Engineering Practice
Subject meets with 3.004
Prereq: Calculus I (GIR) and Physics I (GIR)
U (Spring)
1-2-6 units

Introduces students to the interdisciplinary nature of 21st-century engineering projects with three threads of learning: a technical toolkit, a social science toolkit, and a methodology for problem-based learning. Students encounter the social, political, economic, and technological challenges of engineering practice by participating in actual engineering projects involving public transportation and information infrastructure with faculty and industry. Student teams create prototypes and mixed media reports with exercises in project planning, analysis, design, optimization, demonstration, reporting and team building. Preference to first-year students.  
L. Kimerling

3.004 Principles of Engineering Practice
Subject meets with 3.003
Prereq: Calculus I (GIR) and Physics I (GIR)
U (Spring)
3-3-6 units

Introduces students to the interdisciplinary nature of 21st-century engineering projects with three threads of learning: a technical toolkit, a social science toolkit, and a methodology for problem-based learning. Students encounter the social, political, economic and technological challenges of engineering practice via case studies and participation in engineering projects. Includes a six-stage term project in which student teams develop solutions through exercises in project planning, analysis, design, optimization, demonstration, reporting, and team building.  
L. Kimerling

3.005 Passion Projects: Living in a Material World
Prereq: None
U (Spring)
Not offered regularly; consult department
1-2-6 units

Project-based seminar in which students formulate and answer questions about a material or object that interests and inspires them. Uses cutting-edge equipment to characterize the materials' structure in order to understand its role and functionality. Analyzes the lifecycle of the material to better understand the full use case. Culminates in the creation of a website, video, and final presentation in which students share the results of their research. Preference to first-year students; limited to 15.  
J. Grossman

3.006 NEET Seminar: Advanced Materials Machines
Prereq: Permission of instructor
U (Fall, Spring)
1-0-2 units
Can be repeated for credit.

Seminar for students enrolled in the Advanced Materials Machines NEET thread. Focuses on topics around innovative materials manufacturing via guest lectures and research discussions.  
E. Olivetti

3.007 Introduction to Materials and Mechanical Design
Prereq: None
U (Fall)
2-3-1 units

Focuses on hands-on experience with characterization techniques, instrumentation, design thinking and optimizing solutions within design constraints. Applied to ideas relevant to materials science and mechanical engineering. Includes introductions to modern, rapid prototyping and characterization tools in the context of a design problem, followed by discovery-based labs illustrating manufacturing concepts. Culminates in a student-directed making experience.  
E. Olivetti
3.008 IAP in India - Humanistic Co-design of Assistive Technology in the Developing World
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (IAP)
Units arranged
Experiential practicum during which students innovate an assistive technology by engaging in a humanistic co-design process with someone who has a disability and lives in the developing world. Provides a unique platform to explore the complex engineering requirements of designing assistive technologies that must be relied upon in unpredictable environments. Students select a specialty within the field to investigate current state-of-the-art technologies and identify the facets of the material, mechanical and electrical design where innovation is possible. Previous experience designing and prototyping products using mechanical, material, electrical, or computational techniques suggested. Opportunities for funded travel available. May be taken for up to 12 units. Enrollment limited; preference to students looking to carry these projects forward as independent research projects.
K. Keane

3.012 Fundamentals of Materials Science and Engineering
Prereq: Chemistry (GIR) and Coreq: (3.016A, 18.03, or 18.032); or permission of instructor
U (Fall)
5-0-10 units. REST
Describes the fundamentals of structure and energetics that underpin materials science. Presents thermodynamic concepts and the laws governing equilibrium properties, and the connections between thermodynamic concepts and materials phenomena, such as phase transformations, multiphase equilibria, and chemical reactions. Introduces computerized thermodynamics. Structure of noncrystalline, crystalline, and liquid-crystalline states. Symmetry and tensor properties of materials. Point, line, and surface imperfections in materials. Diffraction and structure determination.
R. Jaramillo, C. Ross

3.014 Materials Laboratory
Prereq: None
U (Fall)
1-4.7 units. Institute LAB
Experimental exploration of the connections between structure, properties, processing, and performance of materials. Hands-on experience with materials characterization techniques and instrumentation. Covers methodology of technical communication (written and oral) with a view to integrate experimental design, execution, and analysis. Concurrent enrollment in 3.012 and 3.014 strongly recommended.
J. LeBeau, D. Sadoway

3.016A Computational and Mathematics Preparation for Materials Scientists and Engineers I (New)
Prereq: Calculus II (GIR); Coreq: 3.012
U (Fall)
3-0-3 units
Introduces computational techniques and applications of mathematics to prepare students for a Materials Science and Engineering curriculum. Students study computation/visualization and math techniques and apply them with symbolic algebra software (Mathematica). Students code and visualize topics from symmetry and structure of materials and thermodynamics. Topics include symmetry and geometric transformations using linear algebra, review of calculus of several variables, numerical solutions to differential equations, tensor transformations, eigensystems, quadratic forms, and random walks. Supports concurrent material in 3.012 and 3.014.
W. C. Carter

3.016B Computational and Mathematics Preparation for Materials Scientists and Engineers II (New)
Prereq: 3.016A; Coreq: 3.022 and 3.024
U (Spring)
3-0-3 units
Continues 3.016A with applications to microstructural evolution, electronic optical and magnetic properties of materials. Topics in 3.022 and 3.024 are emphasized and reinforced with visualization, computational, and mathematical techniques. Mathematics topics include symbolic and numerical solutions to partial differential equations, Fourier analysis, Bloch waves, analysis of random walks, linear stability analysis.
W. C. Carter

3.017 Modelling, Problem Solving, Computing, and Visualization
Prereq: ((3.014, 3.022, or 3.024) and (3.016B, 6.0001, 12.010, or 16.66)) or permission of instructor
U (Spring)
2-2-8 units
Covers development and design of models for materials processes and structure-property relations. Emphasizes techniques for solving equations from models or simulating their behavior. Assesses methods for visualizing solutions and aesthetics of the graphical presentation of results. Topics include symmetry and structure, classical and statistical thermodynamics, solid state physics, mechanics, phase transformations and kinetics, statistics and presentation of data.
W. C. Carter
3.021 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject.
Offered under: 1.021, 3.021, 10.333, 22.00
Prereq: 3.016B, 18.03, or permission of instructor
U (Spring)
4-0-8 units. REST

Basic concepts of computer modeling and simulation in science and engineering. Uses techniques and software for simulation, data analysis and visualization. Continuum, mesoscale, atomistic and quantum methods used to study fundamental and applied problems in physics, chemistry, materials science, mechanics, engineering, and biology. Examples drawn from the disciplines above are used to understand or characterize complex structures and materials, and complement experimental observations.

M. Buehler, R. Gomez-Bombarelli

3.022 Microstructural Evolution in Materials
Prereq: 3.012
U (Spring)
3-3-6 units

Covers microstructures, defects, and structural evolution in all classes of materials. Topics include solution kinetics, interface stability, dislocations and point defects, diffusion, surface energetics, grains and grain boundaries, grain growth, nucleation and precipitation, and electrophysical reactions. Lectures illustrate a range of examples and applications based on metals, ceramics, electronic materials, polymers, and biomedical materials. Explores the evolution of microstructure through experiments involving optical and electron microscopy, calorimetry, electrochemical characterization, surface roughness measurements, and other characterization methods. Investigates structural transitions and structure-property relationships through practical materials examples.

J. Hu, G. Beach, Y. Chiang

3.024 Electronic, Optical and Magnetic Properties of Materials
Prereq: 3.012
U (Spring)
3-3-6 units

Uses fundamental principles of quantum mechanics, solid state physics, electricity and magnetism to describe how the electronic, optical and magnetic properties of materials originate. Illustrates how these properties can be designed for particular applications, such as diodes, solar cells, optical fibers, and magnetic data storage. Involves experimentation using spectroscopy, resistivity, impedance and magnetometry measurements, behavior of light in waveguides, and other characterization methods. Uses practical examples to investigate structure-property relationships.

P. Anikeeva, G. Beach, Y. Chiang

3.032 Mechanical Behavior of Materials
Prereq: Physics I (GIR) and (3.016B or 18.03)
U (Fall)
3-1-8 units

Basic concepts of solid mechanics and mechanical behavior of materials: elasticity, stress-strain relationships, stress transformation, viscoelasticity, plasticity and fracture. Continuum behavior as well as atomistic explanations of the observed behavior are described. Examples from engineering as well as biomechanics. Lab experiments and demonstrations give hands-on experience of the physical concepts. Offers a combination of online and in-person instruction.

C. Tasan, M. Dao

3.034 Organic and Biomaterials Chemistry
Subject meets with 3.034A
Prereq: Chemistry (GIR)
U (Fall)
4-0-8 units

Focuses on the chemistry and chemical structure-property relationships of soft synthetic and biologically derived materials, and aims to develop a fundamental understanding of the molecular nature of materials. Topics include methods for preparing synthetic polymers by step- and chain-growth polymerizations; polymerization reaction kinetics; chemistry of proteins and nucleic acids; DNA nanotechnology; synthetic polypeptides and artificial amino acids; application of biologically derived materials into biomedical and sensing applications; electroactive organic materials; and polymer processing and mechanical properties. Includes firsthand application of lecture topics through design-oriented experiments.

R. Macfarlane

3.034A Organic and Biomaterials Chemistry
Subject meets with 3.034
Prereq: Chemistry (GIR)
U (Fall)
4-0-8 units

Focuses on the chemistry and chemical structure-property relationships of soft synthetic and biologically derived materials. Topics include methods for preparing synthetic polymers by step and chain growth polymerizations; polymerization reaction kinetics; chemistry of proteins, nucleic acids, polysaccharides and lipids; enzymatic reactions; electroactive organic materials; polymer mechanical properties and processing techniques; applications of biological and biomaterials; self-assembly of polymer, nanoparticle, and biological materials; instrumental techniques for characterizing soft materials. 3.034A students also complete additional written assignments in place of the 3.034 laboratory component.

R. Macfarlane
3.035 Problems in Materials Science and Engineering
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For undergraduates desiring to carry on projects of their own choosing, which may be experimental, theoretical, or of a design nature. Also for undergraduate studies arranged by students or staff, which may consist of seminars, assigned reading, or laboratory projects. See UROP Coordinator for registration procedures.

3.038 Problems in Materials Science and Engineering
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

For undergraduates desiring to carry on projects of their own choosing, which may be experimental, theoretical, or of a design nature. Also for undergraduate studies arranged by students or staff, which may consist of seminars, assigned reading, or laboratory projects. See UROP Coordinator for registration procedures.

3.042 Materials Project Laboratory
Prereq: 3.014, 3.032, or 3.044
U (Fall, Spring)
1-6-5 units

Student project teams design and fabricate a working prototype using materials processing technologies (e.g. solid works 3-D design software, computer numerical controlled mill, injection molding, thermoforming, investment casting, powder processing, three-dimensional printing, physical vapor deposition) appropriate for the materials and device of interest. Goals include using MSE fundamentals in a practical application; understanding trade-offs between design, processing, and performance and cost; and fabrication of a deliverable prototype. Emphasis on teamwork, project management, communications and computer skills, with extensive hands-on work using student and MIT laboratory shops. Teams document their progress and final results by means of written and oral communication. Limited to 25.

M. Tarkanian

3.044 Materials Processing
Prereq: 3.012 and 3.022
U (Spring)
4-0-8 units

Introduction to materials processing science, with emphasis on heat transfer, chemical diffusion, and fluid flow. Uses an engineering approach to analyze industrial-scale processes, with the goal of identifying and understanding physical limitations on scale and speed. Covers materials of all classes, including metals, polymers, electronic materials, and ceramics. Considers specific processes, such as melt-processing of metals and polymers, deposition technologies (liquid, vapor, and vacuum), colloid and slurry processing, viscous shape forming, and powder consolidation.

E. Olivetti

3.046 Thermodynamics of Materials
Prereq: 3.012 or permission of instructor
U (Spring)
4-0-8 units. REST

Explores equilibrium thermodynamics through its application to topics in materials science and engineering. Begins with a fast-paced review of introductory classical and statistical thermodynamics. Students select additional topics to cover; examples include batteries and fuel cells, solar photovoltaics, magnetic information storage, extractive metallurgy, corrosion, thin solid films, and computerized thermodynamics.

R. Jaramillo

3.052 Nanomechanics of Materials and Biomaterials
Prereq: 3.032 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Latest scientific developments and discoveries in the field of nanomechanics, i.e. the deformation of extremely tiny (10-9 meters) areas of synthetic and biological materials. Lectures include a description of normal and lateral forces at the atomic scale, atomistic aspects of adhesion, nanoindentation, molecular details of fracture, chemical force microscopy, elasticity of individual macromolecular chains, intermolecular interactions in polymers, dynamic force spectroscopy, biomolecular bond strength measurements, and molecular motors.

C. Ortiz
3.053[J] Molecular, Cellular, and Tissue Biomechanics
Same subject as 2.797[J], 6.024[J], 20.310[J]
Prereq: Biology (GIR), (2.370 or 20.110[J]), and (3.016B or 18.03)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units
See description under subject 20.310[J].  
M. Bathe, A. Grodzinsky

3.054 Cellular Solids: Structure, Properties, Applications
Subject meets with 3.36
Prereq: 3.032
U (Spring)
2-0-10 units
Discusses processing and structure of cellular solids as they are created from polymers, metals, ceramics, glasses, and composites; derivation of models for the mechanical properties of honeycombs and foams; and how unique properties of honeycombs and foams are exploited in applications such as lightweight structural panels, energy absorption devices, and thermal insulation. Covers applications of cellular solids in medicine, such as increased fracture risk due to trabecular bone loss in patients with osteoporosis, the development of metal foam coatings for orthopedic implants, and designing porous scaffolds for tissue engineering that mimic the extracellular matrix. Includes modelling of cellular materials applied to natural materials and biomimicking. Offers a combination of online and in-person instruction. Students taking graduate version complete additional assignments.
L. Gibson

3.055[J] Biomaterials Science and Engineering
Same subject as 20.363[J]
Subject meets with 3.963[J], 20.463[J]
Prereq: 3.034, 20.110[J], or permission of instructor
U (Fall)
3-0-9 units
See description under subject 20.363[J].  
D. Irvine, K. Ribbeck

3.063 Polymer Physics
Subject meets with 3.942
Prereq: 3.012
U (Spring)
4-0-8 units
The mechanical, optical, electrical, and transport properties of polymers and other types of “soft matter” are presented with respect to the underlying physics and physical chemistry of polymers and colloids in solution, and solid states. Topics include how enthalpy and entropy determine conformation, molecular dimensions and packing of polymer chains and colloids and supramolecular materials. Examination of the structure of glassy, crystalline, and rubbery elastic states of polymers; thermodynamics of solutions, blends, crystallization; liquid crystallinity, microphase separation, and self-assembled organic-inorganic nanocomposites. Case studies of relationships between structure and function in technologically important polymeric systems. Students taking graduate version complete additional assignments.
A. Alexander-Katz

3.064 Polymer Engineering
Prereq: 3.032 and 3.044
U (Fall)
3-0-9 units
Overview of polymer material science and engineering. Treatment of physical and chemical properties, mechanical characterization, processing, and their control through inspired polymer material design.
N. Holten-Andersen

3.07 Introduction to Ceramics
Prereq: 3.012
U (Fall)
3-0-9 units
Discusses structure-property relationships in ceramic materials. Includes hierarchy of structures from the atomic to microstructural levels. Defects and transport, solid-state electrochemical processes, phase equilibria, fracture and phase transformations are discussed in the context of controlling properties for various applications of ceramics. Numerous examples from current technology.
Y. Chiang
3.071 Amorphous Materials
Prereq: (3.022 and 3.024) or permission of instructor
U (Fall)
3-0-9 units
Discusses the fundamental material science behind amorphous solids (non-crystalline materials). Covers formation of amorphous solids; amorphous structures and their electrical and optical properties; and characterization methods and technical applications.
J. Hu

3.074 Imaging of Materials
Prereq: 3.024
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units
Principles and applications of imaging techniques for materials characterization including transmission and scanning electron microscopy and scanning probe microscopy. Topics include electron diffraction; image formation in transmission and scanning electron microscopy; diffraction and phase contrast; imaging of crystals and crystal imperfections; review of the most recent advances in electron microscopy for bio- and nanosciences; analysis of chemical composition and electronic structure at the atomic scale. Lectures, real-case studies and computer simulations.
Staff

3.080 Strategic Materials Selection
Prereq: 3.012, 3.014, or permission of instructor
U (Spring)
3-0-9 units
Provides a survey of methods for evaluating choice of material and explores the implications of that choice. Topics include manufacturing economics and utility analysis. Students carry out a group project selecting materials technology options based on economic characteristics.
R. Kirchain

3.081 Industrial Ecology of Materials
Subject meets with 3.560
Prereq: 3.012, 3.014, or permission of instructor
U (Fall)
3-0-9 units
Covers quantitative techniques to address principles of substitution, dematerialization, and waste mining implementation in materials systems. Includes life-cycle and materials flow analysis of the impacts of materials extraction; processing; use; and recycling for materials, products, and services. Student teams undertake a case study regarding materials and technology selection using the latest methods of analysis and computer-based models of materials process. Students taking graduate version complete additional assignments.
E. Olivetti

3.085[J] Venture Engineering
Same subject as 2.912[J], 15.373[J]
Prereq: None
U (Spring)
3-0-9 units
See description under subject 15.373[J].
S. Stern, E. Fitzgerald

3.086 Innovation and Commercialization of Materials Technology
Subject meets with 3.207
Prereq: None
U (Spring)
4-0-8 units
Introduces the fundamental process of innovating and its role in promoting growth and prosperity. Exposes students to innovation through team projects as a structured process, while developing skills to handle multiple uncertainties simultaneously. Provides training to address these uncertainties through research methods in the contexts of materials technology development, market applications, industry structure, intellectual property, and other factors. Case studies place the project in a context of historical innovations with worldwide impact. Combination of projects and real-world cases help students identify how they can impact the world through innovation.
E. Fitzgerald
3.087 Materials, Societal Impact, and Social Innovation
Prereq: 1.050, 2.001, 3.012, 10.467, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units

Students work on exciting, team-based projects at the interdisciplinary frontiers of materials research within a societal and humanistic context. Includes topics such as frontier research and inquiry, social innovation, human-centered design thinking, computational design, and additive manufacturing.
C. Ortiz, E. Spero

3.091 Introduction to Solid-State Chemistry
Prereq: None
U (Fall, Spring)
5-0-7 units. CHEMISTRY
Credit cannot also be received for 5.111, 5.112, CC.5111, ES.5111, ES.5112

Basic principles of chemistry and their application to engineering systems. The relationship between electronic structure, chemical bonding, and atomic order. Characterization of atomic arrangements in crystalline and amorphous solids: metals, ceramics, semiconductors, and polymers. Topical coverage of organic chemistry, solution chemistry, acid-base equilibria, electrochemistry, biochemistry, chemical kinetics, diffusion, and phase diagrams. Examples from industrial practice (including the environmental impact of chemical processes), from energy generation and storage (e.g., batteries and fuel cells), and from emerging technologies (e.g., photonic and biomedical devices).
J. Grossman, N. Holten-Andersen, R. Macfarlane

3.094 Materials in Human Experience
Prereq: None
U (Spring)
2-3-4 units. HASS-S

Examines the ways in which people in ancient and contemporary societies have selected, evaluated, and used materials of nature, transforming them to objects of material culture. Some examples: Maya use of lime plaster for frescoes, books and architectural sculpture; sounds and colors of powerful metals in Mesoamerica; cloth and fiber technologies in the Inca empire. Explores ideological and aesthetic criteria often influential in materials development. Laboratory/workshop sessions provide hands-on experience with materials discussed in class. Subject complements 3.091. Enrollment may be limited.
H. N. Lechtman, D. Hosler

3.095 Introduction to Metalsmithing
Prereq: None
U (Spring)
2-3-4 units. HASS-A

Centers around art history, design principles, sculptural concepts, and metallurgical processes. Covers metalsmithing techniques of enameling, casting, and hollowware. Students create artworks that interpret lecture material and utilize metalsmithing techniques and metal as means of expression. Also covers topics of art patronage, colonial influence upon arts production, and gender and class issues in making. Lectures and lab sessions supplemented by a visiting artist lecture and art museum field trip. Limited to 12.
T. Fadenrecht

3.14 Physical Metallurgy
Subject meets with 3.40[J], 22.71[J]
Prereq: 3.022 and 3.032
U (Fall)
Not offered regularly; consult department
3-0-9 units

Focuses on the links between the processing, structure, and properties of metals and alloys. First, the physical bases for strength, stiffness, and ductility are discussed with reference to crystallography, defects, and microstructure. Second, phase transformations and microstructural evolution are studied in the context of alloy thermodynamics and kinetics. Together, these components comprise the modern paradigm for designing metallic microstructures for optimized properties. Concludes with a focus on processing/microstructure/property relationships in structural engineering alloys, particularly steels and aluminum alloys. Students taking the graduate version explore the subject in greater depth.
C. Tasan

3.15 Electrical, Optical, and Magnetic Materials and Devices
Prereq: 3.024
U (Spring)
3-0-9 units

Explores the relationships between the performance of electrical, optical, and magnetic devices and the microstructural and defect characteristics of the materials from which they are constructed. Features a device-motivated approach that places strong emphasis on the design of functional materials for emerging technologies. Applications center around diodes, transistors, memristors, batteries, photodetectors, solar cells (photovoltaics) and solar-to-fuel converters, displays, light emitting diodes, lasers, optical fibers and optical communications, photonic devices, magnetic data storage and spintronics.
J. L.M. Rupp
3.152 Magnetic Materials
Subject meets with 3.45
Prereq: 3.024
U (Spring)
3-0-9 units

Topics include origin of magnetism in materials, magnetic domains and domain walls, magnetostatics, magnetic anisotropy, antiferro- and ferrimagnetism, magnetism in thin films and nanoparticles, magnetotransport phenomena, and magnetic characterization. Discusses a range of applications, including magnetic recording, spin-valves, and tunnel-junction sensors. Assignments include problem sets and a term paper on a magnetic device or technology. Students taking graduate version complete additional assignments. C. Ross

3.154[J] Materials Performance in Extreme Environments
Same subject as 22.054[J]
Prereq: 3.032 and 3.044
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-2-7 units

Studies the behavior of materials in extreme environments typical of those in which advanced energy systems (including fossil, nuclear, solar, fuel cells, and battery) operate. Takes both a science and engineering approach to understanding how current materials interact with their environment under extreme conditions. Explores the role of modeling and simulation in understanding material behavior and the design of new materials. Focuses on energy and transportation related systems. Staff

Same subject as 6.152[J]
Prereq: Calculus II (GIR), Chemistry (GIR), Physics II (GIR), or permission of instructor
U (Fall)
3-4-5 units

See description under subject 6.152[J]. Enrollment limited. J. Michel, J. Scholvin

3.156 Photonic Materials and Devices
Subject meets with 3.46
Prereq: 3.024 and (3.016B or 18.03)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units


3.16 Industrial Challenges in Metallic Materials Selection
Subject meets with 3.39
Prereq: 3.012 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units

Advanced metals and alloy design with emphasis in advanced steels and non-ferrous alloys. Applies physical metallurgy concepts to solve specific problems targeting sustainable, efficient and safer engineered solutions. Discusses industrial challenges involving metallic materials selection and manufacturing for different value chains and industrial segments. Includes applications in essential segments of modern life, such as transportation, energy and structural applications. Recognizing steel as an essential engineering material, subject covers manufacturing and end-uses of advanced steels ranging from microalloyed steels to highly alloyed steels. Also covers materials for very low temperature applications such as superconducting materials and for higher temperature applications such as superalloys. Students taking graduate version complete additional assignments. T. Carneiro
3.171 Structural Materials and Manufacturing
Prereq: 3.012 and 3.014
U (Fall, Spring; partial term)
2-0-10 units
Can be repeated for credit. Credit cannot also be received for 2.821[J], 3.371[J]
Combines online and in-person lectures to discuss structural materials selection, design and processing using examples from deformation processes, casting, welding and joining, non-destructive evaluation, failure and structural life assessment, and codes and standards. Emphasizes the underlying science of a given process rather than a detailed description of the technique or equipment. Presented in modules to be selected by student. Students taking graduate version must submit additional work. Meets with 3.371[J] when offered concurrently.
T. Eagar

3.18 Materials Science and Engineering of Clean Energy
Subject meets with 3.70
Prereq: 3.022 and 3.024
U (Spring)
3-0-9 units
Develops the materials principles, limitations, and challenges of clean energy technologies, including solar, energy storage, thermoelectrics, fuel cells, and novel fuels. Draws correlations between the limitations and challenges related to key figures of merit and the basic underlying thermodynamic, structural, transport, and physical principles, as well as to the means for fabricating devices exhibiting optimum operating efficiencies and extended life at reasonable cost. Students taking graduate version complete additional assignments.
D. Sadoway

3.19 Sustainable Chemical Metallurgy
Subject meets with 3.50
Prereq: 3.022
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units
Covers principles of metal extraction processes. Provides a direct application of the fundamentals of thermodynamics and kinetics to the industrial production of metals from their ores, e.g., iron, aluminum, or reactive metals and silicon. Discusses the corresponding economics and global challenges. Addresses advanced techniques for sustainable metal extraction, particularly with respect to greenhouse gas emissions. Students taking graduate version complete additional assignments.
A. Allanore

3.20 Materials at Equilibrium
Prereq: (3.012, 3.014, 3.022, 3.024, 3.034, and 3.042) or permission of instructor
G (Fall)
5-0-10 units
A. Allanore

3.207 Innovation and Commercialization
Subject meets with 3.086
Prereq: None
G (Spring)
4-0-8 units
Explores in depth projects on a particular materials-based technology. Investigates the science and technology of materials advances and their strategic value, explore potential applications for fundamental advances, and determine intellectual property related to the materials technology and applications. Students map progress with presentations, and are expected to create an end-of-term document enveloping technology, intellectual property, applications, and potential commercialization. Lectures cover aspects of technology, innovation, entrepreneurship, intellectual property, and commercialization of fundamental technologies.
E. Fitzgerald

3.21 Kinetic Processes in Materials
Prereq: 3.012, 3.022, 3.044, or permission of instructor
G (Spring)
5-0-10 units
Unified treatment of phenomenological and atomistic kinetic processes in materials. Provides the foundation for the advanced understanding of processing, microstructural evolution, and behavior for a broad spectrum of materials. Topics include irreversible thermodynamics; rate and transition state theory, diffusion; nucleation and phase transitions; continuous phase transitions; grain growth and coarsening; capillarity driven morphological evolution; and interface stability during phase transitions.
C. Thompson, M. Cima
3.22 Mechanical Behavior of Materials
Prereq: 3.032 or permission of instructor
G (Spring)
4-0-8 units
Explores how the macroscale mechanical behavior of materials originates from fundamental, microscale mechanisms of elastic and inelastic deformation. Topics include: elasticity, viscoelasticity, plasticity, creep, fracture, and fatigue. Case studies and examples are drawn from a variety of material classes: metals, ceramics, polymers, thin films, composites, and cellular materials.
C. Tasan

3.23 Electrical, Optical, and Magnetic Properties of Materials
Prereq: 8.03 and 18.03
G (Fall)
4-0-8 units
Origin of electrical, magnetic and optical properties of materials. Focus on the acquisition of quantum mechanical tools. Analysis of the properties of materials. Presentation of the postulates of quantum mechanics. Examination of the hydrogen atom, simple molecules and bonds, and the behavior of electrons in solids and energy bands. Introduction of the variation principle as a method for the calculation of wavefunctions. Study of how and why materials respond to different electrical, magnetic and electromagnetic fields and probes. Survey of common devices such as transistors, magnetic storage media, optical fibers.
G. Beach

3.24 Structure of Materials (New)
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Studies the underlying structure of materials in order to deepen understanding of structure-property relationships. For crystalline materials, fundamentals of structural description includes lattices, point and space groups, symmetry and tensor properties. Concepts of structure will then be discussed for other types of material: soft matter, amorphous solids, liquid crystals, two-dimensional materials and nanostructured materials. Includes structural descriptions of interfaces and defects. Also introduces some of the key techniques for structure determination.
F. M. Ross, J. LeBeau, S. Gradecak

3.30[J] Properties of Solid Surfaces
Same subject as 22.75[J]
Prereq: 3.20, 3.21, or permission of instructor
G (Spring)
3-0-9 units
See description under subject 22.75[J].
B. Yildiz

3.31[J] Radiation Damage and Effects in Nuclear Materials
Same subject as 22.74[J]
Subject meets with 22.074
Prereq: 3.21, 22.14, or permission of instructor
G (Fall)
3-0-9 units
See description under subject 22.74[J].
M. Short, B. Yildiz

3.320 Atomistic Computer Modeling of Materials
Prereq: 3.022, 3.20, 3.23, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
K. Keane

3.33[J] Defects in Materials
Same subject as 22.73[J]
Prereq: 3.21 and 3.22
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examines point, line, and planar defects in structural and functional materials. Relates their properties to transport, radiation response, phase transformations, semiconductor device performance and quantum information processing. Focuses on atomic and electronic structures of defects in crystals, with special attention to optical properties, dislocation dynamics, fracture, and charged defects population and diffusion. Examples also drawn from other systems, e.g., disclinations in liquid crystals, domain walls in ferromagnets, shear bands in metallic glass, etc.
J. Li
3.34 Imaging of Materials  
Prereq: 3.024, 3.23, or permission of instructor  
G (Spring)  
3-0-9 units

Principles and applications of (scanning) transmission electron microscopy. Topics include electron optics and aberration correction theory; modeling and simulating the interactions of electrons with the specimen; electron diffraction; image formation in transmission and scanning transmission electron microscopy; diffraction and phase contrast; imaging of crystals and crystal imperfections; review of the most recent advances in electron microscopy for bio- and nanosciences; analysis of chemical composition and electronic structure at the atomic scale. Lectures complemented by real-case studies, computer simulations/data analysis, and a parallel hands-on laboratory.  
J. LeBeau, F. M. Ross, S. Gradecak

3.35 Fracture and Fatigue  
Prereq: 3.22 or permission of instructor  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units

Advanced study of material failure in response to mechanical stresses. Damage mechanisms include microstructural changes, crack initiation, and crack propagation under monotonic and cyclic loads. Covers a wide range of materials: metals, ceramics, polymers, thin films, biological materials, composites. Describes toughening mechanisms and the effect of material microstructures. Includes stress-life, strain-life, and damage-tolerant approaches. Emphasizes fracture mechanics concepts and latest applications for structural materials, biomaterials, microelectronic components as well as nanostructured materials. Limited to 10.  
M. Dao

3.36 Cellular Solids: Structure, Properties, Applications  
Subject meets with 3.054  
Prereq: 3.032 or permission of instructor  
G (Spring)  
2-0-10 units

Discusses processing and structure of cellular solids as they are created from polymers, metals, ceramics, glasses, and composites; derivation of models for the mechanical properties of honeycombs and foams; and how unique properties of honeycombs and foams are exploited in applications such as lightweight structural panels, energy absorption devices, and thermal insulation. Covers applications of cellular solids in medicine, such as increased fracture risk due to trabecular bone loss in patients with osteoporosis, the development of metal foam coatings for orthopedic implants, and designing porous scaffolds for tissue engineering that mimic the extracellular matrix. Includes modelling of cellular materials applied to natural materials and biomimicking. Offers a combination of online and in-person instruction. Students taking graduate version complete additional assignments.  
Staff

3.371[J] Structural Materials  
Same subject as 2.821[J]  
Prereq: Permission of instructor  
G (Fall, Spring, Summer; partial term)  
2-0-10 units

Combines online and in-person lectures to discuss structural materials selection, design and processing using examples from deformation processes, casting, welding and joining, non-destructive evaluation, failure and structural life assessment, and codes and standards. Emphasizes the underlying science of a given process rather than a detailed description of the technique or equipment. Presented in modules to be selected by student. Students taking graduate version must submit additional work. Meets with 3.171 when offered concurrently.  
T. Eagar, A. Slocum
3.38 Ceramics: Processing, Properties and Functional Devices
Prereq: None
G (Fall)
3-0-9 units
Explores modern ceramic processing - ranging from large-scale synthesis, 3D manufacturing and printing to nanoscale-thin film structures integrated for microelectronics useful for material, chemical, electronic or mechanical engineers. Examples of devices studied include opto-electronic materials, sensors, memories, batteries, solar-to-fuel convertors, and solid oxide fuel cells. Provides the skills and guidance to design ceramic and glassy materials for large-scale components as energy storage or convertors, or for nano-scale electronic applications in information storage devices.
J. L. M. Rupp

3.39 Industrial Challenges in Metallic Materials Selection
Subject meets with 3.16
Prereq: 3.20 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Advanced metals and alloy design with emphasis in advanced steels and non-ferrous alloys. Applies physical metallurgy concepts to solve specific problems aiming at sustainable, efficient and safer engineered solutions. Discusses industrial challenges involving metallic materials selection and manufacturing for different value chains and industrial segments. Includes applications in essential segments of modern life such as transportation, energy and structural applications. Recognizing steel as an essential engineering material, the course will cover manufacturing and end-uses of advanced steels ranging from microalloyed steels to highly alloyed steels. Materials for very low temperature applications such as superconducting materials and for higher temperature applications such as superalloys will also be covered. Students taking graduate version complete additional assignments.
T. Carneiro

3.40[J] Modern Physical Metallurgy
Same subject as 22.71[J]
Subject meets with 3.14
Prereq: 3.022 and 3.032
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examines how the presence of 1-, 2- and 3-D defects and second phases control the mechanical, electromagnetic and chemical behavior of metals and alloys. Considers point, line and interfacial defects in the context of structural transformations including annealing, spinodal decomposition, nucleation, growth, and particle coarsening. Concentrates on structure-function relationships, and in particular how grain size, interstitial and substitutional solid solutions, and second-phase particles impact mechanical and other properties. Industrially relevant case studies illustrate lecture concepts. Students taking the graduate version explore the subject in greater depth.
C. Tasan

3.41 Colloids, Surfaces, Absorption, Capillarity, and Wetting Phenomena
Prereq: 3.20 and 3.21
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Integrates elements of physics and chemistry toward the study of material surfaces. Begins with classical colloid phenomena and the interaction between surfaces in different media. Discusses the mechanisms of surface charge generation as well as how dispersion forces are created and controlled. Continues with exploration of chemical absorption processes and surface design of inorganic and organic materials. Includes examples in which such surface design can be used to control critical properties of materials in applications. Addresses firstly how liquids interact with solids as viewed by capillarity and wetting phenomena. Studies how materials are used in processes and applications that are intended to control liquids, and how the surface chemistry and structure of those materials makes such applications possible.
M. Cima
3.42 Electronic Materials Design
Prereq: 3.23
G (Fall)
3-0-9 units
Extensive and intensive examination of structure-processing-property correlations for a wide range of materials including metals, semiconductors, dielectrics, and optical materials. Topics covered include defect equilibria; junction characteristics; photodiodes, light sources and displays; bipolar and field effect transistors; chemical, thermal and mechanical transducers; data storage. Emphasis on materials design in relation to device performance.
H. L. Tuller

3.43 Integrated Microelectronic Devices
Same subject as 6.720
Prereq: 3.42 or 6.012
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
See description under subject 6.720.
J. A. del Alamo, H. L. Tuller

3.44 Materials Processing for Micro- and Nano-Systems
Prereq: 3.20 and 3.21
G (Fall)
3-0-9 units
Processing of bulk, thin film, and nanoscale materials for applications in electronic, magnetic, electromechanical, and photonic devices and microsystems. Topics include growth of bulk, thin-film, nanoscale single crystals via vapor and liquid phase processes; formation, patterning and processing of thin films, with an emphasis on relationships among processing, structure, and properties; and processing of systems of nanoscale materials. Examples from materials processing for applications in high-performance integrated electronic circuits, micro-/nano-electromechanical devices and systems and integrated sensors.
C. V. Thompson

3.45 Magnetic Materials
Subject meets with 3.152
Prereq: 3.23
G (Spring)
3-0-9 units
Topics include origin of magnetism in materials, magnetic domains and domain walls, magnetostatics, anisotropy, antiferro- and ferrimagnetism, magnetization dynamics, spintronics, magnetism in thin films and nanoparticles, magnetotransport phenomena, and magnetic characterization. Discusses a range of applications, including magnetic recording, spintronic memory, magnetooptical devices, and multiferrics. Assignments include problem sets and a term paper on a magnetic device or technology. Students taking graduate version complete additional assignments.
C. Ross

3.46 Photonic Materials and Devices
Subject meets with 3.156
Prereq: 3.23
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
J. Hu
3.50 Sustainable Chemical Metallurgy
Subject meets with 3.19
Prereq: 3.022 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Covers principles of metal extraction processes. Provides a direct application of the fundamentals of thermodynamics and kinetics to the industrial production of metals from their ores, e.g. iron, aluminum, or reactive metals and silicon. Discusses the corresponding economics and global challenges. Addresses advanced techniques for sustainable metal extraction, particularly with respect to greenhouse gas emissions. Students taking graduate version complete additional assignments.
A. Allanore

3.53 Electrochemical Processing of Materials
Prereq: 3.044
G (Spring)
3-0-6 units
D. R. Sadoway

3.560 Industrial Ecology of Materials
Subject meets with 3.081
Prereq: 3.20 or permission of instructor
G (Fall)
3-0-9 units
Covers quantitative techniques to address principles of substitution, dematerialization, and waste mining implementation in materials systems. Includes life-cycle and materials flow analysis of the impacts of materials extraction; processing; use; and recycling for materials, products, and services. Student teams undertake a case study regarding materials and technology selection using the latest methods of analysis and computer-based models of materials process. Students taking graduate version complete additional assignments.
E. Olivetti

3.57 Materials Selection, Design, and Economics
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-6 units
A survey of techniques for analyzing how the choice of materials, processes, and design determine properties, performance, and cost. Topics include production and cost functions, mathematical optimization, evaluation of single and multi-attribute utility, decision analysis, materials property charts, and performance indices. Students use analytical techniques to develop a plan for starting a new materials-related business.
Staff

3.65 Soft Matter Characterization
Prereq: Permission of instructor
G (Fall)
1-2-9 units
Focuses on the design and execution of advanced experiments to characterize soft materials, such as synthetic and natural polymers, biological composites, and supramolecular nanomaterials. Each week focuses on a new characterization technique explored through interactive lectures, demonstrations, and lab practicum sessions in which students gain experience in key experimental aspects of soft matter sample preparation and characterization. Among others, topics include chemical characterization, rheology and viscometry, microscopy, and spectroscopic analyses. Limited to 15.
J. Ortony

3.69 Teaching Fellows Seminar
Prereq: None
G (Fall)
2-0-1 units
Can be repeated for credit.
Provides instruction to help prepare students for teaching at an advanced level and for industry or academic career paths. Topics include preparing a syllabus, selecting a textbook, scheduling assignments and examinations, lecture preparation, “chalk and talk” vs. electronic presentations, academic honesty and discipline, preparation of examinations, grading practices, working with teaching assistants, working with colleagues, mentoring outside the classroom, pursuing academic positions, teaching through technical talks, and successful grant writing strategies.
C. Schuh
3.691 Teaching Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, Spring)
0-1-0 units
Can be repeated for credit.

Provides classroom or laboratory teaching experience under the supervision of faculty member(s). Students assist faculty by preparing instructional materials, leading discussion groups, and monitoring students’ progress. Limited to Course 3 undergraduates selected by Teaching Assignments Committee.

J. Hu

3.692 Teaching Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Provides classroom or laboratory teaching experience under the supervision of faculty member(s). Students assist faculty by preparing instructional materials, leading discussion groups, and monitoring students’ progress. Credit arranged on a case-by-case basis and reviewed by the department. Limited to Course 3 undergraduates selected by Teaching Assignments Committee.

J. Hu

3.694 Teaching Materials Science and Engineering
Prereq: None
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

undefined

D. Sadoway

3.693-3.699 Teaching Materials Science and Engineering
Prereq: None
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview. Enrollment limited by availability of suitable teaching assignments.

D. Sadoway

3.70 Materials Science and Engineering of Clean Energy
Subject meets with 3.18
Prereq: 3.20, 3.23, or permission of instructor
G (Spring)
3-0-9 units

Develops the materials principles, limitations and challenges in clean energy technologies, including solar, energy storage, thermoelectrics, fuel cells, and novel fuels. Draws correlations between the limitations and challenges related to key figures of merit and the basic underlying thermodynamic, structural, transport, and physical principles, as well as to the means for fabricating devices exhibiting optimum operating efficiencies and extended life at reasonable cost. Students taking graduate version complete additional assignments.

D. Sadoway

3.903[J] Seminar in Polymers and Soft Matter
Same subject as 10.960[J]
Prereq: None
G (Fall, Spring)
2-0-0 units
Can be repeated for credit.

See description under subject 10.960[J].

A. Alexander-Katz, R. E. Cohen, D. Irvine

3.930 Internship Program
Prereq: None
U (Summer)
0-6-0 units

Provides academic credit for first approved materials science and engineering internship. For reporting requirements, consult the faculty internship program coordinator. Limited to Course 3 internship track majors.

T. Eagar

3.931 Internship Program
Prereq: 3.930
U (Fall, Summer)
0-6-0 units

Provides academic credit for second approved materials science and engineering internship in the year following completion of 3.930. For reporting requirements consult the faculty internship program coordinator. Limited to Course 3 internship track majors.

T. Eagar
3.932 Industrial Practice
Prereq: Permission of instructor
G (Summer)
Units arranged
Can be repeated for credit.
Provides academic credit to graduate students for approved internship assignments at companies/national laboratories. Restricted to DMSE SM or PhD/ScD students.
D. Sadoway

3.941[J] Statistical Mechanics of Polymers
Same subject as 10.668[J]
Prereq: 10.568 or permission of instructor
G (Fall)
3-0-9 units
See description under subject 10.668[J].
G. C. Rutledge, A. Alexander-Katz

3.942 Polymer Physics
Subject meets with 3.063
Prereq: 3.032 or permission of instructor
G (Spring)
4-0-8 units
The mechanical, optical, electrical, and transport properties of polymers and other types of “soft matter” are presented with respect to the underlying physics and physical chemistry of polymers and colloids in solution, and solid states. Topics include how enthalpy and entropy determine conformation, molecular dimensions and packing of polymer chains and colloids and supramolecular materials. Examination of the structure of glassy, crystalline, and rubbery elastic states of polymers; thermodynamics of solutions, blends, crystallization; liquid crystallinity, microphase separation, and self-assembled organic-inorganic nanocomposites. Case studies of relationships between structure and function in technologically important polymeric systems. Students taking graduate version complete additional assignments.
A. Alexander-Katz

3.963[J] Biomaterials Science and Engineering
Same subject as 20.463[J]
Subject meets with 3.055[J], 20.363[J]
Prereq: 3.034, 20.110[J], or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 20.463[J].
D. Irvine, K. Ribbeck

3.971[J] Molecular, Cellular, and Tissue Biomechanics
Same subject as 2.798[J], 6.524[J], 10.537[J], 20.410[J]
Prereq: Biology (GIR) and (2.002, 2.006, 6.013, 10.301, or 10.302)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 20.410[J].
R. D. Kamm, K. J. Van Vliet

Archaeology and Archaeological Science

3.981 Communities of the Living and the Dead: the Archaeology of Ancient Egypt
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Examines the development of complex societies in Egypt over a 3000-year period. Uses archaeological and historical sources to determine how and why prehistoric communities coalesced into a long-lived and powerful state. Studies the remains of ancient settlements, tombs, and temples, exploring their relationships to one another and to the geopolitical landscape of Egypt and the Mediterranean world. Considers the development of advanced technologies, rise of social hierarchy, expansion of empire, role of writing, and growth of a complex economy.
Staff

3.982 The Ancient Andean World
Prereq: None
U (Spring)
3-0-6 units. HASS-S
Examines development of Andean civilization which culminated in the extraordinary empire established by the Inka. Archaeological, ethnographic, and ethnohistorical approaches. Particular attention to the unusual topography of the Andean area, its influence upon local ecology, and the characteristic social, political, and technological responses of Andean people to life in a topographically “vertical” world. Characteristic cultural styles of prehistoric Andean life.
D. Hosler
3.983 Ancient Mesoamerican Civilization
Prereq: None
U (Fall)
3-0-6 units. HASS-S

Examines origins, florescence and collapse of selected civilizations of ancient Mesoamerica using archaeological and ethnohistoric evidence. Focuses on the Maya, including their hieroglyphic writing. Themes include development of art and architecture, urbanism, religious and political institutions, human-environment interactions, and socio-political collapse. Representations of Maya society in contemporary film and media. Limited to 10.
F. Rossi

3.984 Materials in Ancient Societies: Ceramics
Prereq: Permission of instructor
G (Fall)
3-6-3 units

Seminars and labs provide in-depth study of the technologies ancient societies used to produce objects from ceramic materials, including clays and mortars. Seminars cover basic ceramic materials science and engineering and relate materials selection and processing to environment, exchange, political power, and cultural values.
H. N. Lechtman, J. Meanwell

3.985[J] Archaeological Science
Same subject as 5.24[J], 12.011[J]
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 units. HASS-S

Pressing issues in archaeology as an anthropological science. Stresses the natural science and engineering methods archaeologists use to address these issues. Reconstructing time, space, and human ecologies provides one focus; materials technologies that transform natural materials to material culture provide another. Topics include 14C dating, ice core and palynological analysis, GIS and other remote sensing techniques for site location, organic residue analysis, comparisons between Old World and New World bronze production, invention of rubber by Mesoamerican societies, analysis and conservation of Dead Sea Scrolls.
H. N. Lechtman

3.986 The Human Past: Introduction to Archaeology
Prereq: None
U (Fall)
3-0-9 units. HASS-S; CI-H

From an archaeological perspective, examines ancient human activities and the forces that shaped them. Draws on case studies from the Old and/or New World. Exposes students to various classes of archaeological data, such as stone, bone, and ceramics, that help reconstruct the past.
M. Price

3.987 Human Evolution: Data from Palaeontology, Archaeology, and Materials Science
Prereq: None
U (Spring)
3-6-3 units. HASS-S

Examines human physical and cultural evolution over the past five million years via lectures and labs that incorporate data from human palaeontology, archaeology, and materials science. Topics include the evolution of hominin morphology and adaptations; the nature and structure of bone and its importance in human evolution; and the fossil and archaeological evidence for human behavioral and cultural evolution, from earliest times through the Pleistocene. Laboratory sessions include study of stone technology, artifacts, and fossil specimens.
M. Price

3.989 Materials in Ancient Societies: Ceramics Laboratory
Prereq: Permission of instructor
G (Spring)
3-6-3 units

Laboratory analysis of archaeological artifacts of ceramics. Follows on 3.984.
J. Meanwell

3.990 Seminar in Archaeological Method and Theory
Prereq: 3.985[J], 3.986, and 21A.00
U (Fall, Spring)
3-0-6 units

Designed for undergraduate seniors majoring in Archaeology and Materials. Critical analysis of major intellectual and methodological developments in American archaeology, including evolutionary theory, the "New Archaeology," Marxism, formal and ideological approaches. Explores the use of science and engineering methods to reconstruct cultural patterns from archaeological data. Seminar format, with formal presentations by all students. Non-majors fulfilling all prerequisites may enroll by permission of instructors. Instruction and practice in oral and written communication provided.
D. Hosler, H. Lechtman
3.993 Archaeology of the Middle East
Prereq: None
U (Spring)
3-0-6 units. HASS-S

Explores the long history of the Middle East and its role as an enduring center of civilization and human thought. Beginning over 100,000 years ago and ending up in the present day, tackles major issues in the human career through examination of archaeological and written materials. Students track the course of human development in the Middle East, from hunting and gathering to cities and empires.

M. Price

3.997 Graduate Fieldwork in Materials Science and Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of field research in materials science and engineering leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.

D. Hosler, H. Lechtman

3.998 Doctoral Thesis Update Meeting
Prereq: None
G (Fall, Spring)
0-1-0 units

Thesis research update presentation to the thesis committee. Held the first or second academic term after successfully passing the Thesis Area Examination.

Staff

3.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units

See description under subject 2.EPE.

Staff

3.S01 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall)
Units arranged
Can be repeated for credit.

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

3.S02 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall)
Units arranged
Can be repeated for credit.

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

3.S03 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall)
Units arranged
Can be repeated for credit.

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

3.S04 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Spring)
Units arranged
Can be repeated for credit.

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff
3.S05 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Spring)
Units arranged

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

3.S06 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall)
Units arranged

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

3.S07 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

3.S08 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

3.S09 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged [P/D/F]

Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

3.S72 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
G (Spring)
Units arranged

Covers advanced topics in Materials Science and Engineering that are not included in the permanent curriculum.

Staff

3.S70-3.S75 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
G (Fall)
Units arranged

Covers advanced topics in Materials Science and Engineering that are not included in the permanent curriculum.

Staff

3.S76-3.S79 Special Subject in Materials Science and Engineering
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]

Covers advanced topics in Materials Science and Engineering that are not included in the permanent curriculum.

Staff

3.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.

D. Sadoway

3.THU Undergraduate Thesis
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of an SB thesis; to be arranged by the student and an appropriate MIT faculty member. Instruction and practice in oral and written communication.

Information: DMSE Academic Office
3.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Extended participation in work of a research group. Independent study of literature, direct involvement in group’s research (commensurate with student skills), and project work under an individual faculty member. See UROP coordinator for registration procedures.
Information: DMSE Academic Office

3.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Extended participation in work of a research group. Independent study of literature, direct involvement in group’s research (commensurate with student skills), and project work under an individual faculty member. See UROP coordinator for registration procedures.
Information: DMSE Academic Office
MATHEMATICS (COURSE 18)

General Mathematics

18.01 Calculus
Prereq: None
U (Fall, Spring)
5-0-7 units. CALC I
Credit cannot also be received for 18.01A, ES.1801, ES.181A


Fall: L. Guth. Spring: Information: W. Minicozzi

18.02A Calculus
Prereq: Calculus I (GIR)
U (Fall; first half of term)
5-0-7 units. CALC I
Credit cannot also be received for 18.02, 18.022, ES.1802, ES.182A

First half is taught during the last six weeks of the Fall term; covers material in the first half of 18.02 (through double integrals). Second half of 18.02A can be taken either during IAP (daily lectures) or during the second half of the Spring term; it covers the remaining material in 18.02.

Z. Yun

18.02 Calculus
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 units. CALC II
Credit cannot also be received for 18.02, 18.022, CC.1802, ES.1802, ES.182A

Calculus of several variables. Vector algebra in 3-space, determinants, matrices. Vector-valued functions of one variable, space motion. Scalar functions of several variables: partial differentiation, gradient, optimization techniques. Double integrals and line integrals in the plane; exact differentials and conservative fields; Green's theorem and applications, triple integrals, line and surface integrals in space, Divergence theorem, Stokes' theorem; applications.

Fall: D. Maulik. Spring: L. Guth

18.022 Calculus
Prereq: Calculus I (GIR)
U (Fall)
5-0-7 units. CALC II
Credit cannot also be received for 18.02, 18.022, CC.1802, ES.1802, ES.182A

Calculus of several variables. Topics as in 18.02 but with more focus on mathematical concepts. Vector algebra, dot product, matrices, determinant. Functions of several variables, continuity, differentiability, derivative. Parametrized curves, arc length, curvature, torsion. Vector fields, gradient, curl, divergence. Multiple integrals, change of variables, line integrals, surface integrals. Stokes' theorem in one, two, and three dimensions.

A. Borodin
18.03 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
U (Fall, Spring)
5-0-7 units. REST
Credit cannot also be received for CC.1803, ES.1803

Fall: J. Dunkel. Spring: S. Dyatlov

18.031 System Functions and the Laplace Transform
Prereq: None. Coreq: 18.03
U (IAP)
1-0-2 units
Studies basic continuous control theory as well as representation of functions in the complex frequency domain. Covers generalized functions, unit impulse response, and convolution; and Laplace transform, system (or transfer) function, and the pole diagram. Includes examples from mechanical and electrical engineering.

Information: H. R. Miller

18.032 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
U (Spring)
5-0-7 units. REST
Covers much of the same material as 18.03 with more emphasis on theory. The point of view is rigorous and results are proven. Local existence and uniqueness of solutions.

K. Okoudjou

18.04 Complex Variables with Applications
Prereq: Calculus II (GIR) and (18.03 or 18.032)
U (Spring)
4-0-8 units
Credit cannot also be received for 18.075, 18.0751
Complex algebra and functions; analyticity; contour integration, Cauchy’s theorem; singularities, Taylor and Laurent series; residues, evaluation of integrals; multivalued functions, potential theory in two dimensions; Fourier analysis, Laplace transforms, and partial differential equations.

R. R. Rosales

18.05 Introduction to Probability and Statistics
Prereq: Calculus II (GIR)
U (Spring)
4-0-8 units. REST

J. Orloff

18.06 Linear Algebra
Prereq: Calculus II (GIR)
U (Fall, Spring)
4-0-8 units. REST
Credit cannot also be received for 18.700
Basic subject on matrix theory and linear algebra, emphasizing topics useful in other disciplines, including systems of equations, vector spaces, determinants, eigenvalues, singular value decomposition, and positive definite matrices. Applications to least-squares approximations, stability of differential equations, networks, Fourier transforms, and Markov processes. Uses linear algebra software. Compared with 18.700, more emphasis on matrix algorithms and many applications.

Fall: A. Negut. Spring: A. Edelman

18.062[J] Mathematics for Computer Science
Same subject as 6.042[J]
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 units. REST
See description under subject 6.042[J].

F. T. Leighton, Z. R. Abel, A. Moitra

18.065 Matrix Methods in Data Analysis, Signal Processing, and Machine Learning
Subject meets with 18.0651
Prereq: 18.06
U (Spring)
3-0-9 units
Reviews linear algebra with applications to life sciences, finance, engineering, and big data. Covers singular value decomposition, weighted least squares, signal and image processing, principal component analysis, covariance and correlation matrices, directed and undirected graphs, matrix factorizations, neural nets, machine learning, and computations with large matrices.

G. Strang
18.0651 Matrix Methods in Data Analysis, Signal Processing, and Machine Learning
Subject meets with 18.065
Prereq: 18.06
G (Spring)
3-0-9 units
Reviews linear algebra with applications to life sciences, finance, engineering, and big data. Covers singular value decomposition, weighted least squares, signal and image processing, principal component analysis, covariance and correlation matrices, directed and undirected graphs, matrix factorizations, neural nets, machine learning, and computations with large matrices. Students in Course 18 must register for the undergraduate version, 18.065.
G. Strang

18.075 Methods for Scientists and Engineers
Subject meets with 18.0751
Prereq: Calculus II (GIR) and 18.03
U (Spring)
3-0-9 units
Credit cannot also be received for 18.04
Covers functions of a complex variable; calculus of residues. Includes ordinary differential equations; Bessel and Legendre functions; Sturm-Liouville theory; partial differential equations; heat equation; and wave equations.
H. Cheng

18.0751 Methods for Scientists and Engineers
Subject meets with 18.075
Prereq: Calculus II (GIR) and 18.03
G (Spring)
3-0-9 units
Credit cannot also be received for 18.04
Covers functions of a complex variable; calculus of residues. Includes ordinary differential equations; Bessel and Legendre functions; Sturm-Liouville theory; partial differential equations; heat equation; and wave equations. Students in Courses 6, 8, 12, 18, and 22 must register for undergraduate version, 18.075.
H. Cheng

18.085 Computational Science and Engineering I
Subject meets with 18.0851
Prereq: Calculus II (GIR) and (18.03 or 18.032)
U (Fall, Spring, Summer)
3-0-9 units
Review of linear algebra, applications to networks, structures, and estimation, finite difference and finite element solution of differential equations, Laplace’s equation and potential flow, boundary-value problems, Fourier series, discrete Fourier transform, convolution. Frequent use of MATLAB in a wide range of scientific and engineering applications.
Fall: W. G. Strang. Spring: M. Durey

18.0851 Computational Science and Engineering I
Subject meets with 18.085
Prereq: Calculus II (GIR) and (18.03 or 18.032)
G (Fall, Spring, Summer)
3-0-9 units
Review of linear algebra, applications to networks, structures, and estimation, finite difference and finite element solution of differential equations, Laplace’s equation and potential flow, boundary-value problems, Fourier series, discrete Fourier transform, convolution. Frequent use of MATLAB in a wide range of scientific and engineering applications. Students in Course 18 must register for the undergraduate version, 18.085.
Fall: W.G. Strang. Spring: M. Durey

18.086 Computational Science and Engineering II
Subject meets with 18.0861
Prereq: Calculus II (GIR) and (18.03 or 18.032)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units
Information: W. G. Strang
18.0861 Computational Science and Engineering II
Subject meets with 18.086
Prereq: Calculus II (GIR) and (18.03 or 18.032)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Information: W. G. Strang

18.089 Review of Mathematics
Prereq: Permission of instructor
G (Summer)
5-0-7 units
One-week review of one-variable calculus (18.01), followed by concentrated study covering multivariable calculus (18.02), two hours per day for five weeks. Primarily for graduate students in Course 2N. Degree credit allowed only in special circumstances.
Information: W. Minicozzi

18.094[J] Teaching College-Level Science and Engineering
Same subject as 1.95[J], 5.95[J], 7.59[J], 8.395[J]
Subject meets with 2.978
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-0-2 units
See description under subject 5.95[J].
J. Rankin

18.095 Mathematics Lecture Series
Prereq: Calculus I (GIR)
U (IAP)
2-0-4 units
Can be repeated for credit.
Ten lectures by mathematics faculty members on interesting topics from both classical and modern mathematics. All lectures accessible to students with calculus background and an interest in mathematics. At each lecture, reading and exercises are assigned. Students prepare these for discussion in a weekly problem session.
Information: W. Minicozzi

18.098 Internship in Mathematics
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Provides academic credit for students pursuing internships to gain practical experience in the applications of mathematical concepts and methods.
Information: W. Minicozzi

18.099 Independent Study
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Studies (during IAP) or special individual reading (during regular terms). Arranged in consultation with individual faculty members and subject to departmental approval.
Information: W. Minicozzi

Analysis

18.1001 Real Analysis
Subject meets with 18.100A
Prereq: Calculus II (GIR)
G (Fall, Spring)
3-0-9 units
Credit cannot also be received for 18.100B, 18.100P, 18.100Q
Covers fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, interchange of limit operations. Shows the utility of abstract concepts and teaches understanding and construction of proofs. Proofs and definitions are less abstract than in 18.100B. Gives applications where possible. Concerned primarily with the real line. Students in Course 18 must register for undergraduate version 18.100A.
18.1002 Real Analysis
Subject meets with 18.100B
Prereq: Calculus II (GIR)
G (Fall, Spring)
3-0-9 units
Credit cannot also be received for 18.100A, 18.100Q
Covers fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, interchange of limit operations. Shows the utility of abstract concepts and teaches understanding and construction of proofs. More demanding than 18.100A, for students with more mathematical maturity. Places more emphasis on point-set topology and n-space. Students in Course 18 must register for undergraduate version 18.100B.
Fall: R. Bezrukavnikov. Spring: P-K Hung.

18.100A Real Analysis
Subject meets with 18.1001
Prereq: Calculus II (GIR)
U (Fall, Spring)
3-0-9 units
Credit cannot also be received for 18.100B, 18.100P, 18.100Q
Covers fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, interchange of limit operations. Shows the utility of abstract concepts and teaches understanding and construction of proofs. Proofs and definitions are less abstract than in 18.100B. Gives applications where possible. Concerned primarily with the real line.

18.100B Real Analysis
Subject meets with 18.1002
Prereq: Calculus II (GIR)
U (Fall, Spring)
3-0-9 units
Credit cannot also be received for 18.100A, 18.100Q
Covers fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, interchange of limit operations. Shows the utility of abstract concepts and teaches understanding and construction of proofs. More demanding than 18.100A, for students with more mathematical maturity. Places more emphasis on point-set topology and n-space.
Fall: R. Bezrukavnikov. Spring: P-K Hung.

18.100P Real Analysis
Prereq: Calculus II (GIR)
U (Spring)
4-0-11 units
Credit cannot also be received for 18.1001, 18.100A, 18.100B, 18.100Q
Covers fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, interchange of limit operations. Shows the utility of abstract concepts and teaches understanding and construction of proofs. Proofs and definitions are less abstract than in 18.100B. Gives applications where possible. Concerned primarily with the real line. Includes instruction and practice in written communication. Enrollment limited.
C. Mantoulidis

18.100Q Real Analysis
Prereq: Calculus II (GIR)
U (Fall)
4-0-11 units
Credit cannot also be received for 18.1001, 18.1002, 18.100A, 18.100B, 18.100P
Covers fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, interchange of limit operations. Shows the utility of abstract concepts and teaches understanding and construction of proofs. More demanding than 18.100A, for students with more mathematical maturity. Places more emphasis on point-set topology and n-space. Includes instruction and practice in written communication. Enrollment limited.
Y. Zhao

18.101 Analysis and Manifolds
Subject meets with 18.1011
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
U (Fall)
3-0-9 units
Introduction to the theory of manifolds: vector fields and densities on manifolds, integral calculus in the manifold setting and the manifold version of the divergence theorem. 18.901 helpful but not required.
K. Choi
18.1011 Analysis and Manifolds
Subject meets with 18.101
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
G (Fall)
3-0-9 units

Introduction to the theory of manifolds: vector fields and densities on manifolds, integral calculus in the manifold setting and the manifold version of the divergence theorem. 18.9011 helpful but not required. Students in Course 18 must register for the undergraduate version, 18.101.

K. Choi

18.102 Introduction to Functional Analysis
Subject meets with 18.1021
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
U (Spring)
3-0-9 units


R. B. Melrose

18.1021 Introduction to Functional Analysis
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
G (Spring)
3-0-9 units


Students in Course 18 must register for the undergraduate version, 18.102.

R. B. Melrose

18.103 Fourier Analysis: Theory and Applications
Subject meets with 18.103
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
G (Fall)
3-0-9 units

Roughly half the subject devoted to the theory of the Lebesgue integral with applications to probability, and half to Fourier series and Fourier integrals. Students in Course 18 must register for the undergraduate version, 18.103.

G. Staffilani

18.104 Seminar in Analysis
Prereq: 18.100A, 18.100B, 18.100P, or 18.100Q
U (Spring)
3-0-9 units

Students present and discuss material from books or journals. Topics vary from year to year. Instruction and practice in written and oral communication provided. Enrollment limited.

G. Staffilani

18.112 Functions of a Complex Variable
Subject meets with 18.1121
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
U (Fall)
3-0-9 units


W. Zhang
18.1121 Functions of a Complex Variable
Subject meets with 18.112
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
G (Fall)
3-0-9 units
W. Zhang

18.116 Riemann Surfaces
Prereq: 18.112
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Riemann surfaces, uniformization, Riemann-Roch Theorem. Theory of elliptic functions and modular forms. Some applications, such as to number theory.
T. S. Mrowka

18.117 Topics in Several Complex Variables
Prereq: 18.112 and 18.965
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.
Harmonic theory on complex manifolds, Hodge decomposition theorem, Hard Lefschetz theorem. Vanishing theorems. Theory of Stein manifolds. As time permits students also study holomorphic vector bundles on Kahler manifolds.
B. Poonen

18.118 Topics in Analysis
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.
Topics vary from year to year.
L. Guth

18.125 Measure Theory and Analysis
Prereq: 18.100A, 18.100B, 18.100P, or 18.100Q
G (Spring)
3-0-9 units
Provides a rigorous introduction to Lebesgue’s theory of measure and integration. Covers material that is essential in analysis, probability theory, and differential geometry.
D. W. Stroock

18.137 Topics in Geometric Partial Differential Equations
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Can be repeated for credit.
Topics vary from year to year.
T. Colding

18.152 Introduction to Partial Differential Equations
Subject meets with 18.1521
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
U (Spring)
3-0-9 units
Introduces three main types of partial differential equations: diffusion, elliptic, and hyperbolic. Includes mathematical tools, real-world examples and applications, such as the Black-Scholes equation, the European options problem, water waves, scalar conservation laws, first order equations and traffic problems.
K. Choi

18.1521 Introduction to Partial Differential Equations
Subject meets with 18.152
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
G (Spring)
3-0-9 units
Introduces three main types of partial differential equations: diffusion, elliptic, and hyperbolic. Includes mathematical tools, real-world examples and applications, such as the Black-Scholes equation, the European options problem, water waves, scalar conservation laws, first order equations and traffic problems. Students in Course 18 must register for the undergraduate version, 18.152.
K. Choi
18.155 Differential Analysis I
Prereq: 18.102 or 18.103
G (Fall)
3-0-9 units
T. S. Mrowka

18.156 Differential Analysis II
Prereq: 18.155
G (Spring)
3-0-9 units
Second part of a two-subject sequence. Covers variable coefficient elliptic, parabolic and hyperbolic partial differential equations.
R. B. Melrose

18.157 Introduction to Microlocal Analysis
Prereq: 18.155
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
The semi-classical theory of partial differential equations. Discussion of Pseudodifferential operators, Fourier integral operators, asymptotic solutions of partial differential equations, and the spectral theory of Schroedinger operators from the semi-classical perspective. Heavy emphasis placed on the symplectic geometric underpinnings of this subject.
P. Hintz

18.158 Topics in Differential Equations
Prereq: 18.157
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Can be repeated for credit.
Topics vary from year to year.
D. S. Jerison

18.199 Graduate Analysis Seminar
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Studies original papers in differential analysis and differential equations. Intended for first- and second-year graduate students. Permission must be secured in advance.
V. W. Guillemin

Discrete Applied Mathematics

18.200 Principles of Discrete Applied Mathematics
Prereq: None. Coreq: 18.06
U (Spring)
4-0-11 units
Credit cannot also be received for 18.200A
Study of illustrative topics in discrete applied mathematics, including probability theory, information theory, coding theory, secret codes, generating functions, and linear programming. Instruction and practice in written communication provided. Enrollment limited.
P. W. Shor

18.200A Principles of Discrete Applied Mathematics
Prereq: None. Coreq: 18.06
U (Fall)
3-0-9 units
Credit cannot also be received for 18.200
Study of illustrative topics in discrete applied mathematics, including probability theory, information theory, coding theory, secret codes, generating functions, and linear programming.
D. Cifuentes

18.204 Undergraduate Seminar in Discrete Mathematics
Prereq: ((6.042J) or 18.200) and (18.06, 18.700, or 18.701) or permission of instructor
U (Fall, Spring)
3-0-9 units
Seminar in combinatorics, graph theory, and discrete mathematics in general. Participants read and present papers from recent mathematics literature. Instruction and practice in written and oral communication provided. Enrollment limited.
S. Dhara, Z. Jiang, L. Lovasz
18.211 Combinatorial Analysis  
Prereq: Calculus II (GIR) and (18.06, 18.700, or 18.701)  
U (Fall)  
3-0-9 units  
Combinatorial problems and methods for their solution.  
Enumeration, generating functions, recurrence relations,  
construction of bijections. Introduction to graph theory. Prior  
experience with abstraction and proofs is helpful.  
A. Postnikov

18.212 Algebraic Combinatorics  
Prereq: 18.701 or 18.703  
U (Spring)  
3-0-9 units  
Applications of algebra to combinatorics. Topics include walks  
in graphs, the Radon transform, groups acting on posets, Young  
tableaux, electrical networks.  
Y. Zhao

18.217 Combinatorial Theory  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Can be repeated for credit.  
Content varies from year to year.  
Y. Zhao

18.218 Topics in Combinatorics  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  
Can be repeated for credit.  
Topics vary from year to year.  
A. Postnikov

18.219 Seminar in Combinatorics  
Prereq: Permission of instructor  
G (Fall)  
Not offered regularly; consult department  
3-0-9 units  
Can be repeated for credit.  
Content varies from year to year. Readings from current research  
papers in combinatorics. Topics to be chosen and presented by the  
class.  
Information: Y. Zhao

Continuous Applied Mathematics

18.300 Principles of Continuum Applied Mathematics  
Prereq: Calculus II (GIR) and (18.06 or 18.032)  
U (Spring)  
3-0-9 units  
Covers fundamental concepts in continuous applied mathematics.  
Applications from traffic flow, fluids, elasticity, granular flows, etc.  
Also covers continuum limit; conservation laws, quasi-equilibrium;  
kinematic waves; characteristics, simple waves, shocks; diffusion  
(linear and nonlinear); numerical solution of wave equations;  
finite differences, consistency, stability; discrete and fast Fourier  
transforms; spectral methods; transforms and series (Fourier,  
Laplace). Additional topics may include sonic booms, Mach cone,  
causics, lattices, dispersion and group velocity. Uses MATLAB  
computing environment.  
S. Thomson

18.303 Linear Partial Differential Equations: Analysis and  
Numerics  
Prereq: 18.06 or 18.700  
U (Spring)  
3-0-9 units  
Provides students with the basic analytical and computational  
tools of linear partial differential equations (PDEs) for practical  
applications in science and engineering, including heat/diffusion,  
wave, and Poisson equations. Analytics emphasize the viewpoint  
of linear algebra and the analogy with finite matrix problems. Studies  
operator adjoints and eigenproblems, series solutions, Green’s  
functions, and separation of variables. Numerics focus on finite-  
difference and finite-element techniques to reduce PDEs to matrix  
problems, including stability and convergence analysis and implicit/  
explicit timestepping. Some programming required for homework  
and final project.  
O. Kodio

18.305 Advanced Analytic Methods in Science and Engineering  
Prereq: 18.04, 18.075, or 18.112  
G (Fall)  
3-0-9 units  
Covers expansion around singular points: the WKB method on  
ordinary and partial differential equations; the method of stationary  
phase and the saddle point method; the two-scale method and the  
method of renormalized perturbation; singular perturbation and  
boundary-layer techniques; WKB method on partial differential  
equations.  
H. Cheng
18.306 Advanced Partial Differential Equations with Applications
Prereq: (18.03 or 18.032) and (18.04, 18.075, or 18.112)
G (Spring)
3-0-9 units
R. R. Rosales

18.327 Topics in Applied Mathematics
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.
Topics vary from year to year.
L. Demanet

18.330 Introduction to Numerical Analysis
Prereq: Calculus II (GIR) and (18.03 or 18.032)
U (Spring)
3-0-9 units
Basic techniques for the efficient numerical solution of problems in science and engineering. Root finding, interpolation, approximation of functions, integration, differential equations, direct and iterative methods in linear algebra. Knowledge of programming in a language such as MATLAB, Python, or Julia is helpful.
L. Demanet

18.335[J] Introduction to Numerical Methods
Same subject as 6.335[J]
Prereq: 18.06, 18.700, or 18.701
G (Spring)
3-0-9 units
Advanced introduction to numerical analysis: accuracy and efficiency of numerical algorithms. In-depth coverage of sparse-matrix/iterative and dense-matrix algorithms in numerical linear algebra (for linear systems and eigenproblems). Floating-point arithmetic, backwards error analysis, conditioning, and stability. Other computational topics (e.g., numerical integration or nonlinear optimization) may also be surveyed. Final project involves some programming.
S. Johnson

Same subject as 6.335[J]
Prereq: 6.336[J], 16.920[J], 18.085, 18.335[J], or permission of instructor
G (Fall)
3-0-9 units
Unified introduction to the theory and practice of modern, near linear-time, numerical methods for large-scale partial-differential and integral equations. Topics include preconditioned iterative methods; generalized Fast Fourier Transform and other butterfly-based methods; multiresolution approaches, such as multigrid algorithms and hierarchical low-rank matrix decompositions; and low and high frequency Fast Multipole Methods. Example applications include aircraft design, cardiovascular system modeling, electronic structure computation, and tomographic imaging.
K. Burns

18.337[J] Numerical Computing and Interactive Software
Same subject as 6.338[J]
Prereq: 18.06, 18.700, or 18.701
G (Fall)
3-0-9 units
Interdisciplinary introduction to computing with Julia. Covers scientific computing and data analysis problems. Combines knowledge from computer science and computational science illustrating Julia’s approach to scientific computing. Sample scientific computing topics include dense and sparse linear algebra, Fourier transforms, data handling, machine learning, and N-body problems. Provides direct experience with the modern realities of programming supercomputers, GPUs, and multicore in a high-level language.
C. Rackauckas

18.338 Eigenvalues of Random Matrices
Prereq: 18.701 or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Covers the modern main results of random matrix theory as it is currently applied in engineering and science. Topics include matrix calculus for finite and infinite matrices (e.g., Wigner’s semicircle and Marcenko-Pastur laws), free probability, random graphs, combinatorial methods, matrix statistics, stochastic operators, passage to the continuum limit, moment methods, and compressed sensing. Knowledge of MATLAB helpful, but not required.
A. Edelman
18.352[J] Nonlinear Dynamics: The Natural Environment
Same subject as 12.009[J]
Prereq: Calculus II (GIR) and Physics I (GIR); Coreq: 18.03
U (Spring)
3-0-9 units

See description under subject 12.009[J].
D. H. Rothman

18.353[J] Nonlinear Dynamics: Chaos
Same subject as 2.050[J], 12.006[J]
Prereq: Physics II (GIR) and (18.03 or 18.032)
U (Fall)
3-0-9 units

See description under subject 12.006[J].
M. Durey

18.354[J] Nonlinear Dynamics: Continuum Systems
Same subject as 1.062[J], 12.207[J]
Subject meets with 18.3541
Prereq: Physics II (GIR) and (18.03 or 18.032)
U (Spring)
3-0-9 units

General mathematical principles of continuum systems. From microscopic to macroscopic descriptions in the form of linear or nonlinear (partial) differential equations. Exact solutions, dimensional analysis, calculus of variations and singular perturbation methods. Stability, waves and pattern formation in continuum systems. Subject matter illustrated using natural fluid and solid systems found, for example, in geophysics and biology.
J. Dunkel

18.3541 Nonlinear Dynamics: Continuum Systems
Subject meets with 1.062[J], 12.207[J], 18.354[J]
Prereq: Physics II (GIR) and (18.03 or 18.032)
G (Spring)
3-0-9 units

General mathematical principles of continuum systems. From microscopic to macroscopic descriptions in the form of linear or nonlinear (partial) differential equations. Exact solutions, dimensional analysis, calculus of variations and singular perturbation methods. Stability, waves and pattern formation in continuum systems. Subject matter illustrated using natural fluid and solid systems found, for example, in geophysics and biology. Students in Courses 1, 12, and 18 must register for undergraduate version, 18.354[J].
J. Dunkel

18.355 Fluid Mechanics
Prereq: 2.25, 12.800, or 18.354[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Topics include the development of Navier-Stokes equations, inviscid flows, boundary layers, lubrication theory, Stokes flows, and surface tension. Fundamental concepts illustrated through problems drawn from a variety of areas, including geophysics, biology, and the dynamics of sport. Particular emphasis on the interplay between dimensional analysis, scaling arguments, and theory. Includes classroom and laboratory demonstrations.
J. W. Bush

18.357 Interfacial Phenomena
Prereq: 2.25, 12.800, 18.354[J], 18.355, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Fluid systems dominated by the influence of interfacial tension. Elucidates the roles of curvature pressure and Marangoni stress in a variety of hydrodynamic settings. Particular attention to drops and bubbles, soap films and minimal surfaces, wetting phenomena, water-repellency, surfactants, Marangoni flows, capillary origami and contact line dynamics. Theoretical developments are accompanied by classroom demonstrations. Highlights the role of surface tension in biology.
J. W. Bush

18.358[J] Nonlinear Dynamics and Turbulence
Same subject as 1.686[J], 2.033[J]
Subject meets with 1.068
Prereq: 1.060A
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-2-7 units

See description under subject 1.686[J].
L. Bourouiba
### 18.367 Waves and Imaging
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

The mathematics of inverse problems involving waves, with examples taken from reflection seismology, synthetic aperture radar, and computerized tomography. Suitable for graduate students from all departments who have affinities with applied mathematics. Topics include acoustic, elastic, electromagnetic wave equations; geometrical optics; scattering series and inversion; migration and backprojection; adjoint-state methods; Radon and curvilinear Radon transforms; microlocal analysis of imaging; optimization, regularization, and sparse regression.

L. Demanet

### 18.369[J] Mathematical Methods in Nanophotonics
Same subject as 8.315[J]
Prereq: 8.07, 18.303, or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

High-level approaches to understanding complex optical media, structured on the scale of the wavelength, that are not generally analytically solvable. The basis for understanding optical phenomena such as photonic crystals and band gaps, anomalous diffraction, mechanisms for optical confinement, optical fibers (new and old), nonlinearities, and integrated optical devices. Methods covered include linear algebra and eigensystems for Maxwell’s equations, symmetry groups and representation theory, Bloch’s theorem, numerical eigensolver methods, time and frequency-domain computation, perturbation theory, and coupled-mode theories.

S. G. Johnson

### 18.376[J] Wave Propagation
Same subject as 1.138[J], 2.062[J]
Prereq: 2.003[J] and 18.075
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

See description under subject 2.062[J].

T. R. Akylas, R. R. Rosales

### 18.377[J] Nonlinear Dynamics and Waves
Same subject as 1.685[J], 2.034[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

A unified treatment of nonlinear oscillations and wave phenomena with applications to mechanical, optical, geophysical, fluid, electrical and flow-structure interaction problems. Nonlinear free and forced vibrations; nonlinear resonances; self-excited oscillations; lock-in phenomena. Nonlinear dispersive and nondispersive waves; resonant wave interactions; propagation of wave pulses and nonlinear Schrödinger equation. Nonlinear long waves and breaking; theory of characteristics; the Korteweg-de Vries equation; solitons and solitary wave interactions. Stability of shear flows. Some topics and applications may vary from year to year.

R. R. Rosales

### 18.384 Undergraduate Seminar in Physical Mathematics
Prereq: 12.006[J], 18.300, 18.354[J], or permission of instructor
U (Fall)
3-0-9 units

Covers the mathematical modeling of physical systems, with emphasis on the reading and presentation of papers. Addresses a broad range of topics, with particular focus on macroscopic physics and continuum systems: fluid dynamics, solid mechanics, and biophysics. Instruction and practice in written and oral communication provided. Enrollment limited.

H. Ronellenfitsch

### 18.385[J] Nonlinear Dynamics and Chaos
Same subject as 2.036[J]
Prereq: 18.03 or 18.032
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units


R. R. Rosales
18.397 Mathematical Methods in Physics
Prereq: 18.745 or some familiarity with Lie theory
G (Fall)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Content varies from year to year. Recent developments in quantum field theory require mathematical techniques not usually covered in standard graduate subjects.

V. G. Kac

Theoretical Computer Science

18.400[J] Automata, Computability, and Complexity
Same subject as 6.045[J]
Prereq: 6.042[J]
U (Spring)
4-0-8 units
See description under subject 6.045[J].

R. Williams, R. Rubinfeld

18.404 Theory of Computation
Subject meets with 6.840[J], 18.4041[J]
Prereq: 6.042[J] or 18.200
U (Fall)
4-0-8 units
A more extensive and theoretical treatment of the material in 6.045[J]/18.400[J], emphasizing computability and computational complexity theory. Regular and context-free languages. Decidable and undecidable problems, reducibility, recursive function theory. Time and space measures on computation, completeness, hierarchy theorems, inherently complex problems, oracles, probabilistic computation, and interactive proof systems. Students in Course 18 must register for the undergraduate version, 18.404.

M. Sipser

18.4041[J] Theory of Computation
Same subject as 6.840[J]
Subject meets with 18.404
Prereq: 6.042[J] or 18.200
G (Fall)
4-0-8 units
A more extensive and theoretical treatment of the material in 6.045[J]/18.400[J], emphasizing computability and computational complexity theory. Regular and context-free languages. Decidable and undecidable problems, reducibility, recursive function theory. Time and space measures on computation, completeness, hierarchy theorems, inherently complex problems, oracles, probabilistic computation, and interactive proof systems. Interactive proof systems and probabilistically checkable proofs.

R. Williams

18.405[J] Advanced Complexity Theory
Same subject as 6.840[J]
Prereq: 18.404
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

R. Williams

18.408 Topics in Theoretical Computer Science
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Can be repeated for credit.

Study of areas of current interest in theoretical computer science. Topics vary from term to term.

A. Moitra, J. A. Kelner

18.410[J] Design and Analysis of Algorithms
Same subject as 6.046[J]
Prereq: 6.006
U (Fall, Spring)
4-0-8 units
See description under subject 6.046[J].

E. Demaine, M. Goemans
18.415[J] Advanced Algorithms
Same subject as 6.854[J]
Prereq: 6.046[J] and (6.042[J], 18.600, or 6.041)
G (Fall)
5-0-7 units
See description under subject 6.854[J].
A. Moitra, D. R. Karger

18.416[J] Randomized Algorithms
Same subject as 6.856[J]
Prereq: (6.041 or 6.042[J]) and (6.046[J] or 6.854[J])
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
5-0-7 units
See description under subject 6.856[J].
D. R. Karger

18.417 Introduction to Computational Molecular Biology
Prereq: 6.006, 6.01, or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units
Introduces the basic computational methods used to model and predict the structure of biomolecules (proteins, DNA, RNA). Covers classical techniques in the field (molecular dynamics, Monte Carlo, dynamic programming) to more recent advances in analyzing and predicting RNA and protein structure, ranging from Hidden Markov Models and 3-D lattice models to attribute Grammars and tree Grammars.
Information: B. Berger

18.418[J] Topics in Computational Molecular Biology
Same subject as HST.504[J]
Prereq: 6.047, 18.417, or permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.
Covers current research topics in computational molecular biology. Recent research papers presented from leading conferences such as the International Conference on Computational Molecular Biology (RECOMB) and the Conference on Intelligent Systems for Molecular Biology (ISMB). Topics include original research (both theoretical and experimental) in comparative genomics, sequence and structure analysis, molecular evolution, proteomics, gene expression, transcriptional regulation, biological networks, drug discovery, and privacy. Recent research by course participants also covered. Participants will be expected to present individual projects to the class.
B. Berger

18.424 Seminar in Information Theory
Prereq: (6.041, 18.05, or 18.600) and (18.06, 18.700, or 18.701)
U (Fall)
3-0-9 units
Considers various topics in information theory, including data compression, Shannon’s Theorems, and error-correcting codes. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Enrollment limited.
P. W. Shor

18.425[J] Cryptography and Cryptanalysis
Same subject as 6.875[J]
Prereq: 6.046[J]
G (Fall)
3-0-9 units
See description under subject 6.875[J].
S. Goldwasser, S. Micali, V. Vaikuntanathan

18.434 Seminar in Theoretical Computer Science
Prereq: 6.046[J]
U (Spring)
3-0-9 units
Topics vary from year to year. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Enrollment limited.
W. C. Franks

18.435[J] Quantum Computation
Same subject as 2.111[J], 8.370[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Provides an introduction to the theory and practice of quantum computation. Topics covered: physics of information processing; quantum algorithms including the factoring algorithm and Grover’s search algorithm; quantum error correction; quantum communication and cryptography. Knowledge of quantum mechanics helpful but not required.
I. Chuang, A. Harrow, S. Lloyd, P. Shor

18.436[J] Quantum Information Science
Same subject as 6.443[J], 8.371[J]
Prereq: 18.435[J]
G (Spring)
3-0-9 units
See description under subject 8.371[J].
I. Chuang, A. Harrow
18.437[J] Distributed Algorithms
Same subject as 6.852[J]
Prereq: 6.046[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 6.852[J].
N. A. Lynch

18.453 Combinatorial Optimization
Subject meets with 18.4531
Prereq: 18.06, 18.700, or 18.701
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Thorough treatment of linear programming and combinatorial optimization. Topics include matching theory, network flow, matroid optimization, and how to deal with NP-hard optimization problems. Prior exposure to discrete mathematics (such as 18.200) helpful.
Information: M. X. Goemans

18.4531 Combinatorial Optimization
Subject meets with 18.453
Prereq: 18.06, 18.700, or 18.701
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Thorough treatment of linear programming and combinatorial optimization. Topics include matching theory, network flow, matroid optimization, and how to deal with NP-hard optimization problems. Prior exposure to discrete mathematics (such as 18.200) helpful. Students in Course 18 must register for the undergraduate version, 18.453.
Information: M. X. Goemans

18.455 Advanced Combinatorial Optimization
Prereq: 18.453 or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Advanced treatment of combinatorial optimization with an emphasis on combinatorial aspects. Non-bipartite matchings, submodular functions, matroid intersection/union, matroid matching, submodular flows, multicommodity flows, packing and connectivity problems, and other recent developments.
M. X. Goemans

18.456[J] Algebraic Techniques and Semidefinite Optimization
Same subject as 6.256[J]
Prereq: 6.251[J] or 15.093[J]
G (Spring)
3-0-9 units
See description under subject 6.256[J].
P. Parrilo

Logic

18.504 Seminar in Logic
Prereq: (18.06, 18.510, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units
Students present and discuss the subject matter taken from current journals or books. Topics vary from year to year. Instruction and practice in written and oral communication provided. Enrollment limited.
H. Cohn

18.510 Introduction to Mathematical Logic and Set Theory
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
H. Cohn

18.515 Mathematical Logic
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Information: B. Poonen
**Probability and Statistics**

**18.600 Probability and Random Variables**  
Prereq: Calculus II (GIR)  
U (Fall, Spring)  
4-0-8 units. REST  
Credit cannot also be received for 6.041, 6.431, 15.079, 15.079A  
Probability spaces, random variables, distribution functions. Binomial, geometric, hypergeometric, Poisson distributions. Uniform, exponential, normal, gamma and beta distributions. Conditional probability, Bayes theorem, joint distributions. Chebyshev inequality, law of large numbers, and central limit theorem. Credit cannot also be received for 6.041A or 6.041B.  
J. A. Kelner, S. Sheffield

**18.615 Introduction to Stochastic Processes**  
Prereq: 6.041 or 18.600  
G (Spring)  
3-0-9 units  
E. Mossel

**18.642 Topics in Mathematics with Applications in Finance**  
Prereq: 18.03, 18.06, and (18.05 or 18.600)  
U (Fall)  
3-0-9 units  
Introduction to mathematical concepts and techniques used in finance. Lectures focusing on linear algebra, probability, statistics, stochastic processes, and numerical methods are interspersed with lectures by financial sector professionals illustrating the corresponding application in the industry. Prior knowledge of economics or finance helpful but not required.  
P. Kempthorne, V. Strela, J. Xia

**18.650[J] Fundamentals of Statistics**  
Same subject as IDS.014[J]  
Subject meets with 18.6501  
Prereq: 18.600 or 6.041  
U (Fall, Spring)  
4-0-8 units  
Credit cannot also be received for 15.075[J], IDS.013[J]  
A broad treatment of statistics, concentrating on specific statistical techniques used in science and industry. Topics: hypothesis testing and estimation. Confidence intervals, chi-square tests, nonparametric statistics, analysis of variance, regression, correlation, decision theory, and Bayesian statistics. Students in Course 18 must register for the undergraduate version, 18.650[J].  
Fall: P. Rigollet. Spring: T. Maunu

**18.6501 Fundamentals of Statistics**  
Subject meets with 18.650[J], IDS.014[J]  
Prereq: 18.600 or 6.041  
G (Fall, Spring)  
4-0-8 units  
Credit cannot also be received for 15.075[J], IDS.013[J]  
A broad treatment of statistics, concentrating on specific statistical techniques used in science and industry. Topics: hypothesis testing and estimation. Confidence intervals, chi-square tests, nonparametric statistics, analysis of variance, regression, correlation, decision theory, and Bayesian statistics. Students in Course 18 must register for the undergraduate version, 18.650[J].  
Fall: P. Rigollet. Spring: T. Maunu

**18.655 Mathematical Statistics**  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  
Decision theory, estimation, confidence intervals, hypothesis testing. Introduces large sample theory. Asymptotic efficiency of estimates. Exponential families. Sequential analysis.  
P. Kempthorne

**18.657 Topics in Statistics**  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Can be repeated for credit.  
Topics vary from term to term.  
P. Rigollet

**18.675 Theory of Probability (18.175)**  
Prereq: 18.100A, 18.100B, 18.100P, or 18.100Q  
G (Fall)  
3-0-9 units  
Sums of independent random variables, central limit phenomena, infinitely divisible laws, Levy processes, Brownian motion, conditioning, and martingales. Prior exposure to probability (e.g., 18.600) recommended.  
N. Sun
18.676 Stochastic Calculus (18.176)
Prereq: 18.175
G (Spring)
3-0-9 units
Introduction to stochastic processes, building on the fundamental example of Brownian motion. Topics include Brownian motion, continuous parameter martingales, Ito’s theory of stochastic differential equations, Markov processes and partial differential equations, and may also include local time and excursion theory. Students should have familiarity with Lebesgue integration and its application to probability.
N. Sun

18.677 Topics in Stochastic Processes (18.177)
Prereq: 18.675
G (Spring)
3-0-9 units
Can be repeated for credit.
Topics vary from year to year.
S. Sheffield

Algebra and Number Theory

18.700 Linear Algebra
Prereq: Calculus II (GIR)
U (Fall)
3-0-9 units. REST
Credit cannot also be received for 18.06
Vector spaces, systems of linear equations, bases, linear independence, matrices, determinants, eigenvalues, inner products, quadratic forms, and canonical forms of matrices. More emphasis on theory and proofs than in 18.06.
D. A. Vogan

18.701 Algebra I
Prereq: 18.100A, 18.100B, 18.100P, 18.100Q, or permission of instructor
U (Fall)
3-0-9 units
18.701-18.702 is more extensive and theoretical than the 18.700-18.703 sequence. Experience with proofs necessary. 18.701 focuses on group theory, geometry, and linear algebra.
M. Artin

18.702 Algebra II
Prereq: 18.701
U (Spring)
3-0-9 units
Continuation of 18.701. Focuses on group representations, rings, ideals, fields, polynomial rings, modules, factorization, integers in quadratic number fields, field extensions, and Galois theory.
A. Shankar

18.703 Modern Algebra
Prereq: Calculus II (GIR)
U (Spring)
3-0-9 units
Focuses on traditional algebra topics that have found greatest application in science and engineering as well as in mathematics: group theory, emphasizing finite groups; ring theory, including ideals and unique factorization in polynomial and Euclidean rings; field theory, including properties and applications of finite fields. 18.700 and 18.703 together form a standard algebra sequence.
J. Shen

18.704 Seminar in Algebra
Prereq: 18.701, (18.06 and 18.703), or (18.700 and 18.703)
U (Fall)
3-0-9 units
Topics vary from year to year. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Some experience with proofs required. Enrollment limited.
J.-L. Kim

18.705 Commutative Algebra
Prereq: 18.702
G (Fall)
3-0-9 units
Exactness, direct limits, tensor products, Cayley-Hamilton theorem, integral dependence, localization, Cohen-Seidenberg theory, Noether normalization, Nullstellensatz, chain conditions, primary decomposition, length, Hilbert functions, dimension theory, completion, Dedekind domains.
B. Poonen
18.706 Noncommutative Algebra  
Prereq: 18.702  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  
Topics may include Wedderburn theory and structure of Artinian rings, Morita equivalence and elements of category theory, localization and Goldie’s theorem, central simple algebras and the Brauer group, representations, polynomial identity rings, invariant theory growth of algebras, Gelfand-Kirillov dimension.  
R. Bezrukavnikov

18.708 Topics in Algebra  
Prereq: 18.705  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Can be repeated for credit.  
Topics vary from year to year.  
Z. Yun

18.715 Introduction to Representation Theory  
Prereq: 18.702 or 18.703  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  
G. Lusztig

18.721 Introduction to Algebraic Geometry  
Prereq: 18.702 and 18.901  
Acad Year 2019-2020: U (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units  
Presents basic examples of complex algebraic varieties, affine and projective algebraic geometry, sheaves, cohomology.  
M. Artin

18.725 Algebraic Geometry I  
Prereq: None. Coreq: 18.705  
G (Fall)  
3-0-9 units  
Introduces the basic notions and techniques of modern algebraic geometry. Covers fundamental notions and results about algebraic varieties over an algebraically closed field; relations between complex algebraic varieties and complex analytic varieties; and examples with emphasis on algebraic curves and surfaces. Introduction to the language of schemes and properties of morphisms. Knowledge of elementary algebraic topology, elementary differential geometry recommended, but not required.  
C. Xu

18.726 Algebraic Geometry II  
Prereq: 18.725  
G (Spring)  
3-0-9 units  
Continuation of the introduction to algebraic geometry given in 18.725. More advanced properties of the varieties and morphisms of schemes, as well as sheaf cohomology.  
C. Xu

18.727 Topics in Algebraic Geometry  
Prereq: 18.725  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units  
Can be repeated for credit.  
Topics vary from year to year.  
A. Negut

18.737 Algebraic Groups  
Prereq: 18.705  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  
Structure of linear algebraic groups over an algebraically closed field, with emphasis on reductive groups. Representations of groups over a finite field using methods from étale cohomology. Some results from algebraic geometry are stated without proof.  
B. Poonen
18.745 Lie Groups and Lie Algebras I
Prereq: (18.701 or 18.703) and (18.100A, 18.100B, 18.100P, or 18.100Q)
G (Fall)
3-0-9 units
Covers fundamentals of the theory of Lie algebras and related groups. Topics may include theorems of Engel and Lie; enveloping algebra, Poincare-Birkhoff-Witt theorem; classification and construction of semisimple Lie algebras; the center of their enveloping algebras; elements of representation theory; compact Lie groups and/or finite Chevalley groups.
G. Lusztig

18.747 Infinite-dimensional Lie Algebras
Prereq: 18.745
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Topics vary from year to year.
P. I. Etingof

18.748 Topics in Lie Theory
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.
Topics vary from year to year.
P. I. Etingof

18.755 Lie Groups and Lie Algebras II
Prereq: 18.745 or permission of instructor
G (Spring)
3-0-9 units
A more in-depth treatment of Lie groups and Lie algebras. Topics may include homogeneous spaces and groups of automorphisms; representations of compact groups and their geometric realizations, Peter-Weyl theorem; invariant differential forms and cohomology of Lie groups and homogeneous spaces; complex reductive Lie groups, classification of real reductive groups.
D. A. Vogan

18.757 Representations of Lie Groups
Prereq: 18.745 or 18.755
G (Spring)
Not offered regularly; consult department
3-0-9 units
Covers representations of locally compact groups, with emphasis on compact groups and abelian groups. Includes Peter-Weyl theorem and Cartan-Weyl highest weight theory for compact Lie groups.
Information: R. Bezrukavnikov

18.781 Theory of Numbers
Prereq: None
U (Spring)
3-0-9 units
An elementary introduction to number theory with no algebraic prerequisites. Primes, congruences, quadratic reciprocity, diophantine equations, irrational numbers, continued fractions, partitions.
C. Wan

18.782 Introduction to Arithmetic Geometry
Prereq: 18.702
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Exposes students to arithmetic geometry, motivated by the problem of finding rational points on curves. Includes an introduction to p-adic numbers and some fundamental results from number theory and algebraic geometry, such as the Hasse-Minkowski theorem and the Riemann-Roch theorem for curves. Additional topics may include Mordell's theorem, the Weil conjectures, and Jacobian varieties.
J. Whang

18.783 Elliptic Curves
Subject meets with 18.7831
Prereq: 18.702, 18.703, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Computationally focused introduction to elliptic curves, with applications to number theory and cryptography. Topics include point-counting, isogenies, pairings, and the theory of complex multiplication, with applications to integer factorization, primality proving, and elliptic curve cryptography. Includes a brief introduction to modular curves and the proof of Fermat's Last Theorem.
A. Sutherland
18.7831 Elliptic Curves
Subject meets with 18.783
Prereq: 18.702, 18.703, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Computationally focused introduction to elliptic curves, with applications to number theory and cryptography. Topics include point-counting, isogenies, pairings, and the theory of complex multiplication, with applications to integer factorization, primality proving, and elliptic curve cryptography. Includes a brief introduction to modular curves and the proof of Fermat's Last Theorem. Students in Course 18 must register for the undergraduate version, 18.783.
A. Sutherland

18.784 Seminar in Number Theory
Prereq: 18.701 or (18.703 and (18.06 or 18.700))
U (Spring)
3-0-9 units
Topics vary from year to year. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Enrollment limited.
J.-L. Kim

18.785 Number Theory I
Prereq: None. Coreq: 18.705
G (Fall)
3-0-9 units
Dedekind domains, unique factorization of ideals, splitting of primes. Lattice methods, finiteness of the class group, Dirichlet's unit theorem. Local fields, ramification, discriminants. Zeta and L-functions, analytic class number formula. Adeles and ideles. Statements of class field theory and the Chebotarev density theorem.
A. Sutherland

18.786 Number Theory II
Prereq: 18.785
G (Spring)
3-0-9 units
Continuation of 18.785. More advanced topics in number theory, such as Galois cohomology, proofs of class field theory, modular forms and automorphic forms, Galois representations, or quadratic forms.
W. Zhang

18.787 Topics in Number Theory
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.
Topics vary from year to year.
W. Zhang

Mathematics Laboratory
18.821 Project Laboratory in Mathematics
Prereq: Two mathematics subjects numbered 18.10 or above
U (Fall, Spring)
3-6-3 units. Institute LAB
Guided research in mathematics, employing the scientific method. Students confront puzzling and complex mathematical situations, through the acquisition of data by computer, pencil and paper, or physical experimentation, and attempt to explain them mathematically. Students choose three projects from a large collection of options. Each project results in a laboratory report subject to revision; oral presentation on one or two projects. Projects drawn from many areas, including dynamical systems, number theory, algebra, fluid mechanics, asymptotic analysis, knot theory, and probability. Enrollment limited.
H. Cohn, R. Bezrukavnikov

Topology and Geometry
18.900 Geometry and Topology in the Plane
Prereq: 18.03 or 18.06
U (Fall)
3-0-9 units
Covers selected topics in geometry and topology, which can be visualized in the two-dimensional plane. Polygons and polygonal paths. Billiards. Closed curves and immersed curves. Algebraic curves. Triangulations and complexes. Hyperbolic geometry. Geodesics and curvature. Other topics may be included as time permits.
P. Seidel
18.901 Introduction to Topology
Subject meets with 18.9011
Prereq: 18.100A, 18.100B, 18.100P, 18.100Q, or permission of instructor
U (Fall, Spring)
3-0-9 units
Introduces topology, covering topics fundamental to modern analysis and geometry. Topological spaces and continuous functions, connectedness, compactness, separation axioms, covering spaces, and the fundamental group.  
Fall: M. Stoffregen. Spring: G. Lusztig

18.9011 Introduction to Topology
Subject meets with 18.901
Prereq: 18.100A, 18.100B, 18.100P, 18.100Q, or permission of instructor
G (Fall, Spring)
3-0-9 units
Introduces topology, covering topics fundamental to modern analysis and geometry. Topological spaces and continuous functions, connectedness, compactness, separation axioms, covering spaces, and the fundamental group. Students in Course 18 must register for the undergraduate version, 18.901.  
Fall: M. Stoffregen. Spring: G. Lusztig

18.904 Seminar in Topology
Prereq: 18.901
U (Fall)
3-0-9 units
Topics vary from year to year. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Enrollment limited.  
T. Bachmann

18.905 Algebraic Topology I
Prereq: 18.901 and (18.701 or 18.703)
G (Fall)
3-0-9 units
Singular homology, CW complexes, universal coefficient and Künneth theorems, cohomology, cup products, Poincaré duality.  
Z. Xu

18.906 Algebraic Topology II
Prereq: 18.905
G (Spring)
3-0-9 units
Continues the introduction to Algebraic Topology from 18.905. Topics include basic homotopy theory, spectral sequences, characteristic classes, and cohomology operations.  
J. Hahn

18.917 Topics in Algebraic Topology
Prereq: 18.906
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Can be repeated for credit.
Content varies from year to year. Introduces new and significant developments in algebraic topology with the focus on homotopy theory and related areas.  
Z. Xu

18.919 Graduate Topology Seminar
Prereq: 18.906
G (Fall)
3-0-9 units
Study and discussion of important original papers in the various parts of algebraic topology. Open to all students who have taken 18.906 or the equivalent, not only prospective topologists.  
H. R. Miller

18.937 Topics in Geometric Topology
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.
Content varies from year to year. Introduces new and significant developments in geometric topology.  
T. S. Mrowka
18.950 Differential Geometry
Subject meets with 18.9501
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
U (Spring)
3-0-9 units
Introduction to differential geometry, centered on notions of curvature. Starts with curves in the plane, and proceeds to higher dimensional submanifolds. Computations in coordinate charts: first and second fundamental form, Christoffel symbols. Discusses the distinction between extrinsic and intrinsic aspects, in particular Gauss' theorema egregium. The Gauss-Bonnet theorem. Geodesics. Examples such as hyperbolic space.

P. Hintz

18.9501 Differential Geometry
Subject meets with 18.950
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
G (Spring)
3-0-9 units
Introduction to differential geometry, centered on notions of curvature. Starts with curves in the plane, and proceeds to higher dimensional submanifolds. Computations in coordinate charts: first and second fundamental form, Christoffel symbols. Discusses the distinction between extrinsic and intrinsic aspects, in particular Gauss' theorema egregium. The Gauss-Bonnet theorem. Geodesics. Examples such as hyperbolic space. Students in Course 18 must register for the undergraduate version, 18.950.

P. Hintz

18.952 Theory of Differential Forms
Prereq: 18.101 and (18.700 or 18.701)
U (Spring)
3-0-9 units
Multilinear algebra: tensors and exterior forms. Differential forms on $\mathbb{R}^n$: exterior differentiation, the pull-back operation and the Poincaré lemma. Applications to physics: Maxwell's equations from the differential form perspective. Integration of forms on open sets of $\mathbb{R}^n$. The change of variables formula revisited. The degree of a differentiable mapping. Differential forms on manifolds and De Rham theory. Integration of forms on manifolds and Stokes' theorem. The push-forward operation for forms. Thom forms and intersection theory. Applications to differential topology.

V. W. Guillemin

18.965 Geometry of Manifolds I
Prereq: 18.101, 18.950, or 18.952
G (Fall)
3-0-9 units
Differential forms, introduction to Lie groups, the DeRham theorem, Riemannian manifolds, curvature, the Hodge theory. 18.966 is a continuation of 18.965 and focuses more deeply on various aspects of the geometry of manifolds. Contents vary from year to year, and can range from Riemannian geometry (curvature, holonomy) to symplectic geometry, complex geometry and Hodge-Kahler theory, or smooth manifold topology. Prior exposure to calculus on manifolds, as in 18.952, recommended.

T. Collins

18.966 Geometry of Manifolds II
Prereq: 18.965
G (Spring)
3-0-9 units
Continuation of 18.965, focusing more deeply on various aspects of the geometry of manifolds. Contents vary from year to year, and can range from Riemannian geometry (curvature, holonomy) to symplectic geometry, complex geometry and Hodge-Kahler theory, or smooth manifold topology.

W. Minicozzi

18.968 Topics in Geometry
Prereq: 18.965
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Can be repeated for credit.

Content varies from year to year.

P. Seidel

18.979 Graduate Geometry Seminar
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.

Content varies from year to year. Study of classical papers in geometry and in applications of analysis to geometry and topology.

T. Mrowka
18.994 Seminar in Geometry
Prereq: (18.06, 18.700, or 18.701) and (18.100A, 18.100B, 18.100P, or 18.100Q)
U (Spring)
3-0-9 units
Students present and discuss subject matter taken from current journals or books. Topics vary from year to year. Instruction and practice in written and oral communication provided. Enrollment limited.
C. Mantoulidis

18.999 Research in Mathematics
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.
Opportunity for study of graduate-level topics in mathematics under the supervision of a member of the department. For graduate students desiring advanced work not provided in regular subjects.
Information: W. Minicozzi

18.UR Undergraduate Research
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Undergraduate research opportunities in mathematics. Permission required in advance to register for this subject. For further information, consult the departmental coordinator.
Information: W. Minicozzi

18.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of a Ph.D. thesis; to be arranged by the student and an appropriate MIT faculty member.
Information: W. Minicozzi

18.5096 Special Subject in Mathematics
Prereq: Permission of instructor
U (Fall, IAP)
Units arranged
Can be repeated for credit.
Opportunity for group study of subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to departmental approval. 18.5097 is graded P/D/F.
Fall: K. Okoudjou

18.5097 Special Subject in Mathematics
Prereq: Permission of instructor
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for group study of subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to departmental approval. 18.5097 is graded P/D/F.
Information: W. Minicozzi

18.5190 Special Subject in Mathematics (New)
Prereq: Permission of instructor
U (IAP)
Units arranged
Can be repeated for credit.
Opportunity for group study of subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to departmental approval.
Staff

18.5191 Special Subject in Mathematics (New)
Prereq: Permission of instructor
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for group study of subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to departmental approval. 18.5191 is graded P/D/F.
Staff
18.S995 Special Subject in Mathematics
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the mathematics faculty on an ad hoc basis, subject to departmental approval.

E. Mossel

18.S996 Special Subject in Mathematics
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to Departmental approval.

T. Lam

18.S997 Special Subject in Mathematics
Prereq: Permission of instructor
G (IAP)
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to Departmental approval.

Information: W. Minicozzi

18.S998 Special Subject in Mathematics
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.

Opportunity for group study of advanced subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to departmental approval.

Information: W. Minicozzi
MECHANICAL ENGINEERING (COURSE 2)

First-Year Introductory Subjects

2.00A Fundamentals of Engineering Design: Explore Space, Sea and Earth
Prereq: Calculus I (GIR) and Physics I (GIR)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-3-3 units

Student teams formulate and complete space/earth/ocean exploration-based design projects with weekly milestones. Introduces core engineering themes, principles, and modes of thinking. Specialized learning modules enable teams to focus on the knowledge required to complete their projects, such as machine elements, electronics, design process, visualization and communication. Includes exercises in written and oral communication and team building. Examples of projects include surveying a lake for milfoil, from a remote controlled aircraft, and then sending out robotic harvesters to clear the invasive growth; and exploration to search for the evidence of life on a moon of Jupiter, with scientists participating through teleoperation and supervisory control of robots. Enrollment limited; preference to freshmen.

D. Frey

2.00B Toy Product Design
Prereq: None
U (Spring)
3-5-1 units

Provides students with an overview of design for entertainment and play, as well as opportunities in creative product design and community service. Students develop ideas for new toys that serve clients in the community, and work in teams with local sponsors and with experienced mentors on a themed toy design project. Students enhance creativity and experience fundamental aspects of the product development process, including determining customer needs, brainstorming, estimation, sketching, sketch modeling, concept development, design aesthetics, detailed design, and prototyping. Includes written, visual, and oral communication. Enrollment limited; preference to freshmen.

D. R. Wallace

2.00C[J] Design for Complex Environmental Issues: Building Solutions and Communicating Ideas
Same subject as 1.016[J], EC.746[J]
Prereq: None
U (Spring)
3-1-5 units

Students work in small groups, under the guidance of researchers from MIT, to pursue specific aspects of the year’s Terrascope problem. Teams design and build prototypes, graphic displays and other tools to communicate their findings and display them in a Bazaar of Ideas open to the MIT community. Some teams develop particular solutions, others work to provide deeper understanding of the issues, and others focus on ways to communicate these ideas with the general public. Students’ work is evaluated by independent experts. Offers students an opportunity to develop ideas from the fall semester and to work in labs across MIT. Limited to first-year students.

A. W. Epstein, S. L. Hsu

Core Undergraduate Subjects

2.00 Introduction to Design
Prereq: None
U (Fall; second half of term)
2-2-2 units

Project-based introduction to product development and engineering design. Emphasizes key elements of the design process, including defining design problems, generating ideas, and building solutions. Presents a range of design techniques to help students think about, evaluate, and communicate designs, from sketching to physical prototyping, as well as other types of modeling. Students work both individually and in teams. Enrollment limited; preference to Course 2-A sophomores.

M. Yang

2.001 Mechanics and Materials I
Prereq: Physics I (GIR); Coreq: 2.087 or 18.03
U (Fall, Spring)
4-1-7 units. REST

Introduction to statics and the mechanics of deformable solids. Emphasis on the three basic principles of equilibrium, geometric compatibility, and material behavior. Stress and its relation to force and moment; strain and its relation to displacement; linear elasticity with thermal expansion. Failure modes. Application to simple engineering structures such as rods, shafts, beams, and trusses. Application to biomechanics of natural materials and structures.

S. Socrate, M. Culpepper, D. Parks, K. Kamrin
2.002 Mechanics and Materials II  
Prereq: Chemistry (GIR) and 2.001  
U (Spring)  
3-3-6 units

Introduces mechanical behavior of engineering materials, and the use of materials in mechanical design. Emphasizes the fundamentals of mechanical behavior of materials, as well as design with materials. Major topics: elasticity, plasticity, limit analysis, fatigue, fracture, and creep. Materials selection. Laboratory experiments involving projects related to materials in mechanical design. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.  
L. Anand, K. Kamrin, P. Reis

2.003[J] Dynamics and Control I  
Same subject as 1.053[J]  
Prereq: Physics II (GIR); Coreq: 2.087 or 18.03  
U (Fall, Spring)  
4-1-7 units. REST

J. K. Vandiver, N. C. Makris, N. M. Patrikalakis, T. Peacock, D. Gossard, K. Turitsyn

2.004 Dynamics and Control II  
Prereq: Physics II (GIR) and 2.003[J]  
U (Fall, Spring)  
4-2-6 units

Modeling, analysis, and control of dynamic systems. System modeling: lumped parameter models of mechanical, electrical, and electromechanical systems; interconnection laws; actuators and sensors. Linear systems theory: linear algebra; Laplace transform; transfer functions, time response and frequency response, poles and zeros; block diagrams; solutions via analytical and numerical techniques; stability. Introduction to feedback control: closed-loop response; PID compensation; steady-state characteristics, root-locus design concepts, frequency-domain design concepts. Laboratory experiments and control design projects. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.  
G. Barbastathis, D. Del Vecchio, D. C. Gossard, D. E. Hardt, S. Lloyd

2.005 Thermal-Fluids Engineering I  
Prereq: (Calculus II (GIR), Physics II (GIR), and (2.086, 6.0002, or 18.06)) or permission of instructor  
U (Fall, Spring)  
5-0-7 units

J. Buongiorno, P. F. J. Lermusiaux

2.006 Thermal-Fluids Engineering II  
Prereq: 2.005 or (2.051 and 2.06)  
U (Fall, Spring)  
5-0-7 units

R. Karnik, B. Gallant, C. Buie
2.007 Design and Manufacturing I
Prereq: 2.001 and 2.670; Coreq: 2.086
U (Spring)
3-4-5 units
Develops students’ competence and self-confidence as design engineers. Emphasis on the creative design process bolstered by application of physical laws. Instruction on how to complete projects on schedule and within budget. Robustness and manufacturability are emphasized. Subject relies on active learning via a major design-and-build project. Lecture topics include idea generation, estimation, concept selection, visual thinking, computer-aided design (CAD), mechanism design, machine elements, basic electronics, technical communication, and ethics. Lab fee. Limited enrollment. Pre-registration required for lab assignment; special sections by lottery only.

D. Frey, S. Kim, A. Winter

2.008 Design and Manufacturing II
Prereq: 2.007; or Coreq: 2.017[J] and (2.005 or 2.051)
U (Fall, Spring)
3-3-6 units. Partial Lab
Integration of design, engineering, and management disciplines and practices for analysis and design of manufacturing enterprises. Emphasis is on the physics and stochastic nature of manufacturing processes and systems, and their effects on quality, rate, cost, and flexibility. Topics include process physics and control, design for manufacturing, and manufacturing systems. Group project requires design and fabrication of parts using mass-production and assembly methods to produce a product in quantity. Six units may be applied to the General Institute Lab Requirement. Satisfies 6 units of Institute Laboratory credit. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.


2.009 The Product Engineering Process
Prereq: 2.001, 2.003[J], (2.005 or 2.051), and (2.00B, 2.670, or 2.678)
U (Fall)
3-3-9 units
Students develop an understanding of product development phases and experience working in teams to design and construct high-quality product prototypes. Design process learned is placed into a broader development context. Primary goals are to improve ability to reason about design alternatives and apply modeling techniques appropriate for different development phases; understand how to gather and process customer information and transform it into engineering specifications; and use teamwork to resolve the challenges in designing and building a substantive product prototype. Instruction and practice in oral communication provided. Enrollment may be limited due to laboratory capacity; preference to Course 2 seniors.

D. R. Wallace

2.013 Engineering Systems Design
Subject meets with 2.733
Prereq: (2.001, 2.003[J], (2.005 or 2.051), and (2.00B, 2.670, or 2.678)) or permission of instructor
U (Fall)
0-6-6 units
Focuses on the design of engineering systems to satisfy stated performance, stability, and/or control requirements. Emphasizes individual initiative, application of fundamental principles, and the compromises inherent in the engineering design process. Culminates in the design of an engineering system, typically a vehicle or other complex system. Includes instruction and practice in written and oral communication through team presentations, design reviews, and written reports. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.

D. Hart
2.014 Engineering Systems Development
Subject meets with 2.734
Prereq: (2.001, 2.003[J], (2.005 or 2.051), and (2.00B, 2.670, or 2.678)) or permission of instructor
U (Spring)
0-6-6 units
Can be repeated for credit.
Focuses on implementation and operation of engineering systems. Emphasizes system integration and performance verification using methods of experimental inquiry. Students refine their subsystem designs and the fabrication of working prototypes. Includes experimental analysis of subsystem performance and comparison with physical models of performance and with design goals. Component integration into the full system, with detailed analysis and operation of the complete vehicle in the laboratory and in the field. Includes written and oral reports. Students carry out formal reviews of the overall system design. Instruction and practice in oral and written communication provided. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.
D. Hart

2.016 Hydrodynamics
Prereq: 2.005
U (Fall)
4-0-8 units
Covers fundamental principles of fluid mechanics and applications to practical ocean engineering problems. Basic geophysical fluid mechanics, including the effects of salinity, temperature, and density; heat balance in the ocean; large scale flows. Hydrostatics. Linear free surface waves, wave forces on floating and submerged structures. Added mass, lift and drag forces on submerged bodies. Includes final project on current research topics in marine hydrodynamics.
A. H. Techet

2.017[J] Design of Electromechanical Robotic Systems
Same subject as 1.015[J]
Prereq: 2.003[J], 2.016, and 2.678; Coreq: 2.671
U (Spring)
3-3-6 units. Partial Lab
Design, construction, and testing of field robotic systems, through team projects with each student responsible for a specific subsystem. Projects focus on electronics, instrumentation, and machine elements. Design for operation in uncertain conditions is a focus point, with ocean waves and marine structures as a central theme. Basic statistics, linear systems, Fourier transforms, random processes, spectra and extreme events with applications in design. Lectures on ethics in engineering practice included. Instruction and practice in oral and written communication provided. Satisfies 6 units of Institute Laboratory credit. Enrollment may be limited due to laboratory capacity.
M. Triantafyllou, T. Consi

2.019 Design of Ocean Systems
Prereq: 2.001, 2.003[J], and (2.005 or 2.016)
U (Spring)
3-3-6 units
Complete cycle of designing an ocean system using computational design tools for the conceptual and preliminary design stages. Team projects assigned, with each student responsible for a specific subsystem. Lectures cover hydrodynamics; structures; power and thermal aspects of ocean vehicles, environment, materials, and construction for ocean use; generation and evaluation of design alternatives. Focus on innovative design concepts chosen from high-speed ships, submersibles, autonomous vehicles, and floating and submerged deep-water offshore platforms. Lectures on ethics in engineering practice included. Instruction and practice in oral and written communication provided. Enrollment may be limited due to laboratory capacity; preference to Course 2 seniors.
C. Chryssostomidis, M. S. Triantafyllou

2.05 Thermodynamics
Prereq: 2.001
U (Fall; first half of term)
Not offered regularly; consult department
3-0-3 units
Provides an introduction to thermodynamics, including first law (coupled and uncoupled systems, incompressible liquid, ideal gas) and second law (equilibrium, reversibility and irreversibility). Explores systems in communication with heat reservoirs; quasi-static processes; and heat engines and refrigeration. Properties of open systems, including mass, energy and entropy transfer.
C. Buie
2.051 Introduction to Heat Transfer
Prereq: 2.05
U (Fall; second half of term)
Not offered regularly; consult department
2-0-4 units


J. H. Lienhard, E. N. Wang, A. Hosoi

2.06 Fluid Dynamics
Prereq: 2.001
U (Spring; first half of term)
2-0-4 units


G. H. McKinley

2.086 Numerical Computation for Mechanical Engineers
Prereq: Calculus II (GIR) and Physics I (GIR); Coreq: 2.087 or 18.03
U (Fall, Spring)
2-2-8 units. REST

Covers elementary programming concepts, including variable types, data structures, and flow control. Provides an introduction to linear algebra and probability. Numerical methods relevant to MechE, including approximation (interpolation, least squares, and statistical regression), integration, solution of linear and nonlinear equations, and ordinary differential equations. Presents deterministic and probabilistic approaches. Uses examples from MechE, particularly from robotics, dynamics, and structural analysis. Assignments require MATLAB programming. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.

D. Frey, F. Hover, N. Hadjiconstantinou

2.087 Engineering Mathematics: Linear Algebra and ODEs
Prereq: Calculus II (GIR) and Physics I (GIR)
U (Fall; first half of term)
Not offered regularly; consult department
2-0-4 units

Introduction to linear algebra and ordinary differential equations (ODEs), including general numerical approaches to solving systems of equations. Linear systems of equations, existence and uniqueness of solutions, Gaussian elimination. Initial value problems, 1st and 2nd order systems, forward and backward Euler, RK4. Eigenproblems, eigenvalues and eigenvectors, including complex numbers, functions, vectors and matrices.

A. Hosoi, T. Peacock

Dynamics and Acoustics

2.032 Dynamics
Prereq: 2.003[J]
G (Fall)
4-0-8 units


T. R. Akylas, T. Peacock, N. Hadjiconstantinou

2.033[J] Nonlinear Dynamics and Turbulence
Same subject as 1.686[J], 18.358[J]
Subject meets with 1.068
Prereq: 1.060A
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-2-7 units

See description under subject 1.686[J].

L. Bourouiba
2.034[J] Nonlinear Dynamics and Waves
Same subject as 1.685[J], 18.377[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
A unified treatment of nonlinear oscillations and wave phenomena with applications to mechanical, optical, geophysical, fluid, electrical and flow-structure interaction problems. Nonlinear free and forced vibrations; nonlinear resonances; self-excited oscillations; lock-in phenomena. Nonlinear dispersive and nondispersive waves; resonant wave interactions; propagation of wave pulses and nonlinear Schrodinger equation. Nonlinear long waves and breaking; theory of characteristics; the Korteweg-de Vries equation; solitons and solitary wave interactions. Stability of shear flows. Some topics and applications may vary from year to year.
R. R. Rosales

2.036[J] Nonlinear Dynamics and Chaos
Same subject as 18.385[J]
Prereq: 18.03 or 18.032
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 18.385[J].
R. R. Rosales

2.050[J] Nonlinear Dynamics: Chaos
Same subject as 12.006[J], 18.353[J]
Prereq: Physics II (GIR) and (18.03 or 18.032)
U (Fall)
3-0-9 units
See description under subject 12.006[J].
M. Durey

2.060[J] Structural Dynamics
Same subject as 1.581[J], 16.221[J]
Subject meets with 1.058
Prereq: 18.03 or permission of instructor
G (Fall)
3-1-8 units
See description under subject 1.581[J].
T. Cohen

2.062[J] Wave Propagation
Same subject as 1.138[J], 18.376[J]
Prereq: 2.003[J] and 18.075
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
T. R. Akylas, R. R. Rosales

2.065 Acoustics and Sensing
Subject meets with 2.066
Prereq: 2.003[J], 6.003, 8.03, or 16.003
U (Spring)
3-0-9 units
Introduces the fundamental concepts of acoustics and sensing with waves. Provides a unified theoretical approach to the physics of image formation through scattering and wave propagation in sensing. The linear and nonlinear acoustic wave equation, sources of sound, including musical instruments. Reflection, refraction, transmission and absorption. Bearing and range estimation by sensor array processing, beamforming, matched filtering, and focusing. Diffraction, bandwidth, ambient noise and reverberation limitations. Scattering from objects, surfaces and volumes by Green’s Theorem. Forward scatter, shadows, Babinet’s principle, extinction and attenuation. Ray tracing and waveguides in remote sensing. Applications to acoustic, radar, seismic, thermal and optical sensing and exploration. Students taking the graduate version complete additional assignments.
N. C. Makris
2.066 Acoustics and Sensing
Subject meets with 2.065
Prereq: 2.003[J], 6.003, 8.03, 16.003, or permission of instructor
G (Spring)
3-0-9 units
Introduces the fundamental concepts of acoustics and sensing with waves. Provides a unified theoretical approach to the physics of image formation through scattering and wave propagation in sensing. The linear and nonlinear acoustic wave equation, sources of sound, including musical instruments. Reflection, refraction, transmission and absorption. Bearing and range estimation by sensor array processing, beamforming, matched filtering, and focusing. Diffraction, bandwidth, ambient noise and reverberation limitations. Scattering from objects, surfaces and volumes by Green’s Theorem. Forward scatter, shadows, Babinet’s principle, extinction and attenuation. Ray tracing and waveguides in remote sensing. Applications to acoustic, radar, seismic, thermal and optical sensing and exploration. Students taking the graduate version of the subject complete additional assignments.
N. C. Makris

Solid Mechanics and Materials

2.071 Mechanics of Solid Materials
Prereq: 2.002
G (Spring)
4-0-8 units
Fundamentals of solid mechanics applied to the mechanical behavior of engineering materials. Kinematics of deformation, stress, and balance principles. Isotropic linear elasticity and isotropic linear thermal elasticity. Variational and energy methods. Linear viscoelasticity. Small-strain elastic-plastic deformation. Mechanics of large deformation; nonlinear hyperelastic material behavior. Foundations and methods of deformable-solid mechanics, including relevant applications. Provides base for further study and specialization within solid mechanics, including continuum mechanics, computational mechanics (e.g., finite-element methods), plasticity, fracture mechanics, structural mechanics, and nonlinear behavior of materials.
L. Anand, D. M. Parks

2.072 Mechanics of Continuous Media
Prereq: 2.071
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Principles and applications of continuum mechanics. Kinematics of deformation. Thermomechanical conservation laws. Stress and strain measures. Constitutive equations including some examples of their microscopic basis. Solution of some basic problems for various materials as relevant in materials science, fluid dynamics, and structural analysis. Inherently nonlinear phenomena in continuum mechanics. Variational principles.
L. Anand

2.073 Solid Mechanics: Plasticity and Inelastic Deformation
Prereq: 2.071
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Physical basis of plastic/inelastic deformation of solids; metals, polymers, granular/rock-like materials. Continuum constitutive models for small and large deformation of elastic-(visco)plastic solids. Analytical and numerical solution of selected boundary value problems. Applications to deformation processing of metals.
L. Anand, D. M. Parks

2.074 Solid Mechanics: Elasticity
Prereq: 2.002 and 18.03
G (Fall)
3-0-9 units
R. Abeyaratne
2.075 Mechanics of Soft Materials
Prereq: None
G (Fall)
3-0-9 units
Covers a number of fundamental topics in the emerging field of soft and active materials, including polymer mechanics and physics, poroelasticity, viscoelasticity, and mechanics of electro-magneto-active and other responsive polymers. Lectures, recitations, and experiments elucidate the basic mechanical and thermodynamic principles underlying soft and active materials. Develops an understanding of the fundamental mechanisms for designing soft materials that possess extraordinary properties, such as stretchable, tough, strong, resilient, adhesive and responsive to external stimuli, from molecular to bulk scales.
X. Zhao

2.076[J] Mechanics of Heterogeneous Materials
Same subject as 16.223[J]
Prereq: 2.002, 3.032, 16.20, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 16.223[J].
B. L. Wardle, S-G. Kim

2.080[J] Structural Mechanics
Same subject as 1.573[J]
Prereq: 2.002
G (Fall)
4-0-8 units
Applies solid mechanics fundamentals to the analysis of marine, civil, and mechanical structures. Continuum concepts of stress, deformation, constitutive response and boundary conditions are reviewed in selected examples. The principle of virtual work guides mechanics modeling of slender structural components (e.g., beams; shafts; cables, frames; plates; shells), leading to appropriate simplifying assumptions. Introduction to elastic stability. Material limits to stress in design. Variational methods for computational structural mechanics analysis.
T. Wierzbicki, D. Parks

2.081[J] Plates and Shells: Static and Dynamic Analysis
Same subject as 16.230[J]
Prereq: 2.071, 2.080[J], or permission of instructor
G (Spring)
3-1-8 units
T. Sapsis

2.082 Ship Structural Analysis and Design
Prereq: 2.081[J] and 2.701
G (Spring; second half of term)
3-0-3 units
Design application of analysis developed in 2.081[J]. Ship longitudinal strength and hull primary stresses. Ship structural design concepts. Design limit states including plate bending, column and panel buckling, panel ultimate strength, and plastic analysis. Matrix stiffness, and introduction to finite element analysis. Computer projects on the structural design of a midship module.
R. S. McCord, T. Wierzbicki
Computational Engineering

2.089[J] Computational Geometry
Same subject as 1.128[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units


N. M. Patrikalakis, D. C. Gossard

2.091[J] Software and Computation for Simulation
Same subject as 1.124[J]
Prereq: 1.00 or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

See description under subject 1.124[J].

J. R. Williams

2.092 Finite Element Analysis of Solids and Fluids I
Subject meets with 2.093
Prereq: 2.001 and 2.003[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units

Finite element methods for analysis of steady-state and transient problems in solid, structural, fluid mechanics, and heat transfer. Presents finite element methods and solution procedures for linear and nonlinear analyses using largely physical arguments. Demonstrates finite element analyses. Homework involves use of an existing general purpose finite element analysis program. Includes modeling of problems and interpretation of numerical results. Students taking graduate version complete additional assignments.

K. J. Bathe

2.093 Finite Element Analysis of Solids and Fluids I
Subject meets with 2.092
Prereq: 2.001 and 2.003[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Finite element methods for analysis of steady-state and transient problems in solid, structural, fluid mechanics, and heat transfer. Presents finite element methods and solution procedures for linear and nonlinear analyses using largely physical arguments. Demonstrates finite element analyses. Homework involves use of an existing general purpose finite element analysis program. Includes modeling of problems and interpretation of numerical results. Students taking graduate version complete additional assignments.

K. J. Bathe

2.096[J] Introduction to Numerical Simulation
Same subject as 6.336[J], 16.910[J]
Prereq: 18.03 or 18.06
G (Fall)
3-6-3 units

See description under subject 6.336[J].

L. Daniel

2.097[J] Numerical Methods for Partial Differential Equations
Same subject as 6.339[J], 16.920[J]
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 units

See description under subject 16.920[J].

Q. Wang, S. Groth

2.098 Introduction to Finite Element Methods for Partial Differential Equations
Prereq: 2.086 and 18.06
G (Spring)
3-0-9 units


A. Patera
2.099[J] Computational Mechanics of Materials
Same subject as 16.225[J]
Prereq: Permission of instructor
6 (Spring)
3-0-9 units
See description under subject 16.225[J].
R. Radovitzky

System Dynamics and Control

2.110[J] Information, Entropy, and Computation
Same subject as 6.050[J]
Prereq: Physics I (GIR)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-6 units
Explores the ultimate limits to communication and computation, with an emphasis on the physical nature of information and information processing. Topics include information and computation, digital signals, codes, and compression. Biological representations of information. Logic circuits, computer architectures, and algorithmic information. Noise, probability, and error correction. The concept of entropy applied to channel capacity and to the second law of thermodynamics. Reversible and irreversible operations and the physics of computation. Quantum computation.
S. Lloyd, P. Penfield, Jr.

2.111[J] Quantum Computation
Same subject as 8.370[J], 18.435[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject 18.435[J].
i. Chuang, A. Harrow, S. Lloyd, P. Shor

2.12 Introduction to Robotics
Subject meets with 2.120
Prereq: 2.004
U (Spring)
3-2-7 units
Presents the fundamentals of robot mechanisms, dynamics, and controls. Planar and spatial kinematics, differential motion, energy method for robot mechanics; mechanism design for manipulation and locomotion; multi-rigid-body dynamics; force and compliance control, balancing control, visual feedback, human-machine interface; actuators, sensors, wireless networking, and embedded software. Weekly laboratories include real-time control, vehicle navigation, arm and end-effector design, and balancing robot control. Group term project requires design and fabrication of robotic systems. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.
H. Asada

2.120 Introduction to Robotics
Subject meets with 2.12
Prereq: 2.003[J], 2.004, or permission of instructor
G (Spring)
3-2-7 units
Presents the fundamentals of robot mechanisms, dynamics, and controls. Planar and spatial kinematics, differential motion, energy method for robot mechanics; mechanism design for manipulation and locomotion; multi-rigid-body dynamics; force and compliance control, balancing control, visual feedback, human-machine interface; actuators, sensors, wireless networking, and embedded software. Weekly laboratories include real-time control, vehicle navigation, arm and end-effector design, and balancing robot control. Group term project requires design and fabrication of robotic systems. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity.
H. Asada, J. J. Leonard
2.121 Stochastic Systems (New)
Subject meets with 2.122
Prereq: None. Coreq: 2.004
U (Spring)
3-0-9 units
G. Barbastathis, P. F. Lermusiaux, N. C. Makris, N. M. Patrikalakis, T. P. Sapsis, M. S. Triantafyllou

2.122 Stochastic Systems
Subject meets with 2.121
Prereq: 2.004 and 2.087
G (Spring)
4-0-8 units
G. Barbastathis, P. F. Lermusiaux, N. C. Makris, N. M. Patrikalakis, T. P. Sapsis, M. S. Triantafyllou

2.131 Advanced Instrumentation and Measurement
Prereq: Permission of instructor
G (Spring)
3-6-3 units
Provides training in advanced instrumentation and measurement techniques. Topics include system level design, fabrication and evaluation with emphasis on systems involving concepts and technology from mechanics, optics, electronics, chemistry and biology. Simulation, modeling and design software. Use of a wide range of instruments/techniques (e.g., scanning electron microscope, dynamic signal/system analyzer, impedance analyzer, laser interferometer) and fabrication/machining methods (e.g., laser micro-machining, stereo lithography, computer controlled turning and machining centers). Theory and practice of both linear and nonlinear system identification techniques. Lab sessions include instruction and group project work. No final exam.
I. W. Hunter

2.14 Analysis and Design of Feedback Control Systems
Subject meets with 2.140
Prereq: 2.004
U (Spring)
3-3-6 units
Develops the fundamentals of feedback control using linear transfer function system models. Analysis in time and frequency domains. Design in the s-plane (root locus) and in the frequency domain (loop shaping). Describing functions for stability of certain non-linear systems. Extension to state variable systems and multivariable control with observers. Discrete and digital hybrid systems and use of z-plane design. Extended design case studies and capstone group projects. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.
D. L. Trumper, K. YouCEF-Toumi

2.140 Analysis and Design of Feedback Control Systems
Subject meets with 2.14
Prereq: 2.004 or permission of instructor
G (Spring)
3-3-6 units
Develops the fundamentals of feedback control using linear transfer function system models. Analysis in time and frequency domains. Design in the s-plane (root locus) and in the frequency domain (loop shaping). Describing functions for stability of certain non-linear systems. Extension to state variable systems and multivariable control with observers. Discrete and digital hybrid systems and use of z-plane design. Extended design case studies and capstone group projects. Student taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity.
D. Rowell, D. L. Trumper, K. YouCEF-Toumi
2.141 Modeling and Simulation of Dynamic Systems
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Modeling multidomain engineering systems at a level of detail suitable for design and control system implementation. Network representation, state-space models; multiport energy storage and dissipation, Legendre transforms; nonlinear mechanics, transformation theory, Lagrangian and Hamiltonian forms; Control-relevant properties. Application examples may include electromechanical transducers, mechanisms, electronics, fluid and thermal systems, compressible flow, chemical processes, diffusion, and wave transmission.
N. Hogan

2.151 Advanced System Dynamics and Control
Prereq: 2.004 and (2.087 or 18.06)
G (Fall)
4-0-8 units
Analytical descriptions of state-determined dynamic physical systems; time and frequency domain representations; system characteristics - controllability, observability, stability; linear and nonlinear system responses. Modification of system characteristics using feedback. State observers, Kalman filters. Modeling/ performance trade-offs in control system design. Basic optimization tools. Positive systems. Emphasizes applications to physical systems.
J.-J. E. Slotine, K. YouCEF-Toumi, N. Hogan

2.152[J] Nonlinear Control
Same subject as 9.110[J]
Prereq: 2.151, 6.241[J], 16.31, or permission of instructor
G (Spring)
3-0-9 units
J.-J. E. Slotine

2.153 Adaptive Control
Prereq: 2.151
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Introduces the foundation of adaptive control in continuous-time and discrete-time systems. Adaptive control is the ability to self-correct a controller in the presence of parametric uncertainties using online information is its main and most compelling feature. Examples drawn from aerospace, propulsion, automotive, and energy systems will be used to elucidate the underlying concepts.
A. Annaswamy

2.154 Maneuvering and Control of Surface and Underwater Vehicles
Prereq: 2.22
G (Fall)
3-0-9 units
M. S. Triantafyllou

2.16 Learning Machines (New)
Subject meets with 2.168
Prereq: 2.086, 18.075, and (18.05 or 6.041)
U (Spring)
4-0-8 units
Introduces fundamental concepts and encourages open-ended exploration of the increasingly topical intersection between artificial intelligence and the physical sciences. Energy and information, and their respective optimality conditions are used to define supervised and unsupervised learning algorithms; as well as ordinary and partial differential equations. Subsequently, physical systems with complex constitutive relationships are drawn from elasticity, biophysics, fluid mechanics, hydrodynamics, acoustics, and electromagnetics to illustrate how machine learning-inspired optimization can approximate solutions to forward and inverse problems in these domains.
G. Barbastathis
2.160 Identification, Estimation, and Learning
Prereq: 2.151
G (Fall)
3-0-9 units
Provides a broad theoretical basis for system identification, estimation, and learning. Least squares estimation and its convergence properties, Kalman filter and extended Kalman filter, noise dynamics and system representation, function approximation theory, neural nets, radial basis functions, wavelets, Volterra expansions, informative data sets, persistent excitation, asymptotic variance, central limit theorems, model structure selection, system order estimate, maximum likelihood, unbiased estimates, Cramer-Rao lower bound, Kullback-Leibler information distance, Akaike's information criterion, experiment design, and model validation.
H. Asada

2.165[J] Robotics
Same subject as 9.175[J]
Prereq: 2.151 or permission of instructor
G (Spring)
3-0-9 units
J.-J. E. Slotine, H. Asada

2.166 Autonomous Vehicles
Prereq: 6.041B or permission of instructor
G (Spring)
3-1-8 units
Theory and application of probabilistic techniques for autonomous mobile robotics. Topics include probabilistic state estimation and decision making for mobile robots; stochastic representations of the environment; dynamic models and sensor models for mobile robots; algorithms for mapping and localization; planning and control in the presence of uncertainty; cooperative operation of multiple mobile robots; mobile sensor networks; application to autonomous marine (underwater and floating), ground, and air vehicles.
J. J. Leonard

2.168 Learning Machines
Subject meets with 2.16
Prereq: None
G (Spring)
3-0-9 units
Introduces fundamental concepts and encourages open-ended exploration of the increasingly topical intersection between artificial intelligence and the physical sciences. Energy and information, and their respective optimality conditions are used to define supervised and unsupervised learning algorithms; as well as ordinary and partial differential equations. Subsequently, physical systems with complex constitutive relationships are drawn from elasticity, biophysics, fluid mechanics, hydrodynamics, acoustics, and electromagnetics to illustrate how machine learning-inspired optimization can approximate solutions to forward and inverse problems in these domains.
G. Barbastathis

2.171 Analysis and Design of Digital Control Systems
Prereq: 2.14, 2.151, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-3-6 units
A comprehensive introduction to digital control system design, reinforced with hands-on laboratory experiences. Major topics include discrete-time system theory and analytical tools; design of digital control systems via approximation from continuous time; direct discrete-time design; loop-shaping design for performance and robustness; state-space design; observers and state-feedback; quantization and other nonlinear effects; implementation issues. Laboratory experiences and design projects connect theory with practice.
D. L. Trumper

2.18[J] Biomolecular Feedback Systems
Same subject as 6.557[J]
Subject meets with 2.180[J], 6.027[J]
Prereq: Biology (GIR), 18.03, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Comprehensive introduction to dynamics and control of biomolecular systems with emphasis on design/analysis techniques from control theory. Provides a review of biology concepts, regulation mechanisms, and models. Covers basic enabling technologies, engineering principles for designing biological functions, modular design techniques, and design limitations. Students taking graduate version complete additional assignments.
D. Del Vecchio, R. Weiss
2.180[J] Biomolecular Feedback Systems
Same subject as 6.027[J]
Subject meets with 2.18[J], 6.557[J]
Prereq: Biology (GIR), 18.03, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units

Comprehensive introduction to dynamics and control of biomolecular systems with emphasis on design/analysis techniques from control theory. Provides a review of biology concepts, regulation mechanisms, and models. Covers basic enabling technologies, engineering principles for designing biological functions, modular design techniques, and design limitations. Students taking graduate version complete additional assignments.
D. Del Vecchio

2.183[J] Biomechanics and Neural Control of Movement
Same subject as 9.34[J]
Subject meets with 2.184
Prereq: 2.004 or permission of instructor
G (Spring)
3-0-9 units

Quantitative knowledge of human movement behavior is important in a growing number of engineering applications (medical and rehabilitation technology, athletic and military equipment, human-computer interaction, vehicle performance, etc.). Presents a quantitative, model-based description of how biomechanical and neural factors interact in human sensory-motor behavior, focusing mainly on the upper limbs. Students survey recent literature on how motor behavior is controlled, comparing biological and robotic approaches to similar tasks. Topics may include a review of relevant neural, muscular and skeletal physiology, neural feedback and "equilibrium-point" theories, co-contraction strategies, impedance control, kinematic redundancy, optimization, intermittency, contact tasks and tool use. Students taking the graduate version will complete additional assignments.
N. Hogan

2.184 Biomechanics and Neural Control of Movement
Subject meets with 2.183[J], 9.34[J]
Prereq: 2.004 or permission of instructor
U (Spring)
3-0-9 units

Quantitative knowledge of human movement behavior is important in a growing number of engineering applications (medical and rehabilitation technology, athletic and military equipment, human-computer interaction, vehicle performance, etc.). Presents a quantitative, model-based description of how biomechanical and neural factors interact in human sensory-motor behavior, focusing mainly on the upper limbs. Students survey recent literature on how motor behavior is controlled, comparing biological and robotic approaches to similar tasks. Topics may include a review of relevant neural, muscular and skeletal physiology, neural feedback and "equilibrium-point" theories, co-contraction strategies, impedance control, kinematic redundancy, optimization, intermittency, contact tasks and tool use. Students taking the graduate version will complete additional assignments.
N. Hogan

Fluid Mechanics and Combustion

2.20 Marine Hydrodynamics
Prereq: 1.060, 2.006, 2.016, or 2.06
G (Fall)
4-1-7 units

D. K. P. Yue
2.22 Design Principles for Ocean Vehicles
Prereq: 2.20
G (Spring)
3-3-6 units
Design tools for analysis of linear systems and random processes related to ocean vehicles; description of ocean environment including random waves, ocean wave spectra and their selection; short and long term wave statistics; and ocean currents. Advanced hydrodynamics for design of ocean vehicles and offshore structures including wave forces on towed and moored structures; inertia vs. drag dominated flows; vortex induced vibrations of offshore structures; ship seakeeping and sensitivity of seakeeping performance. Design exercises in application of principles. Several laboratory exercises emphasizing modern measurement techniques, model testing, and flow diagnostic tools.
M. S. Triantafyllou

2.23 Hydrofoils and Propellers
Prereq: 2.20 and 18.085
Acad Year 2019-2020: G (Spring; first half of term)
Acad Year 2020-2021: Not offered
2-0-4 units
Reviews the theory and design of hydrofoil sections; lifting and thickness problems for sub-cavitating sections and unsteady flow problems. Covers lifting line and lifting surface theory with applications to hydrofoil craft, rudder, control surface, propeller and wind turbine rotor design. Topics include propeller lifting line and lifting surface theory; wake adapted propellers, steady and unsteady propeller thrust and torque; waterjets; performance analysis and design of wind turbine rotors. Presents numerical principles of vortex lattice and lifting surface panel methods. Projects illustrate the development of theoretical and computational methods for lifting, propulsion and wind turbine applications.
P. D. Sclavounos

2.24[J] Ocean Wave Interaction with Ships and Offshore Energy Systems
Same subject as 1.692[J]
Prereq: 2.20 and 18.085
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units
Surface wave theory, conservation laws and boundary conditions, properties of regular surface waves and random ocean waves. Linearized theory of floating body dynamics, kinematic and dynamic free surface conditions, body boundary conditions. Simple harmonic motions. Diffraction and radiation problems, added mass and damping matrices. General reciprocity identities on diffraction and radiation. Ship wave resistance theory, Kelvin wake physics, ship seakeeping in regular and random waves. Discusses point wave energy absorbers, beam sea and head-sea devises, oscillating water column device and Well's turbine. Discusses offshore floating energy systems and their interaction with ambient waves, current and wind, including oil and gas platforms, liquefied natural gas (LNG) vessels and floating wind turbines. Homework drawn from real-world applications.
P. D. Sclavounos

2.25 Fluid Mechanics
Prereq: 2.006 or 2.06; Coreq: 18.075 or 18.085
G (Fall)
4-0-8 units
A. F. Ghoniem, A. E. Hosoi, G. H. McKinley, A. T. Patera

2.250[J] Fluids and Diseases
Same subject as 1.631[J], HST.537[J]
Subject meets with 1.063
Prereq: None
G (Spring)
3-3-6 units
See description under subject 1.631[J].
L. Bourouiba
2.26[J] Advanced Fluid Dynamics
Same subject as 1.63[J]
Prereq: 18.085 and (2.25 or permission of instructor)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
4-0-8 units

Fundamentals of fluid dynamics intrinsic to natural physical phenomena and/or engineering processes. Discusses a range of topics and advanced problem-solving techniques. Sample topics include brief review of basic laws of fluid motion, scaling and approximations, creeping flows, boundary layers in high-speed flows, steady and transient, similarity method of solution, buoyancy-driven convection in porous media, dispersion in steady or oscillatory flows, physics and mathematics of linearized instability, effects of shear and stratification. In alternate years, two of the following modules will be offered: I: Geophysical Fluid Dynamics of Coastal Waters, II: Capillary Phenomena, III: Non-Newtonian Fluids, IV: Flagellar Swimming.
T. R. Akylas, G. H. McKinley, R. Stocker

2.28 Fundamentals and Applications of Combustion
Prereq: 2.006 or (2.051 and 2.06)
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

A. F. Ghoniem

2.29 Numerical Fluid Mechanics
Subject meets with 2.290
Prereq: 18.075 and (2.006, 2.016, 2.06, 2.20, or 2.25)
G (Spring)
4-0-8 units

P. F. J. Lermusiaux

2.290 Numerical Fluid Mechanics (New)
Subject meets with 2.29
Prereq: 2.005
U (Spring)
4-0-8 units

P. Lermusiaux
### 2.341[J] Macromolecular Hydrodynamics
Same subject as 10.531[J]
Prereq: 2.25, 10.301, or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-6 units


R. C. Armstrong, G. H. McKinley

### MEMS and Nanotechnology

#### 2.37 Fundamentals of Nanoengineering
Subject meets with 2.370
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Presents the fundamentals of molecular modeling in engineering in the context of nanoscale mechanical engineering applications. Statistical mechanics and its connection to engineering thermodynamics. Molecular origin and limitations of macroscopic descriptions and constitutive relations for equilibrium and non-equilibrium behavior. Introduction to molecular simulation, solid-state physics and electrokinetic phenomena. Discusses molecular approaches to modern nanoscale engineering problems. Graduate students are required to complete additional assignments with stronger analytical content.

N. G. Hadjiconstantinou

#### 2.372[J] Design and Fabrication of Microelectromechanical Systems
Same subject as 6.777[J]
Subject meets with 2.374[J], 6.717[J]
Prereq: (Physics II (GIR) and (2.003[J] or 6.003)) or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Provides an introduction to microsystem design. Covers material properties, microfabrication technologies, structural behavior, sensing methods, electromechanical actuation, thermal actuation and control, multi-domain modeling, noise, and microsystem packaging. Applies microsystem modeling, and manufacturing principles to the design and analysis a variety of microscale sensors and actuators (e.g., optical MEMS, bioMEMS, and inertial sensors). Emphasizes modeling and simulation in the design process. Students taking the graduate version complete additional assignments.

Staff

#### 2.374[J] Design and Fabrication of Microelectromechanical Systems
Same subject as 6.717[J]
Subject meets with 2.372[J], 6.777[J]
Prereq: (Physics II (GIR) and (2.003[J] or 6.003)) or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units

See description under subject 6.717[J].

Staff
2.391[J] Nanostructure Fabrication
Same subject as 6.781[J]
Prereq: (2.710, 6.152[J], or 6.161) or permission of instructor
G (Spring)
4-0-8 units
See description under subject 6.781[J].
K. K. Berggren

Thermodynamics

2.42 General Thermodynamics
Prereq: Permission of instructor
G (Fall)
3-0-9 units
General foundations of thermodynamics from an entropy point of view, entropy generation and transfer in complex systems. Definitions of work, energy, stable equilibrium, available energy, entropy, thermodynamic potential, and interactions other than work (nonwork, heat, mass transfer). Applications to properties of materials, bulk flow, energy conversion, chemical equilibrium, combustion, and industrial manufacturing.
J. Brisson

Heat and Mass Transfer

2.500 Desalination and Water Purification
Prereq: 1.020, 2.006, 10.302, (2.051 and 2.06), or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Introduces the fundamental science and technology of desalinating water to overcome water scarcity and ensure sustainable water supplies. Covers basic water chemistry, flash evaporation, reverse osmosis and membrane engineering, electro dialysis, nanofiltration, solar desalination, energy efficiency of desalination systems, fouling and scaling, environmental impacts, and economics of desalination systems. Open to upper-class undergraduates.
J. H. Lienhard, M. Balaban

2.51 Intermediate Heat and Mass Transfer
Prereq: (2.005 and 18.03) or permission of instructor
U (Fall)
3-0-9 units
Covers conduction (governing equations and boundary conditions, steady and unsteady heat transfer, resistance concept); laminar and turbulent convection (forced-convection and natural-convection boundary layers, external flows); radiation (blackbody and graybody exchange, spectral and solar radiation); coupled conduction, convection, radiation problems; synthesis of analytical, computational, and experimental techniques; and mass transfer at low rates, evaporation.
J. H. Lienhard, A. T. Patera, E. N. Wang

2.52[J] Modeling and Approximation of Thermal Processes
Same subject as 4.424[J]
Prereq: 2.51
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Provides instruction on how to model thermal transport processes in typical engineering systems such as those found in manufacturing, machinery, and energy technologies. Successive modules cover basic modeling tactics for particular modes of transport, including steady and unsteady heat conduction, convection, multiphase flow processes, and thermal radiation. Includes a creative design project executed by the students.
L. R. Glicksman

2.55 Advanced Heat and Mass Transfer
Prereq: 2.51
G (Spring)
4-0-8 units
Advanced treatment of fundamental aspects of heat and mass transport. Covers topics such as diffusion kinetics, conservation laws, laminar and turbulent convection, mass transfer including phase change or heterogeneous reactions, and basic thermal radiation. Problems and examples include theory and applications drawn from a spectrum of engineering design and manufacturing problems.
J. H. Lienhard
2.57 Nano-to-Macro Transport Processes
Subject meets with 2.570
Prereq: 2.005, 2.051, or permission of instructor
G (Fall)
3-0-9 units
Parallel treatments of photons, electrons, phonons, and molecules as energy carriers; aiming at a fundamental understanding of descriptive tools for energy and heat transport processes, from nanoscale to macroscale. Topics include energy levels; statistical behavior and internal energy; energy transport in the forms of waves and particles; scattering and heat generation processes; Boltzmann equation and derivation of classical laws; and deviation from classical laws at nanoscale and their appropriate descriptions. Applications in nanotechnology and microtechnology. Students taking the graduate version complete additional assignments.
G. Chen

2.570 Nano-to-Macro Transport Processes
Subject meets with 2.57
Prereq: 2.005, 2.051, or permission of instructor
U (Fall)
3-0-9 units
Parallel treatments of photons, electrons, phonons, and molecules as energy carriers; aiming at a fundamental understanding of descriptive tools for energy and heat transport processes, from nanoscale to macroscale. Topics include energy levels; statistical behavior and internal energy; energy transport in the forms of waves and particles; scattering and heat generation processes; Boltzmann equation and derivation of classical laws; and deviation from classical laws at nanoscale and their appropriate descriptions. Applications in nanotechnology and microtechnology. Students taking the graduate version complete additional assignments.
G. Chen

2.59[J] Thermal Hydraulics in Power Technology
Same subject as 10.536[J], 22.313[J]
Prereq: 2.006, 10.302, 22.312, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-2-7 units
See description under subject 22.313[J].
E. Baglietto, M. Bucci

Energy and Power Systems

2.60[J] Fundamentals of Advanced Energy Conversion
Same subject as 10.390[J]
Subject meets with 2.62[J], 10.392[J], 22.40[J]
Prereq: 2.006, 2.051 and 2.06, or permission of instructor
U (Spring)
4-0-8 units
Fundamentals of thermodynamics, chemistry, and transport applied to energy systems. Analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance, and environmental impact. Applications to fuel reforming and alternative fuels, hydrogen, fuel cells and batteries, combustion, catalysis, combined and hybrid power cycles using fossil, nuclear and renewable resources. CO₂ separation and capture. Biomass energy. Students taking graduate version complete additional assignments.
A. F. Ghoniem, W. Green

2.603 Fundamentals of Smart and Resilient Grids
Prereq: 2.003[J]
U (Fall)
Not offered regularly; consult department
4-0-8 units
Introduces the fundamentals of power system structure, operation and control. Emphasizes the challenges and opportunities for integration of new technologies: photovoltaic, wind, electric storage, demand response, synchrophasor measurements. Introduces the basics of power system modeling and analysis. Presents the basic phenomena of voltage and frequency stability as well technological and regulatory constraints on system operation. Describes both the common and emerging automatic control systems and operator decision-making policies. Relies on a combination of traditional lectures, homework assignments, and group projects. Students taking graduate version complete additional assignments.
K. Turitsyn
2.61 Internal Combustion Engines
Prereq: 2.006
G (Spring)
Not offered regularly; consult department
3-1-8 units
Fundamentals of how the design and operation of internal combustion engines affect their performance, efficiency, fuel requirements, and environmental impact. Study of fluid flow, thermodynamics, combustion, heat transfer and friction phenomena, and fuel properties, relevant to engine power, efficiency, and emissions. Examination of design features and operating characteristics of different types of internal combustion engines: spark-ignition, diesel, stratified-charge, and mixed-cycle engines. Engine Laboratory project. For graduate and senior undergraduate students.
W. K. Cheng

2.611 Marine Power and Propulsion
Subject meets with 2.612
Prereq: 2.005
G (Fall)
4-0-8 units
Selection and evaluation of commercial and naval ship power and propulsion systems. Analysis of propulsors, prime mover thermodynamic cycles, propeller-engine matching. Propeller selection, waterjet analysis, review of alternative propulsors; thermodynamic analyses of Rankine, Brayton, Diesel, and Combined cycles, reduction gears and integrated electric drive. Battery operated vehicles, fuel cells. Term project requires analysis of alternatives in propulsion plant design for given physical, performance, and economic constraints. Graduate students complete different assignments and exams.
J. Harbour, M. S. Triantafyllou, R. S. McCord

2.612 Marine Power and Propulsion
Subject meets with 2.611
Prereq: 2.005
U (Fall)
4-0-8 units
Selection and evaluation of commercial and naval ship power and propulsion systems. Analysis of propulsors, prime mover thermodynamic cycles, propeller-engine matching. Propeller selection, waterjet analysis, review of alternative propulsors; thermodynamic analyses of Rankine, Brayton, Diesel, and Combined cycles, reduction gears and integrated electric drive. Battery operated vehicles, fuel cells. Term project requires analysis of alternatives in propulsion plant design for given physical, performance, and economic constraints. Graduate students complete different assignments and exams.
J. Harbour, M. S. Triantafyllou, R. S. McCord

Same subject as 10.392[J], 22.40[J]
Subject meets with 2.60[J], 10.390[J]
Prereq: 2.006, (2.051 and 2.06), or permission of instructor
G (Spring)
4-0-8 units
Fundamentals of thermodynamics, chemistry, and transport applied to energy systems. Analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance and environmental impact. Applications to fuel reforming and alternative fuels, hydrogen, fuel cells and batteries, combustion, catalysis, combined and hybrid power cycles using fossil, nuclear and renewable resources. CO₂ separation and capture. Biomass energy. Meets with 2.60[J] when offered concurrently; students taking the graduate version complete additional assignments.
A. F. Ghoniem, W. Green

2.625[J] Electrochemical Energy Conversion and Storage: Fundamentals, Materials and Applications
Same subject as 10.625[J]
Prereq: 2.005, 3.046, 3.53, 10.40, (2.051 and 2.06), or permission of instructor
G (Fall)
4-0-8 units
Fundamental concepts, tools, and applications in electrochemical science and engineering. Introduces thermodynamics, kinetics and transport of electrochemical reactions. Describes how materials structure and properties affect electrochemical behavior of particular applications, for instance in lithium rechargeable batteries, electrochemical capacitors, fuel cells, photo electrochemical cells, and electrolytic cells. Discusses state-of-the-art electrochemical energy technologies for portable electronic devices, hybrid and plug-in vehicles, electrical vehicles. Theoretical and experimental exploration of electrochemical measurement techniques in cell testing, and in bulk and interfacial transport measurements (electronic and ionic resistivity and charge transfer cross the electrode-electrolyte interface).
Y. Shao-Horn
2.626 Fundamentals of Photovoltaics
Subject meets with 2.627
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units


T. Buonassisi

2.627 Fundamentals of Photovoltaics
Subject meets with 2.626
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4-0-8 units


T. Buonassisi

2.650[J] Introduction to Sustainable Energy
Same subject as 10.291[J], 22.081[J]
Subject meets with 1.818[J], 2.65[J], 10.391[J], 11.371[J], 22.811[J]
Prereq: Permission of instructor
U (Fall)
3-1-8 units

See description under subject 22.081[J]. Limited to juniors and seniors.
M. W. Golay

2.651[J] Introduction to Energy in Global Development
Same subject as EC.711[J]
Subject meets with EC.791
Prereq: None
U (Spring)
3-2-7 units

See description under subject EC.711[J]. Enrollment limited by lottery; must attend first class session.
E. Verploegen

Experimental Engineering

2.670 Mechanical Engineering Tools
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-2 units

Introduces the fundamentals of machine tools use and fabrication techniques. Students work with a variety of machine tools including the bandsaw, milling machine, and lathe. Mechanical Engineering students are advised to take this subject in the first IAP after declaring their major. Enrollment may be limited due to laboratory capacity. Preference to Course 2 majors and minors.
M. Culpepper
2.671 Measurement and Instrumentation
Prereq: Physics II (GIR), 2.001, 2.003[J], and 2.086
U (Fall, Spring)
3-3-6 units. Institute LAB

Experimental techniques for observation and measurement of physical variables such as force, strain, temperature, flow rate, and acceleration. Emphasizes principles of transduction, measurement circuitry, MEMS sensors, Fourier transforms, linear and nonlinear function fitting, uncertainty analysis, probability density functions and statistics, system identification, electrical impedance analysis and transfer functions, computer-aided experimentation, and technical reporting. Typical laboratory experiments involve oscilloscopes, electronic circuits including operational amplifiers, thermocouples, strain gauges, digital recorders, lasers, etc. Basic material and lab objectives are developed in lectures. Instruction and practice in oral and written communication provided. Enrollment limited.
I. W. Hunter, M. Kolle, B. Hughey

2.673[J] Instrumentation and Measurement for Biological Systems
Same subject as 20.309[J]
Subject meets with 20.409
Prereq: (Biology (GIR), Physics II (GIR), 6.0002, and 18.03) or permission of instructor
U (Fall, Spring)
3-6-3 units

See description under subject 20.309[J]. Enrollment limited; preference to Course 20 undergraduates.
P. Blainey, S. Manalis, E. Frank, S. Wasserman, J. Bagnall, E. Boyden, P. So

2.674 Introduction to Micro/Nano Engineering Laboratory
Prereq: Physics II (GIR) or permission of instructor
U (Spring)
1-3-2 units
Credit cannot also be received for 2.675, 2.676

Presents concepts, ideas, and enabling tools for nanoengineering through experiential lab modules, which include microfluidics, microelectromechanical systems (MEMS), and nanomaterials and nanoimaging tools such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), and atomic-force microscopy (AFM). Provides knowledge and experience via building, observing and manipulating micro- and nanoscale structures. Exposes students to fluid, thermal, and dynamic systems at small scales. Enrollment limited; preference to Course 2 and 2-A majors and minors.
S. G. Kim, R. Karnik, M. Kolle, J. Kim

2.675 Micro/Nano Engineering Laboratory
Subject meets with 2.676
Prereq: 2.25 and (6.777[J] or permission of instructor)
G (Fall)
2-3-7 units
Credit cannot also be received for 2.674

Covers advanced nanoengineering via practical lab modules in connection with classical fluid dynamics, mechanics, thermodynamics, and material physics. Labs include microfluidic systems, microelectromechanical systems (MEMS), emerging nanomaterials such as graphene, carbon nanotubes (CNTs), and nanoimaging tools. Student teams lead an experimental term project that uses the tools and knowledge acquired through the lab modules and experimental work, and culminates in a report and presentation. Recitations cover idea development, experiment design, planning and execution, and analysis of results pertinent to the project. Enrollment limited.
S. G. Kim, R. Karnik, M. Kolle, J. Kim

2.676 Micro/Nano Engineering Laboratory
Subject meets with 2.675
Prereq: 2.001, 2.003[J], 2.671, and Coreq: (2.005 or (2.051 and 2.06)); or permission of instructor
U (Fall)
2-3-7 units
Credit cannot also be received for 2.674

Studies advanced nanoengineering via experiential lab modules with classical fluid dynamics, mechanics, thermodynamics, and materials science. Lab modules include microfluidic systems; microelectromechanical systems (MEMS); emerging nanomaterials, such as graphene and carbon nanotubes (CNTs); and nanoimaging tools. Recitation develops in-depth knowledge and understanding of physical phenomena observed in the lab through quantitative analysis. Students have the option to engage in term projects led by students taking 2.675. Enrollment limited; preference to Course 2 and 2-AE majors and minors.
S. G. Kim, R. Karnik, M. Kolle, J. Kim
2.677 Design and Experimentation for Ocean Engineering
Prereq: 2.00A and 2.086; Coreq: 2.016 or permission of instructor
U (Fall)
0-3-3 units
Design and experimental observation for ocean engineering systems focusing on the fundamentals of ocean wave propagation, ocean wave spectra and wave dispersion, cavitation, added mass, acoustic sound propagation in water, sea loads on offshore structures, design of experiments for ship model testing, fish-like swimming propulsion, propellers, and ocean energy harvesting. Emphasizes fundamentals of data analysis of signals from random environments using Fourier transforms, noise filtering, statistics and error analysis using MATLAB. Students carry out experiential laboratory exercises in various Ocean Engineering laboratories on campus, including short labs and demos, longer exercises with written reports, and a final experimental design project. Enrollment may be limited due to laboratory capacity.
A. H. Techet

2.678 Electronics for Mechanical Systems
Prereq: Physics II (GIR)
U (Fall, Spring)
2-2-2 units
Practical introduction to the fundamentals of electronics in the context of electro-mechanical systems, with emphasis on experimentation and project work in basic electronics. Laboratory exercises include the design and construction of simple electronic devices, such as power supplies, amplifiers, op-amp circuits, switched mode dc-dc converters, and dc motor drivers. Surveys embedded microcontrollers as system elements. Laboratory sessions stress the understanding of electronic circuits at the component level, but also point out the modern approach of system integration using commercial modules and specialized integrated circuits. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.
D. Rowell

Oceanographic Engineering and Acoustics

2.680 Unmanned Marine Vehicle Autonomy, Sensing, and Communication
Prereq: Permission of instructor
G (Spring)
2-6-4 units
Focuses on software and algorithms for autonomous decision making (autonomy) by underwater vehicles operating in ocean environments. Discusses how autonomous marine vehicles (UMVs) adapt to the environment for improved sensing performance. Covers sensors for acoustic, biological and chemical sensing and their integration with the autonomy system for environmentally adaptive undersea mapping and observation. Introduces students to the underwater acoustic communication environment and various options for undersea navigation, highlighting their relevance to the operation of collaborative undersea networks for environmental sensing. Labs involve the use of the MOOP-IvP autonomy software for the development of integrated sensing, modeling and control solutions. Solutions modeled in simulation environments and include field tests with small autonomous surface and underwater vehicles operated on the Charles River. Limited enrollment.
H. Schmidt, J.J. Leonard, M. Benjamin

2.681 Environmental Ocean Acoustics
Prereq: 2.066, 18.075, or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Fundamentals of underwater sound, and its application to mapping and surveillance in an ocean environment. Wave equations for fluid and elastic media. Reflection and transmission of sound at plane interfaces. Wave theory representation of acoustic source radiation and propagation in shallow and deep ocean waveguides. Interaction of underwater sound with elastic waves in the seabed and an Arctic ice cover, including effects of porosity and anisotropy. Numerical modeling of the propagation of underwater sound, including spectral methods, normal mode theory, and the parabolic equation method, for laterally homogeneous and inhomogeneous environments. Doppler effects. Effects of oceanographic variability and fluctuation - spatial and temporal coherence. Generation and propagation of ocean ambient noise. Modeling and simulation of signals and noise in traditional sonar systems, as well as modern, distributed, autonomous acoustic surveillance systems.
H. Schmidt
2.682 Acoustical Oceanography
Prereq: 2.681
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.

Provides brief overview of what important current research topics are in oceanography (physical, geological, and biological) and how acoustics can be used as a tool to address them. Three typical examples are climate, bottom geology, and marine mammal behavior. Addresses the acoustic inverse problem, reviewing inverse methods (linear and nonlinear) and the combination of acoustical methods with other measurements as an integrated system. Concentrates on specific case studies, taken from current research journals.

J. F. Lynch, Woods Hole Staff

2.683 Marine Bioacoustics and Geoacoustics
Prereq: 2.681
G (Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Both active and passive acoustic methods of measuring marine organisms, the seafloor, and their interactions are reviewed. Acoustic methods of detecting, observing, and quantifying marine biological organisms are described, as are acoustic methods of measuring geological properties of the seafloor, including depth, and surficial and volumetric composition. Interactions are also described, including effects of biological scatterers on geological measurements, and effects of seafloor scattering on measurements of biological scatterers on, in, or immediately above the seafloor. Methods of determining small-scale material properties of organisms and the seafloor are outlined. Operational methods are emphasized, and corresponding measurement theory is described. Case studies are used in illustration. Principles of acoustic-system calibration are elaborated.

K. G. Foote, Woods Hole Staff

2.684 Wave Scattering by Rough Surfaces and Inhomogeneous Media
Prereq: 2.066 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Can be repeated for credit.

An advanced-level subject designed to give students a working knowledge of current techniques in this area. Material is presented principally in the context of ocean acoustics, but can be used in other acoustic and electromagnetic applications. Includes fundamentals of wave propagation through, and/or scattering by: random media, extended coherent structures, rough surfaces, and discrete scatterers.

T. K. Stanton, A. C. Lavery, Woods Hole Staff

2.687 Time Series Analysis and System Identification
Prereq: 6.011 and 18.06
G (Fall)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Covers matched filtering, power spectral (PSD) estimation, and adaptive signal processing / system identification algorithms. Algorithm development is framed as an optimization problem, and optimal and approximate solutions are described. Reviews time-varying systems, first and second moment representations of stochastic processes, and state-space models. Also covers algorithm derivation, performance analysis, and robustness to modeling errors. Algorithms for PSD estimation, the LMS and RLS algorithms, and the Kalman Filter are treated in detail.

J. C. Preisig, Woods Hole Staff
**2.688 Principles of Oceanographic Instrument Systems -- Sensors and Measurements**  
Prereq: 2.671 and 18.075  
G (Fall)  
3-3-6 units  
Introduces theoretical and practical principles of design of oceanographic sensor systems. Transducer characteristics for acoustic, current, temperature, pressure, electric, magnetic, gravity, salinity, velocity, heat flow, and optical devices. Limitations on these devices imposed by ocean environment. Signal conditioning and recording; noise, sensitivity, and sampling limitations; standards. Principles of state-of-the-art systems being used in physical oceanography, geophysics, submersibles, acoustics discussed in lectures by experts in these areas. Day cruises in local waters during which the students will prepare, deploy and analyze observations from standard oceanographic instruments constitute the lab work for this subject.  
*H. Singh, R. Geyer, A. Michel*

**2.689[J] Projects in Oceanographic Engineering**  
Same subject as 1.699[J]  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  
Projects in oceanographic engineering, carried out under supervision of Woods Hole Oceanographic Institution staff. Given at Woods Hole Oceanographic Institution.  
*J. Preisig, Woods Hole Staff*

**2.690 Corrosion in Marine Engineering**  
Prereq: 3.012 and permission of instructor  
G (Summer)  
3-0-3 units  
Introduction to forms of corrosion encountered in marine systems material selection, coatings and protection systems. Case studies and causal analysis developed through student presentations.  
*J. Page, T. Eagar*

**Naval Architecture**

**2.700 Principles of Naval Architecture**  
Subject meets with 2.701  
Prereq: 2.002  
U (Fall)  
4-2-6 units  
Presents principles of naval architecture, ship geometry, hydrostatics, calculation and drawing of curves of form, intact and damage stability, hull structure strength calculations and ship resistance. Introduces computer-aided naval ship design and analysis tools. Projects include analysis of ship lines drawings, calculation of ship hydrostatic characteristics, analysis of intact and damaged stability, ship model testing, and hull structure strength calculations. Students taking graduate version complete additional assignments.  
*F. S. Hover, A. H. Techet, J. Harbour, P. D. Sclavounos, J. Page*

**2.701 Principles of Naval Architecture**  
Subject meets with 2.700  
Prereq: 2.002  
G (Fall)  
4-2-6 units  
Presents principles of naval architecture, ship geometry, hydrostatics, calculation and drawing of curves of form, intact and damage stability, hull structure strength calculations and ship resistance. Introduces computer-aided naval ship design and analysis tools. Projects include analysis of ship lines drawings, calculation of ship hydrostatic characteristics, analysis of intact and damaged stability, ship model testing, and hull structure strength calculations. Students taking graduate version complete additional assignments.  
*J. Harbour, S. Brizzolara, J. Page*

**2.702 Systems Engineering and Naval Ship Design**  
Prereq: 2.701  
G (Spring)  
3-3-3 units  
Introduces principles of systems engineering and ship design with an overview of naval ship design and acquisition processes, requirements setting, formulation of a systematic plan, design philosophy and constraints, formal decision making methods, selection criteria, optimization, variant analysis, trade-offs, analysis of ship design trends, risk, and cost analysis. Emphasizes the application of principles through completion of a design exercise and project.  
*J. Harbour, J. Page*
2.703 Principles of Naval Ship Design
Prereq: 2.082, 2.20, 2.611, and 2.702
G (Fall)
4-2-6 units
Covers the design of surface ship platforms for naval applications. Includes topics such as hull form selection and concept design synthesis, topside and general arrangements, weight estimation, and technical feasibility analyses (including strength, stability, seakeeping, and survivability). Practical exercises involve application of design principles and utilization of advanced computer-aided ship design tools.
*J. Harbour, J. Page*

2.704 Projects in Naval Ship Conversion Design
Prereq: 2.703
G (IAP, Spring)
1-6-5 units
Focuses on conversion design of a naval ship. A new mission requirement is defined, requiring significant modification to an existing ship. Involves requirements setting, design plan formulation and design philosophy, and employs formal decision-making methods. Technical aspects demonstrate feasibility and desirability. Includes formal written and verbal reports and team projects.
*J. Harbour, J. Page*

2.705 Projects in New Concept Naval Ship Design
Prereq: 2.704
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Focus on preliminary design of a new naval ship, fulfilling a given set of mission requirements. Design plan formulation, system level trade-off studies, emphasizes achieving a balanced design and total system integration. Formal written and oral reports. Team projects extend over three terms.
*J. Harbour, J. Page*

2.707 Submarine Structural Acoustics
Prereq: 2.066
G (Spring; first half of term)
2-0-4 units
Introduction to the acoustic interaction of submerged structures with the surrounding fluid. Fluid and elastic wave equations. Elastic waves in plates. Radiation and scattering from planar structures as well as curved structures such as spheres and cylinders. Acoustic imaging of structural vibrations. Students can take 2.085 in the second half of term.
*H. Schmidt*

2.708 Traditional Naval Architecture Design
Prereq: None
G (IAP)
2-0-1 units
Week-long intensive introduction to traditional design methods in which students hand draw a lines plan of a N. G. Herreshoff (MIT Class of 1870) design based on hull shape offsets taken from his original design model. After completing the plan, students then carve a wooden half-hull model of the boat design. Covers methods used to develop hull shape analysis data from lines plans. Provides students with instruction in safe hand tool use and how to transfer their lines to 3D in the form of their model. Limited to 15.
*K. Hasselbalch, J. Harbour*

Optics

2.71 Optics
Subject meets with 2.710
Prereq: (Physics II (GIR), 2.004, and 18.03) or permission of instructor
G (Fall)
3-0-9 units
Introduction to optical science with elementary engineering applications. Geometrical optics: ray-tracing, aberrations, lens design, apertures and stops, radiometry and photometry. Wave optics: basic electrodynamic, polarization, interference, wave-guiding, Fresnel and Fraunhofer diffraction, image formation, resolution, space-bandwidth product. Emphasis on analytical and numerical tools used in optical design. Graduate students are required to complete additional assignments with stronger analytical content, and an advanced design project.
*G. Barbastathis, P. T. So*

2.710 Optics
Subject meets with 2.71
Prereq: (Physics II (GIR), 2.004, and 18.03) or permission of instructor
G (Fall)
3-0-9 units
Introduction to optical science with elementary engineering applications. Geometrical optics: ray-tracing, aberrations, lens design, apertures and stops, radiometry and photometry. Wave optics: basic electrodynamic, polarization, interference, wave-guiding, Fresnel and Fraunhofer diffraction, image formation, resolution, space-bandwidth product. Emphasis on analytical and numerical tools used in optical design. Graduate students are required to complete additional assignments with stronger analytical content, and an advanced design project.
*G. Barbastathis, P. T. So*
2.715[J] Optical Microscopy and Spectroscopy for Biology and Medicine
Same subject as 20.487[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Introduces the theory and the design of optical microscopy and its applications in biology and medicine. The course starts from an overview of basic optical principles allowing an understanding of microscopic image formation and common contrast modalities such as dark field, phase, and DIC. Advanced microscopy imaging techniques such as total internal reflection, confocal, and multiphoton will also be discussed. Quantitative analysis of biochemical microenvironment using spectroscopic techniques based on fluorescence, second harmonic, Raman signals will be covered. We will also provide an overview of key image processing techniques for microscopic data.

P. T. So, C. Sheppard

2.717 Optical Engineering
Prereq: 2.710 or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Theory and practice of optical methods in engineering and system design. Emphasis on diffraction, statistical optics, holography, and imaging. Provides engineering methodology skills necessary to incorporate optical components in systems serving diverse areas such as precision engineering and metrology, bio-imaging, and computing (sensors, data storage, communication in multi-processor systems). Experimental demonstrations and a design project are included.

P. T. So, G. Barbathis

2.718 Photonic Materials
Subject meets with 2.719
Prereq: 2.003[J], 6.161, 8.03, or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 units


G. Barbathis, N. Fang

2.719 Photonic Materials
Subject meets with 2.718
Prereq: 2.003[J], 6.161, 8.03, or permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units


G. Barbathis, N. Fang
Design

2.70 FUNdaMENTALS of Precision Product Design
Subject meets with 2.77
Prereq: 2.008
U (Spring)
3-3-6 units

Examines design, selection, and combination of machine elements to produce a robust precision system. Introduces process, philosophy and physics-based principles of design to improve/enable renewable power generation, energy efficiency, and manufacturing productivity. Topics include linkages, power transmission, screws and gears, actuators, structures, joints, bearings, error apportionment, and error budgeting. Considers each topic with respect to its physics of operation, mechanics (strength, deformation, thermal effects) and accuracy, repeatability, and resolution. Includes guest lectures from practicing industry and academic leaders. Students design, build, and test a small benchtop precision machine, such as a heliostat for positioning solar PV panels or a two or three axis machine. Prior to each lecture, students review the pre-recorded detailed topic materials and then converge on what parts of the topic they want covered in extra depth in lecture. Students are assessed on their preparation for and participation in class sessions. Students taking graduate version complete additional assignments. Enrollment limited.

A. Slocum

2.77 FUNdaMENTALS of Precision Product Design
Subject meets with 2.70
Prereq: 2.008
G (Spring)
3-3-6 units

Examines design, selection, and combination of machine elements to produce a robust precision system. Introduces process, philosophy and physics-based principles of design to improve/enable renewable power generation, energy efficiency, and manufacturing productivity. Topics include linkages, power transmission, screws and gears, actuators, structures, joints, bearings, error apportionment, and error budgeting. Considers each topic with respect to its physics of operation, mechanics (strength, deformation, thermal effects) and accuracy, repeatability, and resolution. Includes guest lectures from practicing industry and academic leaders. Students design, build, and test a small benchtop precision machine, such as a heliostat for positioning solar PV panels or a two or three axis machine. Prior to each lecture, students review the pre-recorded detailed topic materials and then converge on what parts of the topic they want covered in extra depth in lecture. Students are assessed on their preparation for and participation in class sessions. Students taking graduate version complete additional assignments. Enrollment limited.

A. Slocum

2.72 Elements of Mechanical Design
Subject meets with 2.720
Prereq: 2.008 and (2.005 or 2.051); Coreq: 2.671
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-3-6 units

Advanced study of modeling, design, integration, and best practices for use of machine elements, such as bearings, bolts, belts, flexures, and gears. Modeling and analysis is based upon rigorous application of physics, mathematics, and core mechanical engineering principles, which are reinforced via laboratory experiences and a design project in which students model, design, fabricate, and characterize a mechanical system that is relevant to a real-world application. Activities and quizzes are directly related to, and coordinated with, the project deliverables. Develops the ability to synthesize, model and fabricate a design subject to engineering constraints (e.g., cost, time, schedule). Students taking graduate version complete additional assignments. Enrollment limited.

M. L. Culpepper
2.720 Elements of Mechanical Design
Subject meets with 2.72
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-3-6 units
Advanced study of modeling, design, integration, and best practices for use of machine elements, such as bearings, bolts, belts, flexures, and gears. Modeling and analysis is based upon rigorous application of physics, mathematics, and core mechanical engineering principles, which are reinforced via laboratory experiences and a design project in which students model, design, fabricate, and characterize a mechanical system that is relevant to a real-world application. Activities and quizzes are directly related to, and coordinated with, the project deliverables. Develops the ability to synthesize, model and fabricate a design subject to engineering constraints (e.g., cost, time, schedule). Students taking graduate version complete additional assignments.
M. L. Culpepper

2.722[J] D-Lab: Design
Same subject as EC.720[J]
Prereq: 2.670 or permission of instructor
U (Spring)
3-0-9 units
See description under subject EC.720[J]. Enrollment limited by lottery; must attend first class session.
S. Grama, J. Arul

2.723 Engineering Innovation and Design
Engineering School-Wide Elective Subject.
Offered under: 2.723, 6.902, 16.662
Prereq: None
U (Fall, Spring)
2-1-3 units
See description under subject 6.902.
B. Kotely

2.729[J] D-Lab: Design for Scale
Same subject as EC.729[J]
Subject meets with 2.789[J], EC.797[J]
Prereq: None. Coreq: 2.008; or permission of instructor
U (Fall)
3-2-7 units
See description under subject EC.729[J].
M. Yang

2.733 Engineering Systems Design
Subject meets with 2.013
Prereq: (2.001, 2.003[J], (2.005 or 2.051), and (2.00B, 2.670, or 2.678)) or permission of instructor
G (Fall)
0-6-6 units
Focuses on the design of engineering systems to satisfy stated performance, stability, and/or control requirements. Emphasizes individual initiative, application of fundamental principles, and the compromises inherent in the engineering design process. Culminates in the design of an engineering system, typically a vehicle or other complex system. Includes instruction and practice in written and oral communication through team presentation, design reviews, and written reports. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity.
D. Hart

2.734 Engineering Systems Development
Subject meets with 2.014
Prereq: (2.001, 2.003[J], (2.005 or 2.051), and (2.00B, 2.670, or 2.678)) or permission of instructor
G (Spring)
0-6-6 units
Focuses on the implementation and operation of engineering systems. Emphasizes system integration and performance verification using methods of experimental inquiry. Students refine their subsystem designs and the fabrication of working prototypes. Includes experimental analysis of subperformance and comparison with physical models of performance and with design goals. Component integration into the full system, with detailed analysis and operation of the complete vehicle in the laboratory and in the field. Includes written and oral reports. Students carry out formal reviews of the overall system design. Instruction and practice in oral and written communication provided. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity.
D. Hart
2.737 Mechatronics
Prereq: 6.002 and (2.14, 6.302, or 16.30)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-5-4 units

Introduction to designing mechatronic systems, which require integration of the mechanical and electrical engineering disciplines within a unified framework. Significant laboratory-based design experiences form subject’s core. Final project. Topics include: low-level interfacing of software with hardware; use of high-level graphical programming tools to implement real-time computation tasks; digital logic; analog interfacing and power amplifiers; measurement and sensing; electromagnetic and optical transducers; control of mechatronic systems. Limited to 20.
D. L. Trumper, K. Youcef-Toumi

2.739[J] Product Design and Development
Same subject as 15.783[J]
Prereq: 2.009, 15.761, 15.778, 15.814, or permission of instructor
G (Spring)
3-3-6 units

See description under subject 15.783[J]. Engineering students accepted via lottery based on WebSIS pre-registration.
S. Eppinger, M. C. Yang

2.74 Bio-inspired Robotics
Subject meets with 2.74
Prereq: 2.004 or permission of instructor
U (Fall)
3-1-8 units

Interdisciplinary approach to bio-inspired design, with emphasis on principle extraction applicable to various robotics research fields, such as robotics, prosthetics, and human assistive technologies. Focuses on three main components: biomechanics, numerical techniques that allow multi-body dynamics simulation with environmental interaction and optimization, and basic robotics techniques and implementation skills. Students integrate the components into a final robotic system project of their choosing through which they must demonstrate their understanding of dynamics and control and test hypothesized design principles. Students taking graduate version complete additional assignments. Enrollment may be limited due to lab capacity.
S. Kim

2.740 Bio-inspired Robotics
Subject meets with 2.74
Prereq: 2.004 or permission of instructor
G (Fall)
3-3-6 units

Interdisciplinary approach to bio-inspired design, with emphasis on principle extraction applicable to various robotics research fields, such as robotics, prosthetics, and human assistive technologies. Focuses on three main components: biomechanics, numerical techniques that allow multi-body dynamics simulation with environmental interaction and optimization, and basic robotics techniques and implementation skills. Students integrate the components into a final robotic system project of their choosing through which they must demonstrate their understanding of dynamics and control and test hypothesized design principles. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity.
S. Kim

2.744 Product Design
Prereq: 2.009
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Project-centered subject addressing transformation of ideas into successful products which are properly matched to the user and the market. Students are asked to take a more complete view of a new product and to gain experience with designs judged on their aesthetics, ease of use, and sensitivities to the realities of the marketplace. Lectures on modern design process, industrial design, visual communication, form-giving, mass production, marketing, and environmentally conscious design.
D. R. Wallace
2.75[J] Medical Device Design
Same subject as 6.525[J], HST.552[J]
Subject meets with 2.750[J], 6.025[J]
Prereq: 2.008, 6.101, 6.111, 6.115, 22.071, or permission of instructor
G (Fall)
3-0-9 units

Provides an intense project-based learning experience around the
design of medical devices with foci ranging from mechanical to
electro mechanical to electronics. Projects motivated by real-world
clinical challenges provided by sponsors and clinicians who also
help mentor teams. Covers the design process, project management,
and fundamentals of mechanical and electrical circuit and sensor
design. Students work in small teams to execute a substantial term
project, with emphasis placed upon developing creative designs - via
a deterministic design process - that are developed and optimized
using analytical techniques. Instruction and practice in written and
oral communication provided. Students taking graduate version
complete additional assignments. Enrollment limited.
A. H. Slocum, G. Hom, E. Roche, N. C. Hanumara

2.750[J] Medical Device Design
Same subject as 2.025[J]
Subject meets with 2.75[J], 6.525[J], HST.552[J]
Prereq: 2.008, 6.101, 6.111, 6.115, 22.071, or permission of instructor
U (Fall)
3-0-9 units

Provides an intense project-based learning experience around the
design of medical devices with foci ranging from mechanical to
electro mechanical to electronics. Projects motivated by real-world
clinical challenges provided by sponsors and clinicians who also
help mentor teams. Covers the design process, project management,
and fundamentals of mechanical and electrical circuit and sensor
design. Students work in small teams to execute a substantial term
project, with emphasis placed upon developing creative designs - via
a deterministic design process - that are developed and optimized
using analytical techniques. Instruction and practice in written and
oral communication provided. Students taking graduate version
complete additional assignments. Enrollment limited.
A. H. Slocum, G. Hom, E. Roche, N. C. Hanumara

2.752 Development of Mechanical Products
Subject meets with 2.753
Prereq: 2.009, 2.750[J], or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units

Focuses on evolving a product from proof-of-concept to beta
prototype: Includes team building, project planning, budgeting,
resource planning; models for scaling, tolerancing and reliability,
patents, business planning. Students/teams start with a proof-of-
concept product they bring to class or select from projects provided
by instructor. In lieu of taking 12 units of 2.752, students taking 2.752 may write a bachelor's thesis that documents their
contributions to the product developed in the team project. Students
taking the graduate version complete additional assignments.
Enrollment limited; preference to Course 2 majors and minors.
A. Slocum

2.753 Development of Mechanical Products
Subject meets with 2.752
Prereq: 2.009, 2.750[J], or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Focuses on evolving a product from proof-of-concept to beta
prototype: Includes team building, project planning, budgeting,
resource planning; models for scaling, tolerancing and reliability,
patents, business planning. Students/teams start with a proof-of-
concept product they bring to class or select from projects provided
by instructor. In lieu of taking 12 units of 2.752, students taking 2.752 may write a bachelor's thesis that documents their
contributions to the product developed in the team project. Students
taking the graduate version complete additional assignments.
Enrollment limited.
A. Slocum
2.76 Global Engineering
Subject meets with 2.760
Prereq: 2.008 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Combines rigorous engineering theory and user-centered product design to create technologies for developing and emerging markets. Covers machine design theory to parametrically analyze technologies; bottom-up/top-down design processes; engagement of stakeholders in the design process; socioeconomic factors that affect adoption of products; and developing/emerging market dynamics and their effect on business and technology. Includes guest lectures from subject matter experts in relevant fields and case studies on successful and failed technologies. Student teams apply course material to term-long projects to create new technologies, developed in collaboration with industrial partners and other stakeholders in developing/emerging markets. Students taking graduate version complete additional assignments.

A. Winter

2.760 Global Engineering
Subject meets with 2.76
Prereq: 2.008 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units

Combines rigorous engineering theory and user-centered product design to create technologies for developing and emerging markets. Covers machine design theory to parametrically analyze technologies; bottom-up/top-down design processes; engagement of stakeholders in the design process; socioeconomic factors that affect adoption of products; and developing/emerging market dynamics and their effect on business and technology. Includes guest lectures from subject matter experts in relevant fields and case studies on successful and failed technologies. Student teams apply course material to term-long projects to create new technologies, developed in collaboration with industrial partners and other stakeholders in developing/emerging markets. Students taking graduate version complete additional assignments.

A. Winter

2.777 Large and Complex Systems Design and Concept Development (New)
Subject meets with 2.778
Prereq: 2.008 or permission of instructor
U (Fall)
3-0-9 units

Examines structured principles and processes to develop concepts for large and complex systems. Term projects introduce students to large-scale system development with several areas of emphasis, including idea generation, concept development and refinement, system-level thinking, briefing development and presentation, and proposal generation. Interactive lectures and presentations guide students throughout the course to develop and deliver team presentations focused on solving large and complex problems. Includes a semester-long project in which students apply design tools/processes to solve a specific problem. Students taking graduate version complete the project individually.

S. Kim

2.778 Large and Complex Systems Design and Concept Development
Subject meets with 2.777
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Examines structured principles and processes to develop concepts for large and complex systems. Term projects introduce students to large-scale system development with several areas of emphasis, including idea generation, concept development and refinement, system-level thinking, briefing development and presentation, and proposal generation. Interactive lectures and presentations guide students throughout the course to develop and deliver individual and team presentations focused on solving large and complex problems. Includes a semester-long project in which students apply design tools/processes to solve a specific problem. Students taking graduate version complete project individually. Limited enrollment.

S. G. Kim

Bioengineering

2.772[J] Thermodynamics of Biomolecular Systems
Same subject as 20.110[J]
Prereq: Calculus II (GIR), Chemistry (GIR), and Physics I (GIR)
U (Fall)
5-0-7 units. REST

See description under subject 20.110[J].

M. Birnbaum C. Voligt
2.78[J] Principles and Practice of Assistive Technology
Same subject as 6.811[J], HST.420[J]
Prereq: Permission of instructor
U (Fall)
2-4-6 units
See description under subject 6.811[J].
R. C. Miller, J. E. Greenberg, J. J. Leonard

2.782[J] Design of Medical Devices and Implants
Same subject as HST.524[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Spring)
3-0-9 units
I. V. Yannas, M. Spector

2.785[J] Cell-Matrix Mechanics
Same subject as HST.523[J]
Prereq: (Biology (GIR), Chemistry (GIR), and 2.001) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Mechanical forces play a decisive role during development of tissues and organs, during remodeling following injury as well as in normal function. A stress field influences cell function primarily through deformation of the extracellular matrix to which cells are attached. Deformed cells express different biosynthetic activity relative to undeformed cells. The unit cell process paradigm combined with topics in connective tissue mechanics form the basis for discussions of several topics from cell biology, physiology, and medicine.
I. V. Yannas, M. Spector

2.787[J] Tissue Engineering and Organ Regeneration
Same subject as HST.535[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Fall)
3-0-9 units
See description under subject HST.535[J].
M. Spector, I. V. Yannas

2.788 Mechanical Engineering and Design of Living Systems (New)
Prereq: None
G (Fall)
4-2-6 units
For students interested in research at the interface of mechanical engineering, biology, and materials science. Specific emphasis lies on interfacing living systems with engineered materials and devices, and on engineering living system behavior.
M. Kolle, M. Guo

2.789[J] D-Lab: Design for Scale (New)
Same subject as EC.797[J]
Subject meets with 2.729[J], EC.729[J]
Prereq: None. Coreq: 2.008; or permission of instructor
G (Fall)
3-2-7 units
See description under subject EC.797[J].
M. Yang, H. Quintus-Bosz, S. Grama, K. Bergeron

2.79[J] Biomaterials: Tissue Interactions
Same subject as HST.522[J]
Prereq: (Biology (GIR), Chemistry (GIR), and Physics I (GIR)) or permission of instructor
G (Fall)
3-0-9 units
Principles of materials science and cell biology underlying the development and implementation of biomaterials for the fabrication of medical devices/implants, including artificial organs and matrices for tissue engineering and regenerative medicine. Employs a conceptual model, the “unit cell process for analysis of the mechanisms underlying wound healing and tissue remodeling following implantation of biomaterials/devices in various organs, including matrix synthesis, degradation, and contraction. Methodology of tissue and organ regeneration. Discusses methods for biomaterials surface characterization and analysis of protein adsorption on biomaterials. Design of implants and prostheses based on control of biomaterials-tissue interactions. Comparative analysis of intact, biodegradable, and bioreplaceable implants by reference to case studies. Criteria for restoration of physiological function for tissues and organs.
I. V. Yannas, M. Spector
2.791[J] Cellular Neurophysiology and Computing
Same subject as 6.021[J], 9.21[J], 20.370[J]
Subject meets with 2.794[J], 6.521[J], 9.021[J], 20.470[J], HST.541[J]
Prereq: Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, 20.110[J]), or permission of instructor
U (Fall)
5-2-5 units
See description under subject 6.021[J]. Preference to juniors and seniors.
J. Han, T. Heldt

2.792[J] Quantitative and Clinical Physiology
Same subject as 6.022[J], HST.542[J]
Subject meets with 2.796[J], 6.522[J]
Prereq: Physics II (GIR), 18.03, or permission of instructor
U (Spring)
4-2-6 units
See description under subject 6.022[J].
T. Heldt, R. G. Mark

2.793[J] Fields, Forces and Flows in Biological Systems
Same subject as 6.023[J], 20.330[J]
Prereq: Physics II (GIR) and (2.005, 6.021[J], or permission of instructor); Coreq: 20.309[J]
U (Spring)
4-0-8 units
See description under subject 20.330[J].
J. Han, S. Manalis

2.794[J] Cellular Neurophysiology and Computing
Same subject as 6.521[J], 9.021[J], 20.470[J], HST.541[J]
Subject meets with 2.791[J], 6.021[J], 9.21[J], 20.370[J]
Prereq: (Physics II (GIR), 18.03, and (2.005, 6.002, 6.003, 10.301, or 20.110[J])) or permission of instructor
G (Fall)
5-2-5 units
See description under subject 6.521[J].
J. Han, T. Heldt

2.795[J] Fields, Forces, and Flows in Biological Systems
Same subject as 6.561[J], 10.539[J], 20.430[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject 20.430[J].
M. Bathe, A. J. Grodzinsky

2.796[J] Quantitative Physiology: Organ Transport Systems
Same subject as 6.522[J]
Subject meets with 2.792[J], 6.022[J], HST.542[J]
Prereq: 6.021[J] and (2.006 or 6.013)
G (Spring)
4-2-6 units
See description under subject 6.522[J].
T. Heldt, R. G. Mark

2.797[J] Molecular, Cellular, and Tissue Biomechanics
Same subject as 3.053[J], 6.024[J], 20.310[J]
Prereq: Biology (GIR), (2.370 or 20.110[J]), and (3.016B or 18.03)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena over a range of length scales. Topics include structure of tissues and the molecular basis for macroscopic properties; chemical and electrical effects on mechanical behavior; cell mechanics, motility and adhesion; biomembranes; biomolecular mechanics and molecular motors. Experimental methods for probing structures at the tissue, cellular, and molecular levels.
M. Bathe, A. Grodzinsky

2.798[J] Molecular, Cellular, and Tissue Biomechanics
Same subject as 3.971[J], 6.524[J], 10.537[J], 20.410[J]
Prereq: Biology (GIR) and (2.002, 2.006, 6.013, 10.301, or 10.302)
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena over a range of length scales. Topics include structure of tissues and the molecular basis for macroscopic properties; chemical and electrical effects on mechanical behavior; cell mechanics, motility and adhesion; biomembranes; biomolecular mechanics and molecular motors. Experimental methods for probing structures at the tissue, cellular, and molecular levels.
R. D. Kamm, K. J. Van Vliet
2.799 The Cell as a Machine
Prereq: 5.07[J], 7.05, or 18.03
G (Fall)
3-3-6 units
Examines a variety of essential cellular functions from the perspective of the cell as a machine. Includes phenomena such as nuclear organization, protein synthesis, cell and membrane mechanics, cell migration, cell cycle control, cell transformation. Lectures are provided by video twice per week; live 3-hour recitation one evening per week. Course is taken simultaneously by students at multiple universities; homework and take-home exams common to all students. Preference to students in Courses 2 and 20.
R. Kamm, M. Sheetz, H. Yu

Manufacturing

2.810 Manufacturing Processes and Systems
Prereq: 2.001, 2.006, and 2.008
G (Fall)
3-3-6 units
Introduction to manufacturing processes and manufacturing systems including assembly, machining, injection molding, casting, thermoforming, and more. Emphasis on the physics and randomness and how they influence quality, rate, cost, and flexibility. Attention to the relationship between the process and the system, and the process and part design. Project (in small groups) requires fabrication (and some design) of a product using several different processes (as listed above). Enrollment may be limited due to laboratory constraints.
T. G. Gutowski

2.812 Solving for Carbon Neutrality at MIT (New)
Subject meets with 2.832
Prereq: None
U (Spring)
3-3-6 units
Working in teams, students address the problem of reducing MIT's greenhouse gas emissions in a manner consistent with the climate goals of maintaining our planet in a suitable regime to support human society and the environment. Solution scenarios include short-, middle- and long-term strategies. Experts from MIT's faculty and operations staff, as well as outside experts who address the multidisciplinary features of the problem guide solutions. These include climate science, ethics, carbon accounting, cost estimating, MIT's energy supply, energy demand, and infrastructure, new technologies, financial instruments, electricity markets, policy, human behavior, and regulation. Develops skills to address carbon neutrality at other universities, and at other scales, including cities and nations. Students taking graduate version complete additional assignments.
T. Gutowski, J. Newman

2.813 Energy, Materials, and Manufacturing
Subject meets with 2.83
Prereq: 2.008 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Introduction to the major dilemma that faces manufacturing and society for the 21st century: how to support economic development while protecting the environment. Subject addresses industrial ecology, materials flows, life-cycle analysis, thermodynamic analysis and exergy accounting, manufacturing process performance, product design analysis, design for the environment, recycling and ecological economics. Combines lectures and group discussions of journal articles and selected literature, often with opposing views. Graduate students complete term-long project with report required for graduate credit.
T. G. Gutowski

2.821[J] Structural Materials
Same subject as 3.371[J]
Prereq: Permission of instructor
G (Fall, Spring, Summer; partial term)
2-0-10 units
Can be repeated for credit. Credit cannot also be received for 3.171
See description under subject 3.371[J].
T. Eagar, A. Slocum
**2.83 Energy, Materials and Manufacturing**  
Subject meets with 2.813  
Prereq: 2.008 or permission of instructor  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units  

Introduction to the major dilemma that faces manufacturing and society for the 21st century: how to support economic development while protecting the environment. Subject addresses industrial ecology, materials flows, life-cycle analysis, thermodynamic analysis and exergy accounting, manufacturing process performance, product design analysis, design for the environment, recycling and ecological economics. Combines lectures and group discussions of journal articles and selected literature, often with opposing views. Graduate students complete term-long project with report required for graduate credit.  

T. G. Gutowski

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**2.832 Solving for Carbon Neutrality at MIT (New)**  
Subject meets with 2.812  
Prereq: None  
G (Spring)  
3-3-6 units  

Working in teams, students address the problem of reducing MIT’s greenhouse gas emissions in a manner consistent with the climate goals of maintaining our planet in a suitable regime to support human society and the environment. Solution scenarios include short-, middle- and long-term strategies. Experts from MIT’s faculty and operations staff, as well as outside experts who address the multidisciplinary features of the problem guide solutions. These include climate science, ethics, carbon accounting, cost estimating, MIT’s energy supply, energy demand, and infrastructure, new technologies, financial instruments, electricity markets, policy, human behavior, and regulation. Develops skills to address carbon neutrality at other universities, and at other scales, including cities and nations. Students taking graduate version complete additional assignments.  

T. Gutowski, J. Newman

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**2.830[J] Control of Manufacturing Processes**  
Same subject as 6.780[J]  
Prereq: 2.008, 6.041, or 6.152[J]  
G (Fall)  
3-0-9 units  

Statistical modeling and control in manufacturing processes. Use of experimental design and response surface modeling to understand manufacturing process physics. Defect and parametric yield modeling and optimization. Forms of process control, including statistical process control, run by run and adaptive control, and real-time feedback control. Application contexts include semiconductor manufacturing, conventional metal and polymer processing, and emerging micro-nano manufacturing processes.  

D. E. Hardt, D. S. Boning

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**2.851[J] System Optimization and Analysis for Operations**  
Same subject as 15.066[J]  
Prereq: Calculus II (GIR)  
G (Summer)  
4-0-8 units  

See description under subject 15.066[J]. Restricted to Leaders for Global Operations students.  

Staff

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**2.853 Introduction to Manufacturing Systems**  
Subject meets with 2.854  
Prereq: 2.008  
U (Fall)  
3-0-9 units  

Provides ways to analyze manufacturing systems in terms of material flow and storage, information flow, capacities, and times and durations of events. Fundamental topics include probability, inventory and queueing models, forecasting, optimization, process analysis, and linear and dynamic systems. Factory planning and scheduling topics include flow planning, bottleneck characterization, buffer and batch-size tactics, seasonal planning, and dynamic behavior of production systems. Graduate students are required to complete additional assignments with stronger analytical content.  

S. B. Gershwin
2.854 Introduction to Manufacturing Systems
Subject meets with 2.853
Prereq: Undergraduate mathematics
G (Fall)
3-0-9 units
Provides ways to analyze manufacturing systems in terms of material flow and storage, information flow, capacities, and times and durations of events. Fundamental topics include probability, inventory and queuing models, forecasting, optimization, process analysis, and linear and dynamic systems. Factory planning and scheduling topics include flow planning, bottleneck characterization, buffer and batch-size tactics, seasonal planning, and dynamic behavior of production systems. Graduate students are required to complete additional assignments.
S. B. Gershwin

2.871 D-Lab: Supply Chains (New)
Subject meets with 2.771[J], 15.772[J], EC.733[J]
Prereq: None
G (Fall)
3-3-6 units
Introduces concepts of supply chain design and planning with a focus on supply chains for products destined to improve quality of life in developing countries. Topics include demand estimation, process analysis and improvement, facility location and capacity planning, inventory management, and supply chain coordination. Also covers issues specific to emerging markets, such as sustainable supply chains, choice of distribution channels, and how to account for the value-adding role of a supply chain. Students conduct D-Lab-based projects on supply chain design or improvement. Students taking graduate version will complete additional assignments.
S. C. Graves

2.874[J] Process Data Analytics (New)
Same subject as 10.354[J]
Subject meets with 2.874[J], 10.354[J]
Prereq: 18.03 or permission of instructor
U (Fall)
3-0-6 units
See description under subject 10.354[J].
R. D. Braatz, B. Anthony

2.884[J] Process Data Analytics (New)
Same subject as 10.554[J]
Subject meets with 2.874[J], 10.354[J]
Prereq: None
G (Fall)
3-0-6 units
See description under subject 10.554[J].
R. D. Braatz, B. Anthony

2.888 Professional Seminar in Global Manufacturing Innovation and Entrepreneurship
Prereq: None
G (Spring)
2-0-1 units
Covers a broad range of topics in modern manufacturing, from models and structures for 21st-century operations, to case studies in leadership from the shop floor to the executive office. Also includes global perspectives from Asia, Europe and North America, with guest speakers from all three regions. Explores opportunities for new ventures in manufacturing. Intended primarily for Master of Engineering in Manufacturing students.
D. E. Hardt, S. B. Gershwin

2.890[J] Global Operations Leadership Seminar
Same subject as 10.792[J], 15.792[J], 16.985[J]
Prereq: None
G (Fall, Spring)
2-0-0 units
Can be repeated for credit.
See description under subject 15.792[J]. Preference to LGO students.
T. Roemer

Engineering Management

2.351[J] Introduction to Making
Same subject as 15.351[J]
Prereq: Permission of instructor
G (Fall, Spring)
3-0-3 units
See description under subject 15.351[J]. Enrollment limited; application required.
M. Culpepper, M. Cameron, A. Jay
2.900 Ethics for Engineers
Engineering School-Wide Elective Subject.
Offered under: 1.082, 2.900, 6.904, 10.01, 16.676, 22.014
Subject meets with 6.9041, 20.005
Prereq: None
U (Fall, Spring)
2-0-4 units
See description under subject 10.01.
D. Doneson, B. L. Trout

2.912[J] Venture Engineering
Same subject as 3.085[J], 15.373[J]
Prereq: None
U (Spring)
3-0-9 units
Provides an integrated approach to the development and growth of new innovative ventures. Intended for students who seek to leverage their engineering and science background through innovation-driven entrepreneurship. Emphasizes the concept that innovation-driven entrepreneurs must make a set of interdependent choices under conditions of high uncertainty, and demonstrates that venture engineering involves reducing uncertainty through a structured process of experimental learning and staged commitments. Provides deep understanding of the core technical, customer, and strategic choices and challenges facing start-up innovators, and a synthetic framework for the development and implementation of ventures in dynamic environments.
S. Stern, E. Fitzgerald

2.913[J] Entrepreneurship in Engineering
Same subject as 6.907[J]
Subject meets with 6.933
Prereq: None
U (Spring)
4-0-8 units
See description under subject 6.907[J]. No listeners.
C. Chase

2.916[J] Money for Startups
Same subject as 10.407[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units
See description under subject 10.407[J].
S. Loessberg, D. P. Hart

2.96 Management in Engineering
Engineering School-Wide Elective Subject.
Offered under: 2.96, 6.930, 10.806, 16.653
Prereq: None
U (Fall)
3-1-8 units
Introduction and overview of engineering management. Financial principles, management of innovation, technical strategy and best management practices. Case study method of instruction emphasizes participation in class discussion. Focus is on the development of individual skills and management tools. Restricted to juniors and seniors.
H. S. Marcus, J.-H. Chun

2.961 Management in Engineering
Prereq: None
G (Fall)
3-1-8 units
Introduction and overview of engineering management. Financial principles, management of innovation, technical strategy and best management practices. Case study method of instruction emphasizes participation in class discussion. Focus is on the development of individual skills and management tools.
J.-H. Chun, H. S. Marcus

2.965[J] Global Supply Chain Management
Same subject as 1.265[J], 15.765[J], SCM.265[J]
Prereq: 15.761, 15.778, SCM.260[J], SCM.261[J], or permission of instructor
G (Spring)
Not offered regularly; consult department
2-0-4 units
See description under subject SCM.265[J].
Staff

Advanced Topics and Special Subjects

2.98 Sports Technology: Engineering & Innovation
Subject meets with 2.980
Prereq: None
G (Fall, Spring)
2-2-2 units
Examines the future of sports technology across technical disciplines, including mechanical design, biomechanics, quantified self, sports analytics, and business strategies. Includes visits by leaders in the field to discuss various industries, career pathways, and opportunities for innovation in the field. Projects explore and potentially kickoff larger research and/or entrepreneurial initiatives.
A. Hosoi, C. Chase
2.980 Sports Technology: Engineering & Innovation
Subject meets with 2.98
Prereq: None
U (Fall, Spring) 2-2-8 units
Examine the future of sports technology across technical disciplines, including mechanical design, biomechanics, quantified self, sports analytics, and business strategies. Includes visits by leaders in the field to discuss various industries, career pathways, and opportunities for innovation in the field. Projects explore and potentially kick off larger research and/or entrepreneurial initiatives.
A. Hosoi, C. Chase

2.981 New England Coastal Ecology
Prereq: None
U (IAP) 2-0-1 units
Provides exposure to marine communities found along the coast of New England and how they fit into global patterns. Focuses on the ecology of salt marshes and rocky shores, and the biology of plants and animals that live in these complex habitats. Prepares students to recognize common inhabitants of these two communities and develops understanding of the major environmental factors affecting them, the types of ecological services they provide, and likely impacts of current and future climate change. Includes visits to field and research centers. Limited to 20.
Consult C. Bastidas

2.982 Ecology and Sustainability of Coastal Ecosystems
Prereq: None
U (Fall) 3-2-4 units
Prepares students to recognize coastal ecosystems, their major environmental and biological drivers, and common impacts that human population growth and climate change have on them. Students engage in a semester-long project to address and seek solutions to current challenges in sustainability of human activities on the coast, and to promote resilience of natural communities and ecosystem services.
J. Simpson, C. Bastidas

2.990 Practical Experience
Prereq: None
U (Fall, IAP, Spring, Summer) 0-1-0 units
Can be repeated for credit.
For Mechanical Engineering undergraduates participating in curriculum-related off-campus experiences in mechanical engineering. Before enrolling, students must have an employment offer from a company or organization and must find a Mech E supervisor. Upon completion of the coursework the student must submit a detailed design notebook, approved by the MIT supervisor. Subject to departmental approval. Consult Department Undergraduate Office for details on procedures and restrictions.
Consult R. Karnik

2.991 Introduction to Graduate Study in Mechanical Engineering
Prereq: None
G (Fall) 1-2-0 units
Familiarizes students with the requirements for their desired degree and the resources, both at MIT and beyond, to help them reach their educational and professional goals. Series of interactive lectures and seminars guides students through various aspects of life critical to navigating graduate school successfully. Topics include course requirements, PhD qualifying examinations, advisor/advisee relationships, funding and fellowships, mental health and wellbeing, housing options in the Boston area, and career options after graduation. Limited to first-year graduate students.
C. Buie

2.992 Professional Industry Immersion Project
Prereq: Permission of instructor
G (Summer) Units arranged
Provides students a unique opportunity to participate in industry-based projects. Students gain professional industry experience in mechanical engineering projects that complement their academic experiences. Each project has a company supervisor, a specific advisor, and a course instructor. Course staff help students connect with specific companies and collaboratively design a project of mutual interest and benefit. Requires a written report and project presentation upon completion of a minimum of 10 weeks of off-campus activities. Limited to Mechanical Engineering graduate students.
B. Anthony
**2.993 Independent Study**
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.

Designed for undergraduates wanting to continue substantial projects of own choice, under faculty supervision, in mechanical engineering. Work may be of experimental, theoretical, or design nature. Projects may be arranged individually in most fields of department interest, i.e., in mechanics, design and manufacturing, controls and robotics, thermal science and energy engineering, bioengineering, ocean engineering and nanotechnology. 2.993 is letter-graded; 2.994 is P/D/F.  
*Consult R. Karnik*

**2.994 Independent Study**
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.

Designed for undergraduates wanting to continue substantial projects of own choice, under faculty supervision, in mechanical engineering. Work may be of experimental, theoretical, or design nature. Projects may be arranged individually in most fields of department interest, i.e., in mechanics, design and manufacturing, controls and robotics, thermal science and energy engineering, bioengineering, ocean engineering and nanotechnology. 2.993 is letter-graded; 2.994 is P/D/F.  
*Consult R. Karnik*

**2.995 Advanced Topics in Mechanical Engineering**
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.

Assigned reading and problems or research in distinct areas, either theoretical or experimental, or design. Arranged on individual basis with instructor in the following areas: mechanics and materials, thermal and fluid sciences, systems and design, biomedical engineering, and ocean engineering. Can be repeated for credit only for completely different subject matter.  
*Consult R. Abeyaratne*

**2.996 Advanced Topics in Mechanical Engineering**
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.

Assigned reading and problems or research in distinct areas, either theoretical or experimental, or design. Arranged on individual basis with instructor in the following areas: mechanics and materials, thermal and fluid sciences, systems and design, biomedical engineering, and ocean engineering. Can be repeated for credit only for completely different subject matter.  
*Consult R. Abeyaratne*

**2.997 Advanced Topics in Mechanical Engineering**
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.

Assigned reading and problems or research in distinct areas, either theoretical or experimental, or design. Arranged on individual basis with instructor in the following areas: mechanics and materials, thermal and fluid sciences, systems and design, biomedical engineering, and ocean engineering. Can be repeated for credit only for completely different subject matter.  
*Consult R. Abeyaratne*

**2.998 Advanced Topics in Mechanical Engineering**
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.

Assigned reading and problems or research in distinct areas, either theoretical or experimental, or design. Arranged on individual basis with instructor in the following areas: mechanics and materials, thermal and fluid sciences, systems and design, biomedical engineering, and ocean engineering. Can be repeated for credit only for completely different subject matter.  
*Consult R. Abeyaratne*

**2.5007 Special Subject in Mechanical Engineering**
Prereq: None  
U (Spring)  
Units arranged  

Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.  
*Staff*
2.5670 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

2.5790-2.5792 Graduate Special Subject in Bioengineering
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Advanced lecture, seminar or laboratory course consisting of material in the broadly-defined field of bioengineering not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Consult R. Kamm

2.5793 Graduate Special Subject in Mechanical Engineering
Prereq: None
G (Spring)
Units arranged

Advanced lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

2.5794 Graduate Special Subject in Mechanical Engineering
Prereq: None
G (Spring)
Units arranged

Advanced lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

2.5795 Graduate Special Subject in Mechanical Engineering (New)
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

P. Purohit

2.5796 Special Subject in Mechanical Engineering (New)
Prereq: None
G (Fall)
Units arranged [P/D/F]
Can be repeated for credit.

Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.

Staff

2.597 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
Acad Year 2019–2020: Not offered
Acad Year 2020–2021: U (Fall)
Units arranged
Can be repeated for credit.

Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5972-2.5974 are graded P/D/F.

Consult R. Karnik

2.5971 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (IAP, Spring)
Units arranged
Can be repeated for credit.

Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5972-2.5974 are graded P/D/F.

Consult R. Karnik
2.5972 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5972-2.5974 are graded P/D/F.
Consult R. Karnik

2.5973 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5972-2.5974 are graded P/D/F.
Consult R. Karnik

2.5974 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5972-2.5974 are graded P/D/F.
Consult R. Karnik

2.5975 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. See staff for scheduling information. Limited to 16.
Consult T. Consi

2.5976 Special Subject in Mechanical Engineering
Prereq: None
U (Spring)
Units arranged
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.
A. Patera

2.5980 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
G (IAP)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Advanced lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5980 and 2.5996 are graded P/D/F.
R. Abeyaratne

2.5981 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Advanced lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5980 and 2.5996 are graded P/D/F.
Consult R. Abeyaratne

2.5982 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Advanced lecture, seminar or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5980 and 2.5996 are graded P/D/F.
Consult R. Abeyaratne
2.5983 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Advanced lecture, seminar or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5980 and 2.5996 are graded P/D/F.
A. Hosoi, C. Chase

2.5989 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.
D. Frey, A. Talebinejad

2.5990 Graduate Special Subject in Mechanical Engineering
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. Enrollment limited.
Staff

2.5991 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (Spring)
Units arranged
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.
Consult Staff

2.5992 Graduate Special Subject in Mechanical Engineering
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter.
A. Gopinath

2.5993 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.
Lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5972-2.5974, 2.5992 are graded P/D/F.
R. Karnik

2.5994 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (Spring)
Units arranged
Can be repeated for credit.
Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5972-2.5974 and 2.5992 are graded P/D/F.
Consult R. Karnik

2.5995 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (Fall)
Units arranged
Can be repeated for credit.
Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5972-2.5974 and 2.5992 are graded P/D/F.
Consult R. Karnik
2.5996 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Advanced lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5980 and 2.5996 are graded P/D/F.

Consult R. Abeyaratne

2.5997 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
G (IAP, Spring)
Units arranged
Can be repeated for credit.

Advanced lecture, seminar or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5980 and 2.5996 are graded P/D/F.

Consult R. Abeyaratne

2.5998 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
Units arranged
Can be repeated for credit.

Advanced lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5980 and 2.5996 are graded P/D/F.

Consult R. Abeyaratne, J. Hart

2.5999 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.

Advanced lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. Can be repeated for credit only for completely different subject matter. 2.5980 and 2.5996 are graded P/D/F.

Fall: Consult R. Abeyaratne
Spring: Consult T. Gutowski

Thesis, Research and Practice

2.978 Instruction in Teaching Engineering
Subject meets with 1.95[J], 5.95[J], 7.59[J], 8.395[J], 18.094[J]
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]

Participatory seminar focuses on the knowledge and skills necessary for teaching engineering in higher education. Topics include research on learning; course development; promoting active learning, problem solving, and critical thinking in students; communicating with a diverse student body; using educational technology to further learning; lecturing; creating effective tests and assignments; and assessment and evaluation. Field-work teaching various subjects in the Mechanical Engineering department will complement classroom discussions.

J. Rankin

2.979 Undergraduate Teaching
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For students participating in departmentally approved undergraduate teaching programs. Students assist faculty in the design and execution of the curriculum and actively participate in the instruction and monitoring of the class participants. Students prepare subject materials, lead discussion groups, and review progress. Credit is arranged on a subject-by-subject basis and is reviewed by the department.

A. E. Hosoi

2.999 Engineer's Degree Thesis Proposal Preparation
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

For students who must do additional work to convert an SM thesis to a Mechanical Engineer's (ME) or Naval Engineer's (NE) thesis, or for students who write an ME/NE thesis after having received an SM degree.

R. Abeyaratne, M. S. Triantafyllov
2.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units
Provides sophomores with guided practice in finding opportunities and excelling in the world of practice. Building on the skills and relationships acquired in the Engineering Practice Workshop, students receive coaching to articulate goals, invoke the UPOP network of mentors and employers, identify and pursue opportunities and negotiate terms of their summer assignment. Students complete a 10-12 week internship, which includes filing three progress reports, conducting one informational interview, and possibly hosting a site visit by MIT staff. Returning to campus as juniors, UPOP students take part in reflective exercises that aid assimilation of learning objectives and reinforce the cognitive link between all aspects of the UPOP experience and disciplinary fields of study. Sequence begins in the spring of sophomore year and ends in the fall of junior year.

Staff

2.EPW UPOP Engineering Practice Workshop
Engineering School-Wide Elective Subject.
Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW
Prereq: None
U (Fall, IAP)
1-0-0 units
Develops foundational skills for the world of practice in science, technology, and engineering. Sophomores receive classroom instruction, and one-on-one and small-group coaching in basics of professional identity building. They attend field trips to local employers and receive job interview practice, coached by industry volunteers. Over IAP, students attend a weeklong Team Training Camp of experiential learning modules - led by MIT faculty with the help of MIT alums and other senior professionals in business, engineering, and science where students participate in creative simulations, team problem-solving challenges, and oral presentations, and practice networking with employers. Enrollment limited.

Staff

2.THG Graduate Thesis
Prereq: Permission of advisor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
Consult R. Abeyaratne

2.THU Undergraduate Thesis
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual self-motivated study, research, or design project under faculty supervision. Departmental program requirement: minimum of 6 units. Instruction and practice in written communication provided.
Consult R. Karnik

2.UR Undergraduate Research in Mechanical Engineering
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Individual study, research, or laboratory investigations under faculty supervision, including individual participation in an ongoing research project. See projects listing in Undergraduate Office, 1-110, for guidance.
Consult D. Rowell

2.URG Undergraduate Research in Mechanical Engineering
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Individual study, research, or laboratory investigations under faculty supervision, including individual participation in an ongoing research project. See projects listing in Undergraduate Office, 1-110, for guidance.
Consult N. Fang, K. Kamrin
MEDIA ARTS AND SCIENCES (MAS)

Undergraduate Subjects

MAS.110 Fundamentals of Computational Media Design
Prereq: None
U (Fall)
Not offered regularly; consult department
3-3-6 units. HASS-A; CI-H

History of modern art and design from the perspective of the technologist. Exploration of visual analysis, typography, and technologies for audio/visual expression. Enrollment limited; preference to students in MAS freshman program.
V. M. Bove, Jr.

MAS.111 Introduction to Doing Research in Media Arts and Sciences
Prereq: None
U (Spring)
1-4-1 units

Intended for students pursuing research projects at the Media Laboratory, particularly freshmen and sophomores. Exercises and discussions on topics including Media Lab research areas; documenting research progress; ethical issues in research; patents, copyrights, intellectual property; and giving oral, written, and online presentations of results. A final oral presentation is required. Enrollment limited; preference to students in the Media Arts and Sciences freshman program.
V. M. Bove, Jr.

MAS.131 Computational Camera and Photography
Subject meets with MAS.531
Prereq: Permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 units

Covers the complete pipeline of computational cameras that attempt to digitally capture the essence of visual information by exploiting the synergistic combination of task-specific optics, illumination, sensors, and processing. Students discuss and use thermal, multispectral, high-speed and 3-D range-sensing cameras, as well as camera arrays. Presents opportunities in scientific and medical imaging, and mobile phone-based photography. Also covers cameras for human computer interaction (HCI) and sensors that mimic animal eyes. Intended for students with interest in algorithmic and technical aspects of imaging and photography. Students taking graduate version complete additional assignments.
R. Raskar

MAS.132 Mathematical Methods in Imaging
Subject meets with MAS.532
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
2-0-7 units

Surveys the landscape of imaging techniques and develops skills for conducting imaging research. Reviews technical and social aspects of the evolving camera culture and considers its role in transforming social interactions, reshaping businesses, and influencing communities worldwide. Explores innovative protocols for sharing and consumption of visual media, as well as novel hardware and software tools based on advanced lenses, digital illumination, modern sensors, and emerging image-analysis algorithms. Students taking graduate version complete additional assignments.
R. Raskar

MAS.377[J] Objectification: How to Write (and Talk, and Think) about Objects
Same subject as 21W.734[J]
Subject meets with MAS.677
Prereq: None
U (Spring)
2-0-7 units. HASS-H; CI-H

Examines stylistic strategies for understanding and discussing technological, artistic, and natural objects. Helps students communicate about these objects in a thoughtful and effective way, and improves their ability to envision new objects. Students analyze and discuss professional writing samples from a wide variety of disciplines, then apply their insight during written and oral exercises, including peer critique. Serves as preparation for professional writing and presentation for specialist, technical and general audiences. Students taking graduate version complete additional assignments. Enrollment limited.
V. M. Bove, Jr., N. Jackson

MAS.453[J] Mobile and Sensor Computing
Same subject as 6.808[J]
Prereq: 6.033 or permission of instructor
U (Spring)
3-0-9 units

See description under subject 6.808[J].
H. Balakrishnan, S. Madden, F. Adib
**MAS.490 Independent Study in Media Arts and Sciences**
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Special projects on group or individual basis. Registration subject to prior arrangement of subject matter and supervision by staff.

**Staff**

**MAS.491 Independent Study in Media Arts and Sciences**
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Special projects on group or individual basis. Registration subject to prior arrangement of subject matter and supervision by staff.

**Staff**

**MAS.UR Undergraduate Research in Media Arts and Sciences**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Individual or group study, research, or laboratory investigations under faculty supervision, including individual participation in an ongoing research project. See UROP coordinator for further information.

*C. Schmandt*

**MAS.URG Undergraduate Research in Media Arts and Sciences**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Individual or group study, research, or laboratory investigations under faculty supervision, including individual participation in an ongoing research project. See UROP coordinator for further information.

*C. Schmandt*

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**Graduate Subjects**

**MAS.531 Computational Camera and Photography**
Subject meets with MAS.131
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

Covers the complete pipeline of computational cameras that attempt to digitally capture the essence of visual information by exploiting the synergistic combination of task-specific optics, illumination, sensors, and processing. Students discuss and use thermal, multispectral, high-speed and 3-D range-sensing cameras, as well as camera arrays. Presents opportunities in scientific and medical imaging, and mobile phone-based photography. Also covers cameras for human computer interaction (HCI) and sensors that mimic animal eyes. Intended for students with interest in algorithmic and technical aspects of imaging and photography. Students taking graduate version complete additional assignments.

*R. Raskar*

**MAS.532 Mathematical Methods in Imaging**
Subject meets with MAS.132
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
2-0-7 units

Surveys the landscape of imaging techniques and develops skills for conducting imaging research. Reviews technical and social aspects of the evolving camera culture and considers its role in transforming social interactions, reshaping businesses, and influencing communities worldwide. Explores innovative protocols for sharing and consumption of visual media, as well as novel hardware and software tools based on advanced lenses, digital illumination, modern sensors, and emerging image-analysis algorithms. Students taking graduate version complete additional assignments.

*R. Raskar*
MAS.533 Imaging Ventures: Cameras, Displays, and Visual Computing
Prereq: Permission of instructor
G (Spring)
2-0-7 units
Project-oriented seminar covers the opportunities and challenges for businesses based on emergent imaging innovations. Students analyze the landscape of imaging developments, plan business strategies and brainstorm towards a start-up, business unit, non-profit or citizen sector organization; they are encouraged to form teams and craft a business plan to gain practical experience in imaging research. Includes case studies of established and emerging businesses, and talks by invited business speakers. Surveys commercialization and the innovation landscape in all imaging arenas. Topics include mobile camera phones, cameras in developing countries, image-search, medical imaging, online photo sharing, and computational photography. Enrollment limited.
R. Raskar

MAS.534[J] Engineering Health: Understanding and Designing Affordable Health Diagnostics
Same subject as HST.928[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
3-1-8 units
Designing and building novel health diagnostics and sensors while learning the fundamentals of rapid prototyping, applied optics, signals processing, imaging and other advanced sensing modalities. Students work in teams with a physician and technical mentor to design and construct a cutting edge health diagnostic or device. The best projects may be continued in the Spring semester through a clinical trials and ventures program reaching early trials by the end of the school year.
R. Raskar

MAS.535[J] Engineering Health: Designing and Deploying Affordable Health Diagnostics and Therapeutics
Same subject as HST.929[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
6-0-0 units
Students design and construct a cutting-edge health diagnostic or device and explore opportunities to test and deploy it. Through structured interactions with physicians, and technical rounds at local hospitals, students incorporate user-centric design into their devices and engage with the health community towards implementation. Provides exposure to clinical trials, the FDA, user experience, intellectual property, and entrepreneurship.
R. Raskar

MAS.552[J] City Science
Same subject as 4.557[J]
Prereq: Permission of instructor
G (Fall, Spring)
Can be repeated for credit.
3-0-9 units
Focuses on architectural and mobility interventions that respond to changing patterns of living, working, and transport. Emphasizes mass-customized housing, autonomous parking, charging infrastructure, and shared-use networks of lightweight electric vehicles (LEVs). Students work in small teams and are lead by researchers from the Changing Places group. Projects focus on the application of these ideas to case study cities and may include travel. Invited guests from academia and industry participate. Repeatable for credit with permission of instructor.
K. Larson, R. Chin

MAS.600 Human 2.0
Prereq: Permission of instructor
G (Spring)
0-9-0 units
Covers principles underlying current and future technologies for cognitive, emotional and physical augmentation. Focuses on using anatomical, biomechanical, neuromechanical, biochemical and neurological models of the human body to guide the designs of augmentation technology for persons with either unusual or normal physiologies that wish to extend their cognitive, emotion, social or physical capability to new levels. Topics include robotic exoskeletons and powered orthoses, external limb prostheses, neural implant technology, social-emotional prostheses, and cognitive prostheses. Requires student presentations, critiques of class readings, and a final project including a publication-quality paper. Enrollment limited.
H. Herr
MAS.622[J] Pattern Recognition and Analysis
Same subject as 1.126[J]
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

Fundamentals of characterizing and recognizing patterns and features of interest in numerical data. Basic tools and theory for signal understanding problems with applications to user modeling, affect recognition, speech recognition and understanding, computer vision, physiological analysis, and more. Decision theory, statistical classification, maximum likelihood and Bayesian estimation, nonparametric methods, unsupervised learning and clustering. Additional topics on machine and human learning from active research. Knowledge of probability theory and linear algebra required. Limited to 20.
R. W. Picard

MAS.630 Advanced Seminar: Affective Computing
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-0-10 units

Instructs students on how to develop technologies that help people measure and communicate emotion, that respectfully read and that intelligently respond to emotion, and have internal mechanisms inspired by the useful roles emotions play. Topics vary from year to year, and may include the interaction of emotion with cognition and perception; the communication of human emotion via face, voice, physiology, and behavior; construction of computers, agents, and robots having skills of emotional intelligence; the role of emotion in decision-making and learning; and affective technologies for education, autism, health, and market research applications. Weekly reading, discussion, and a term project required. Enrollment limited.
R. W. Picard

MAS.664[J] Media Ventures
Same subject as 15.376[J]
Prereq: None
G (Spring)
3-0-6 units
Can be repeated for credit.

Seminar surveys internal and external entrepreneurship, based on Media Lab technologies, to increase understanding of how digital innovations grow into societal change. Cases illustrate examples of both successful and failed businesses, as well as difficulties in deploying and diffusing products. Explores a range of business models and opportunities enabled by emerging Media Lab innovations. Students craft a business analysis for one of the featured technology innovations. Past analyses have become the basis for research publications, and new ventures. Particular focus on big data, mobile, and the use of personal data.
A. Pentland, J. Bonsen

MAS.665[J] Development Ventures
Same subject as 15.375[J], EC.731[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Seminar on founding, financing, and building entrepreneurial ventures in developing nations. Challenges students to craft enduring and economically viable solutions to the problems faced by these countries. Cases illustrate examples of both successful and failed businesses, and the difficulties in deploying and diffusing products and services through entrepreneurial action. Explores a range of established and emerging business models, as well as new business opportunities enabled by innovations emerging from MIT labs and beyond. Students develop a business plan executive summary suitable for submission in the MIT $100K Entrepreneurship Competition’s Accelerate Contest or MIT IDEAS.
J. Bonsen, A. Pentland, C. Breazeal
MAS.677 Objectification: How to Write (and Talk, and Think) about Objects
Subject meets with 21W.734[J], MAS.377[J]
Prereq: None
G (Spring)
2-0-7 units
Examines stylistic strategies for understanding and discussing technological, artistic, and natural objects. Helps students communicate about these objects in a thoughtful and effective way, and improves their ability to envision new objects. Students analyze and discuss professional writing samples from a wide variety of disciplines, then apply their insight during written and oral exercises, including peer critique. Serves as preparation for professional writing and presentation for specialist, technical and general audiences. Students taking graduate version complete additional assignments. Enrollment Limited.
V. M. Bove, Jr., N. Jackson

MAS.690 Independent Study in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Opportunity for independent study under regular supervision by a faculty member. Registration subject to prior arrangement of subject matter and supervision by staff.
Staff

MAS.700 News and Participatory Media
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Studies the news as an engineering challenge in light of recent, rapid, and ongoing changes to the way news is delivered and spread. Considers how we discover what events are taking place in different parts of the world and how we explain the importance of these events to readers or viewers, as well as how readers of a story respond to events. Explores the systems journalists and others have used to report and share the news. Focuses on developing one's own tools and methods to address these challenges through weekly reporting assignments and a final project in which students build tools for journalists (professional and otherwise) to use. Limited to 18.
E. Zuckerman

MAS.712 Learning Creative Learning
Prereq: Permission of instructor
G (Spring; first half of term)
1-0-5 units
Can be repeated for credit.
An introduction to ideas and strategies underlying the design of new learning technologies. Focuses especially on technologies that support interest-driven, project-based, collaborative learning experiences. Students analyze innovative learning technologies, discuss underlying educational ideas, examine design principles, create new prototypes and applications.
M. Resnick

MAS.713 Projects in Creative Learning (New)
Prereq: MAS.712 and permission of instructor
G (Fall; second half of term)
1-0-5 units
Building on concepts covered in MAS.712, students design new tools and activities based on the four P's of creative learning: projects, passion, peer, and play.
M. Resnick

MAS.720[J] Scalable Civic Action (New)
Same subject as 15.234[J]
Prereq: None
G (Fall)
2-1-3 units
See description under subject 15.234[J]. Open to undergraduates with permission of instructor.
S. Johnson, A. Lippman

MAS.750 Human-Robot Interaction
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
2-0-7 units
In-depth exploration of the leading research, design principles, and technical challenges in human-robot interaction (HRI), with an emphasis on socially interactive robots. Topics include mixed-initiative interaction, multi-modal interfaces, face-to-face communication, human-robot teamwork, social learning, aspects of social cognition, and long-term interaction. Applications of these topics to the development of personal robots for health, education, elder care, domestic assistance, and other domains will be surveyed. Requires student presentations, critiques of class readings, student projects, and a final project including a publication quality paper.
C. Breazeal
MAS.756 Principles of Awareness
Prereq: Permission of instructor
G (Spring)
0-9-0 units
Can be repeated for credit.

Experiential exploration of various theories and methodologies around awareness. Students keep an open lab book documenting methods and evaluations, and present their findings and observations regularly during class sessions. In the final project, students evaluate various tools, techniques, and interfaces around awareness targeted towards "performance" and "wellbeing." Addresses themes, such as self vs. other, change, relational awareness, non-duality, and joy and happiness. In-class and virtual meetings consist of practice (ranging from meditation to hacking), lectures, and discussions with invited speakers/experts. Some of the talks will be open to the public. Limited to 20-25.

J. Ito and T. Priyadarshi

MAS.771 Autism Theory and Technology
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
2-0-10 units

Illuminates current theories about autism together with challenges faced by people on the autism spectrum. Theories in communicating, interacting socially, managing cognitive and affective overload, and achieving independent lifestyles are covered. In parallel, the course presents state-of-the-art technologies being developed for helping improve both theoretical understanding and practical outcomes. Participants expected to meet and interact with people on the autism spectrum. Weekly reading, discussion, and a term project required. Enrollment limited.

R. Picard

MAS.784 Data Storytelling Studio
Subject meets with CMS.631, CMS.831
Prereq: None
G (Spring)
3-0-9 units

Explores visualization methodologies to conceive and represent systems and data, e.g., financial, media, economic, political, etc. Covers basic methods for research, cleaning, and analysis of datasets. Introduces creative methods of data presentation and storytelling. Considers the emotional, aesthetic, ethical, and practical effects of different presentation methods as well as how to develop metrics for assessing impact. Work centers on readings, visualization exercises, and a final project. Students taking graduate version complete additional assignments.

R. Bhargava

MAS.790 Independent Study in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.

Opportunity for independent study under regular supervision by a faculty member. Registration subject to prior arrangement of subject matter and supervision by staff.

Staff

MAS.808 Decoders 1.0: Microfabricated Devices
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-6 units
Can be repeated for credit.

Explores various microfabricated device layouts and their impacts on the world through guest lectures. Follows with literature review wherein students compose a summary paper based on representative papers published by the guest lecturers. As a final project, students write and publish on the class website a comprehensive perspective article based on guest lectures. May be repeated for credit with permission of instructor. Limited to 10; preference to Media Arts and Sciences students.

C. Dagdeviren

MAS.809 Decoders 1.3: Introduction to Microfabrication
Prereq: Permission of instructor
G (Fall)
3-6-3 units

Lectures along with cleanroom lab sessions (in Conformable Decoders' YellowBox) provide exposure to cleanroom processes and microfabrication techniques. Builds practical experience with all five components of the microfabrication techniques, including cleaning, deposition, patterning, etching, and testing. Working in small teams, students complete a midterm project in which they create a video of a microfabrication process demonstrated in the cleanroom. As a final project, students identify a problem that would be tackled with a collective device fabricated in the cleanroom in following semester. Students work throughout the term to develop a class booklet of microfabrication terms. Limited to 10 students, no listeners.

C. Dagdeviren
MAS.810 Decoders 1.2: Project Realization in Cleanroom
Prereq: MAS.809 and permission of instructor
G (Spring)
3-6-3 units
Builds on the combination of knowledge and skills learned in D1.1 (MAS.809) to guide students to develop their own mechanically adaptive (i.e., stretchable & flexible) piezoelectric systems and write an article about their research findings that will be published on course website by the end of term. Includes a mid-term project/contest in which students submit an image of a process and/or a device component with an artistic/personal view to illustrate how a personality reflects on projects and, more broadly, changes the society. Students also record short videos throughout the term which result in the final video of the project development. Limited to 10; no listeners.

C. Dagdeviren

MAS.825[J] Musical Aesthetics and Media Technology
Same subject as 21M.580[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-3-6 units
In-depth exploration of contemporary concepts in music and media. Studies recent music that uses advanced technology, and the artistic motivations and concerns implied by the new media. Practical experience with computer music technology, including MIDI and post-MIDI systems. Special emphasis on the interactive systems for professionals as well as amateurs. Midterm paper and term project required.

T. Machover

MAS.826[J] Projects in Media and Music
Same subject as 21M.581[J]
Prereq: MAS.825[J]
G (Spring)
3-3-6 units
Can be repeated for credit.

Current computer music concepts and practice. Project-based work on research or production projects using the Media Lab's computer music, interactive, and media resources. Requires significant studio work and a term project. Projects based on class interests and skills, and may be individually or group-based. May be repeated for credit with permission of instructor.

T. Machover

MAS.834 Tangible Interfaces
Prereq: Permission of instructor
G (Fall)
3-3-6 units
Explores design issues surrounding tangible user interfaces, a new form of human-computer interaction. Tangible user interfaces seek to realize seamless interfaces between humans, digital information, and the physical environment by giving physical form to digital information and computation, making bits directly manipulable with hands and perceptible at the periphery of human awareness. In the design studio environment, students explore experimental tangible interface designs, theories, applications, and underlying technologies, using concept sketches, posters, physical mockups, and working prototypes.

H. Ishii

MAS.836 Sensor Technologies for Interactive Environments
Prereq: Permission of instructor
G (Spring)
3-3-6 units
A broad introduction to a host of sensor technologies, illustrated by applications drawn from human-computer interfaces and ubiquitous computing. After extensively reviewing electronics for sensor signal conditioning, the lectures cover the principles and operation of a variety of sensor architectures and modalities, including pressure, strain, displacement, proximity, thermal, electric and magnetic field, optical, acoustic, RF, inertial, and bioelectric. Simple sensor processing algorithms and wired and wireless network standards are also discussed. Students are required to complete written assignments, a set of laboratories, and a final project.

J. Paradiso

MAS.837 Principles of Electronic Music Interfaces
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Explores the ways in which electronic music is controlled and performed. A solid historical perspective is presented, tracing the development of various families of electronic musical controllers and instruments from their genesis in the late 1800s onwards. Design principles and engineering detail are also given for various current and classic controllers. Evolving issues in the control of computer music for live performance and interactive installations are discussed, including computer mapping of sensor signals and transduced gesture onto sound, music, and other media. Weekly reading assignments are given, and a final project or paper is required.

J. Paradiso
MAS.841 Evolution: Natural and Directed
Prereq: None
G (Spring)
3-0-9 units
Covers topics in molecular evolution, including mutation, recombination, evolvability, sexual reproduction and substitutes, experimental and directed evolution, genomic conflict, and gene drive. Features discussion-based critical analyses of the primary literature. At the end of the term, students prepare short research proposals emphasizing research strategy, experimental design, presentation, and writing. They also write a short grant proposal or manuscript intended for publication.
K. Esvelt

MAS.858 Asking How Space Enabled Designs Advance Justice and Development (New)
Prereq: None
G (Fall)
3-0-9 units
Examines theoretical and practical challenges of applying complex technology, such as space systems, to advance justice and development within human society. Proposes and critiques a concept of justice and development based on attainment of the US Sustainable Development Goals. Analyzes text by historians and economists around global patterns of uneven technology access. Teaches systems engineering tools to analyze the context, stakeholders, functions and forms of complex systems that impact society. Presents six space technologies used for specific Sustainable Development Goal. Students read several text, discuss key themes, write reflective responses, and write a research proposal on a topic of their choice. Part of two-class series on space technology and sustainable development. Limited to 15.
D. Wood

MAS.862 The Physics of Information Technology
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Self-contained introduction to the governing equations for devices that collect, store, manipulate, transmit and present information. Provides an understanding of how operational device principles work, their uses, the limits on their performance, and how they might be improved. Students review the foundations of thermodynamics and noise, electromagnetics, and the quantum description of materials, and then study their application in areas such as semiconductor logic, magnetic storage, wireless and optical communications, and quantum information and computation.
N. Gershenfeld

MAS.863[J] How to Make (Almost) Anything
Same subject as 4.140[J], 6.943[J]
Prereq: Permission of instructor
G (Fall)
3-9-6 units
Provides a practical hands-on introduction to digital fabrication, including CAD/CAM/CAE, NC machining, 3-D printing and scanning, molding and casting, composites, laser and waterjet cutting, PCB design and fabrication; sensors and actuators; mixed-signal instrumentation, embedded processing, and wired and wireless communications. Develops an understanding of these capabilities through projects using them individually and jointly to create functional systems.
N. Gershenfeld, J. DiFrancesco, J. Lavallee, G. Darcey

MAS.864 The Nature of Mathematical Modeling
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Surveys the range of levels of description useful for the mathematical description of real and virtual worlds, including analytical solutions and approximations for difference and differential equations; finite difference, finite element and cellular automata numerical models; and stochastic processes, nonlinear function fitting, constrained optimization, and data-driven inference. Emphasis on efficient practical implementation of these ideas.
N. Gershenfeld

MAS.865 Rapid-Prototyping of Rapid-Prototyping Machines: How to Make Something that Makes (Almost) Anything
Prereq: MAS.863[J]
G (Spring)
Not offered regularly; consult department
3-9-0 units
Studies rapid-prototyping machines and covers the theory and practice of digital fabrication processes. Weekly lectures supported by readings from research literature. Students work on machine development projects throughout the term.
N. Gershenfeld
**MAS.881[J] Principles of Neuroengineering**
Same subject as 9.422[J], 20.452[J]
Subject meets with 20.352
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Covers how to innovate technologies for brain analysis and engineering, for accelerating the basic understanding of the brain, and leading to new therapeutic insight and inventions. Focuses on using physical, chemical and biological principles to understand technology design criteria governing ability to observe and alter brain structure and function. Topics include optogenetics, noninvasive brain imaging and stimulation, nanotechnologies, stem cells and tissue engineering, and advanced molecular and structural imaging technologies. Includes design projects. Designed for students with engineering maturity who are ready for design. Students taking graduate version complete additional assignments. E. S. Boyden, III

**MAS.883[J] Revolutionary Ventures: How to Invent and Deploy Transformative Technologies**
Same subject as 9.455[J], 15.128[J], 20.454[J]
Prereq: Permission of instructor
G (Fall)
2-0-7 units

Seminar on envisioning and building ideas and organizations to accelerate engineering revolutions. Focuses on emerging technology domains, such as neurotechnology, imaging, cryotechnology, gerontechnology, and bio-and-nano fabrication. Draws on historical examples as well as live case studies of existing or emerging organizations, including labs, institutes, startups, and companies. Goals range from accelerating basic science to developing transformative products or therapeutics. Each class is devoted to a specific area, often with invited speakers, exploring issues from the deeply technical through the strategic. Individually or in small groups, students prototype new ventures aimed at inventing and deploying revolutionary technologies. E. Boyden, J. Bonsen, J. Jacobson

**MAS.890 Independent Study in Media Arts and Sciences**
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for independent study under regular supervision by a faculty member. Registration subject to prior arrangement of subject matter and supervision by staff. **Staff**

**MAS.910 Research in Media Technology**
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

For research assistants in Media Arts and Sciences, where the assigned research is approved for academic credit by the department. **Staff**

**MAS.912 Teaching in Media Arts and Sciences**
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Laboratory, tutorial, or classroom teaching under the supervision of a Media Arts and Sciences faculty member. Students selected by interview. Enrollment limited by availability of suitable teaching assignments. **Staff**

**MAS.914 Practical Experience in Media Arts and Sciences**
Prereq: Permission of instructor
G (Fall, Spring, Summer)
0-1-0 units
Can be repeated for credit.

For Media Arts and Sciences masters students participating in curriculum-related off-campus professional internship experiences. Before enrolling, students must have an employment offer from a company or organization and approval from their advisor. Subject to departmental approval. Upon completion of the activity the student must submit a write-up of the experience, approved by the MIT supervisor. Consult the MAS Office for details on procedures and restrictions. **MAS Staff**
MAS.915 Practical Experience in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall, Spring, Summer)
0-1-0 units
Can be repeated for credit.

For Media Arts and Sciences doctoral students participating in curriculum-related off-campus professional internship experiences. Before enrolling, students must have an employment offer from a company or organization and approval from their advisor. Subject to departmental approval. Upon completion of the activity the student must submit a write-up of the experience, approved by the MIT supervisor. Consult the MAS Office for details on procedures and restrictions.

MAS Staff

MAS.921 Proseminar in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Designed specifically for new doctoral students in the Media Arts and Sciences (MAS) program. Explores intellectual foundations of MAS, unifying themes connecting MAS research, and working practices of MAS researchers. Restricted to MAS doctoral students.

D. Roy

MAS.940 Preparation for SM Thesis
Prereq: Permission of instructor
G (Fall, Spring)
2-0-10 units
Can be repeated for credit.


C. Breazeal, C. Schmandt

MAS.945 Media Arts and Sciences General Exam
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-12-0 units
Can be repeated for credit.

Selected readings for Media Arts and Sciences doctoral students in preparation for their qualifying exams.

Staff

MAS.950 Preparation for Ph.D. Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Selects thesis subject, defines method of approach, and prepares preliminary thesis outline. Independent study, supplemented by frequent individual conferences with staff members. Restricted to doctoral candidates.

Staff

MAS.S10 Special Subject in Media Technology
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Supplementary work in areas not covered by the regular curriculum. Registration subject to prior arrangement.

MAS Staff

MAS.S60-MAS.S64 Special Subject in Media Technology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.

Supplementary work in areas not covered by the regular curriculum. Registration subject to prior arrangement.

Staff

MAS.S65-MAS.S69 Special Subject in Media Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Supplementary work in areas not covered by the regular curriculum. Registration subject to prior arrangement.

Staff

MAS.S70 Special Subject in Media Technology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Supplementary work in areas not covered by the regular curriculum. Registration subject to prior arrangement.

Staff
MAS.S71 Special Subject in Media Technology
Prereq: Permission of instructor
G (Fall, Spring; first half of term)
Units arranged
Can be repeated for credit.
Supplementary work in areas not covered by the regular curriculum.
Registration subject to prior arrangement.
Staff

MAS.S72 Special Subject in Media Technology
Prereq: Permission of instructor
G (Fall, Spring; second half of term)
Units arranged
Can be repeated for credit.
Supplementary work in areas not covered by the regular curriculum.
Registration subject to prior arrangement.
Staff

MAS.S73 Special Subject in Media Technology
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Supplementary work in areas not covered by the regular curriculum.
Registration subject to prior arrangement.
Staff

MAS.S74 Special Subject in Media Technology
Prereq: None
G (Fall, Spring; first half of term)
Units arranged
Can be repeated for credit.
Supplementary work in areas not covered by the regular curriculum.
Registration subject to prior arrangement.
Staff

MAS.S75 Special Subject in Media Technology
Prereq: Permission of instructor
G (Fall, Spring; second half of term)
Units arranged
Can be repeated for credit.
Supplementary work in areas not covered by the regular curriculum.
Registration subject to prior arrangement.
Staff

MAS.S76 Special Subject in Media Arts and Sciences (New)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
Supplementary work in areas not covered by the regular curriculum.
Registration subject to prior arrangement.
Staff

MAS.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research and writing of thesis; to be arranged by the student with supervising committee.
Staff
MILITARY SCIENCE (MS)

ROTC subjects do not carry academic credit at MIT, but they can be counted toward the PE requirement. Up to two points per year with a maximum of four points.

Military Science

**MS.101 Introduction to the Army and Critical Thinking**
Prereq: None. Coreq: MS.102
U (Fall, Spring)
1-3-2 units
Introduces students to the personal challenges and competencies that are critical for effective leadership and communication. Explores how the personal development of cultural understanding, goal setting, time management, stress management and comprehensive fitness relate to leadership, officership, and the Army profession.
D. Barrera

**MS.102 Introduction to the Profession of Arms**
Prereq: None. Coreq: MS.101
U (Fall, Spring)
1-3-2 units
Introduces students to the professional challenges and competencies that are needed for effective execution of the profession of arms and Army communication. Explores how Army ethics and values shape the Army and the specific ways they are inculcated into Army culture. Investigates the Army leadership dimensions, attributes, and core competencies and gain practical experience using critical communication skills.
D. Barrera

**MS.110 American Military History**
Prereq: None
U (Fall, Spring)
2-0-4 units
Develops an understanding of the effects the US military and American society have on each other through thematic exploration of American military history in the context of broader US history, and military strategy and global involvement. Through readings, oral and written presentations, and exams, students describe the role of the US military, its evolution, and its impact on society and technology; and critically analyze an armed conflict using the principles of war.
S. McDonough

**MS.201 Leadership and Decision Making**
Prereq: MS.102 or permission of instructor
U (Fall)
2-3-1 units
Familiarizes students with the professional practice of ethics within the Army by exploring Army values and ethics along with the fundamentals of leadership, personal development, and tactics at the small unit level. Explores ethical and tactical decision-making case studies. Students required to demonstrate writing skills and present information briefings as preparation for development in becoming successful future officers.
S. Kirk

**MS.202 Army Doctrine and Team Development**
Prereq: MS.201 or permission of instructor
U (Spring)
2-3-1 units
Students practice and apply fundamentals of Army leadership, officership, Army values and ethics, personal development, and small unit tactics at the squad level. Provides systematic and specific feedback on individual leader attributes, values, and core leader competencies. Students demonstrate writing skills and present information briefings as preparation for development in becoming successful future officers.
S. Kirk

**MS.301 Applied Team Leadership**
Prereq: MS.202 or permission of instructor
U (Fall)
3-6-3 units
Develops student proficiency in planning and executing complex operations, functioning as a leader of small and medium sized teams, assessing operational environments, accepting prudent risk, and leading fellow students. Through assignment to leadership positions in the ROTC Battalion, students are directly responsible for the training, development, and well-being of underclass students assigned to their charge. Students learn how the Army operates and how to integrate the warfighting functions.
J. Swain
**MS.302 Applied Leadership in Small Unit Operations**
Prereq: MS.301 or permission of instructor
U (Spring)
3-6-3 units
Familiarizes students with group dynamics and how personal identity influences leadership. Students explore bases of power, influence tactics, and leadership self-assessments. Through assignment to leadership positions in the ROTC Battalion, students are responsible for the training, development, and well-being of underclass students. Students experiment with counseling, receive peer feedback, and explore elements of the Army Profession. Students build competence with the basics of maneuvering a platoon, the principles of patrolling including raids, recons, and ambushes.

*J. Swain*

**MS.401 Officership: Mission Command and the Army Officer**
Prereq: MS.302
U (Fall)
3-6-3 units
Develops proficiency in planning and executing complex operations, functioning as a member of an organizational staff, assessing risk, making ethical decisions, and leading fellow students. Through assignment to leadership positions in the ROTC Battalion, students plan and lead the execution of labs, directing and controlling the corps of cadets, enhancing their oral and written communications, and improving their application of troop-leading procedures and problem solving.

*D. Stalker*

**MS.402 Officership: Mission Command and Company Grade Leadership**
Prereq: MS.401
U (Spring)
3-6-3 units
Examines the US National Security Structure and how the Army operates as part of the joint force in a whole of government approach. Studies how various operational variables affect military operations. Through assignment to leadership positions, students actively plan and execute training within the program, direct and control an organization, enhance oral and written communications, and apply troop-leading procedures. Students also examine past leaders through a staff ride to the battlefields of Lexington and Concord.

*D. Stalker*
Music

The Music subjects described below are grouped within seven areas: Introductory, Samplings, History/Culture, Composition/Theory, Performance, Advanced/Special Subjects, and Music and Media. Although most students start with introductory subjects, those who have vocal or instrumental training or extensive exposure to music are encouraged to begin at a higher starting level.

Introductory Subjects

21M.011 Introduction to Western Music
Prereq: None
U (Fall, Spring)
4-0-8 units. HASS-A; CI-H
Provides a broad overview of Western music from the Middle Ages to the 21st century, with emphasis on late baroque, classical, romantic, and modernist styles. Designed to enhance the musical experience by developing listening skills and an understanding of diverse forms and genres. Major composers and works placed in social and cultural contexts. Weekly lectures feature demonstrations by professional performers and introduce topics to be discussed in sections. Enrollment limited.
E. Pollock, M. Marks, T. Neff

21M.013[J] The Supernatural in Music, Literature and Culture
Same subject as 21L.013[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A, HASS-H; CI-H
Explores the relationship between music and the supernatural, focusing on the social history and context of supernatural beliefs as reflected in key literary and musical works from 1600 to the present. Provides an understanding of the place of ambiguity and the role of interpretation in culture, science and art. Explores great works of art by Shakespeare, Verdi, Goethe (in translation), Gounod, Henry James and Benjamin Britten. Readings also include selections from the most recent scholarship on magic and the supernatural. Writing assignments range from web-based projects to analytic essays. No previous experience in music is necessary. Projected guest lectures, musical performances, field trips. Limited to 36.
C. Shadle, M. Fuller

21M.030 Introduction to World Music
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A; CI-H
An introduction to diverse musical traditions of the world. Music from a wide range of geographical areas is studied in terms of structure, performance practice, social use, aesthetics, and cross-cultural contact. Includes hands-on music making, live demonstrations by guest artists, and ethnographic research projects. Enrollment limited by lottery.
P. Tang, L. Tilley

21M.051 Fundamentals of Music
Prereq: None
U (Fall, Spring)
3-2-7 units. HASS-A
Introduces students to the rudiments of music through oral, aural, and written practice utilizing rhythm, melody, intervals, scales, chords, and musical notation. Individual skills are addressed through a variety of approaches, including keyboard practice in the required piano labs and sight singing lab. Intended for students with little to no prior experience reading music or performing. Not open to students who have completed 21M.151, 21M.301, or are participating in a performance ensemble where written music is employed. Limited to 20 per section by lottery.
M. Cuthbert

21M.053 Rhythms of the World (New)
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Experiential, fully-embodied exploration into the fundamentals of music through the lens of largely non-Western, aural music cultures. From Bali to Ghana, Cuba to India, Zimbabwe to Andalucía, students think about, talk about, and make music in new ways. Examines some of the basic concepts of music – structure, melody-making, meter, rhythm, movement, etc. – studying their diverse incarnations in different music cultures and encouraging a breadth of perspective and engagement. Introduces students to many different musical practices, engaging with them through active music-making, in-depth discussion, listening and analysis, and creative composition. No musical experience required. Limited to 18.
L. Tilley
21M.065 Introduction to Musical Composition
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 units. HASS-A

Through a progressive series of composition projects, students investigate the sonic organization of musical works and performances, focusing on fundamental questions of unity and variety. Aesthetic issues are considered in the pragmatic context of the instructions that composers provide to achieve a desired musical result, whether these instructions are notated in prose, as graphic images, or in symbolic notation. Weekly listening, reading, and composition assignments draw on a broad range of musical styles and intellectual traditions, from various cultures and historical periods. Basic music reading skills required. Limited to 18.

E. Ziporyn

21M.080 Introduction to Music Technology
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A

Investigates how technology is used in the analysis, modeling, synthesis and composition of music, and its contribution to the artistic production practice. With an eye towards historical context as well as modern usage, topics include the physics of sound, digital representations of music, the Digital Audio Workstation (DAW), analog and digital synthesis techniques, MIDI and sequencing, electronic instrument design, notation software, generative music systems, and computational analysis of music. Weekly assignments focus on both theory and practice, requiring technical proficiency, creative output, and aesthetic consideration. Enrollment limited.

I. Hattwick

Samplings

Students may combine any of the 6-unit subjects listed below for 12 units (one full subject) of credit toward the Humanities, Arts, and Social Sciences (HASS) General Institute Requirement (GIR). Where noted, subjects may be repeated for 12 units of HASS GIR credit. See the HASS Requirement website (https://registrar.mit.edu/registration-academics/academic-requirements/hass-requirement/substitutions-within-hass-requirement) for details.

21M.121 Tuning Systems and Temperament
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring; first half of term)
2-0-4 units

Surveys selected tunings of the scale, including Pythagorean, just intonation, mean-tone, and equal temperaments, as well as non-Western systems and the impact of tunings and temperaments on musical composition and performance. Student projects will be based on live demonstrations as well as reading and listening assignments.

T. Neff

21M.129 Moments in Music: History/Culture
Prereq: Permission of instructor
U (Fall, Spring; first half of term)
2-0-4 units
Can be repeated for credit.

Examines a particular moment in music history, an era, style, or even the composition of a major work through analysis and cultural context. Goes into further depth on a particular topic than would be possible in a longer survey. Periods and topics vary. Examples include minimalism, The Beatles, A Cappella, or The Lion King. May be repeated once for credit if content differs. Enrollment limited.

M. Marks, T. Neff

21M.139 Moments in Music: Composition
Prereq: Permission of instructor
U (Fall, Spring; first half of term)
2-0-4 units
Can be repeated for credit.

Practice in a particular compositional technique not normally covered in the Harmony and Counterpoint or Musical Composition sequences. Possible topics include Renaissance counterpoint, fugue, ragtime, or indeterminacy. May be repeated once for credit if content differs. Enrollment limited.

C. Shadle
**21M.151 Introductory Music Theory (New)**
Prereq: Permission of instructor
U (Spring; second half of term)
1-1-4 units

Introduction to theoretical elements of music for students who need preparation in the fundamentals of music theory prior to taking 21M.301. Requires ability to read notation in at least one clef. Covers many of the same topics as 21M.051 but at a faster pace. Coverage includes intervals, triads, major and minor keys, basic musical analysis over a variety of idioms in Western music. Also emphasizes developing the ear, voice, and keyboard skills. Ability to read music required. Not open to students who have completed 21M.051, 21M.301 or 21M.302. Limited to 20 per section by lottery. 
*Staff*

**21M.159 Moments in Music: Theory and Analysis**
Prereq: Permission of instructor
U (Fall; second half of term)
2-0-4 units
Can be repeated for credit.

Specific musical compositions or topics in music theory will provide the basis for analysis and close reading. Topics vary. Examples include a Bach Cantata, a Beethoven Quartet, Pierrot Lunaire, or cross-cultural musical analysis. May be repeated once for credit if content differs. Enrollment limited.
*Staff*

**History/Culture**

**21M.215 Music of the Americas**
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A

A survey of the music of North and South America from the Renaissance to the present, with emphasis on the cross-fertilizations of indigenous and European traditions. Listening assignments will focus on composers as varied as Copland and Still, Revueltas and Chihara.
*C. Shadle*

**21M.220 Medieval and Renaissance Music**
Prereq: None. Coreq: 21M.301
U (Spring)
3-0-9 units. HASS-A

Examines European music from the early Middle Ages until the end of the Renaissance. Includes a chronological survey and intensive study of three topics: chant and its development, music in Italy 1340-1420, and music in Elizabethan England. Focuses on methods and pitfalls in studying music of the distant past. Students' papers, problem sets, and presentations explore lives, genres, and works in depth. Works studied in facsimile of original notation, and from original manuscripts at MIT, where possible.
*M. Cuthbert*

**21M.223[J] Folk Music of the British Isles and North America**
Same subject as 21L.023[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-1-8 units. HASS-A; CI-H

Examines the production, transmission, preservation and the qualities of folk music in the British Isles and North America from the 18th century to the folk revival of the 1960s and the present. Special emphasis on balladry, fiddle styles, and African-American influences. Enrollment limited.
*R. Perry, W. Donaldson*

**21M.226 Jazz**
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A

Historical survey from roots in African and American contexts, including spirituals, blues, and ragtime, through early jazz, Swing, bebop, and post-bop movements, with attention to recent developments. Key jazz styles, the relation of music and society, and major figures such as Armstrong, Ellington, Basie, Goodman, Parker, Monk, Mingus, Coltrane, and others are considered. Some investigation of cross-influences with popular, classical, folk, and rock musics. Enrollment may be limited.
*M. Harvey*
21M.235 Baroque and Classical Music
Prereq: 21M.301 or permission of instructor
U (Fall)
3-0-9 units. HASS-A

Surveys Baroque and Classical genres: opera, cantata, oratorio, sonata, concerto, quartet and symphony. Includes the composers Monteverdi, Schutz, Purcell, Vivaldi, Bach, Handel, Haydn and Mozart. Bases written essays, projects, and oral presentations on live performances as well as listening and reading assignments. Basic music score-reading ability required.

T. Neff

21M.250 Nineteenth-Century Music
Prereq: 21M.301 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A

Surveys Romantic genres including Lied/song, choral music, opera, piano sonata/character cycle, concerto, and symphony/symphonic poem. Includes the composers Beethoven, Schubert, Berlioz, Chopin, Brahms, Wagner, Verdi, Tchaikovsky, and Mahler. Bases written essays and oral presentations on live performances as well as listening and reading assignments. Basic score-reading ability recommended.

T. Neff

21M.260 Music since 1900
Prereq: 21M.301 or permission of instructor
U (Spring)
3-0-9 units. HASS-A

Surveys musical works drawn from many genres, representing stylistic movements that have transformed classical music over the past hundred years. Focal topics include musical modernism, serialism, neoclassicism, nationalism and ideology, minimalism, and aleatoric and noise composition experiments. Discusses electronic and computer music, and new media and the postmodern present. Begins with Stravinsky’s early ballets and ends with music by current MIT composers and other important figures active today. Ability to read music required. Instruction and practice in oral and written communication provided.

M. Marks

21M.269 Studies in Western Music History
Prereq: 21M.301 or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-A
Can be repeated for credit.

Explores particular questions or repertories in Western classical music. Requires individual participation, presentations, and writing. Topics vary each year. Examples include women in music, musical borrowing, the Ars Nova, Schumann, or music after 1990. May be repeated for credit with permission of instructor.

Staff

21M.271 Symphony and Concerto
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A

Explores the style, form, and history of approximately two dozen pieces of canonical symphonic repertoire. Students write short reviews of musicological articles on the rich cultural history of selected works and complete one project about the state of classical music in contemporary society. Basic score-reading ability required.

E. Pollock

21M.273 Opera
Prereq: None
U (Fall)
3-0-9 units. HASS-A

Focuses on the different styles and dramatic approaches exhibited by a range of operas. Central questions include the process of adaptation from source material, the conventions of different operatic eras, and how the works are staged in contrasting productions. Basic score-reading ability required.

E. Pollock
**21M.283 Musicals**
Prereq: One subject in film, music, or theater or permission of instructor
U (Spring)
3-0-9 units. HASS-A

Covers Broadway works and Hollywood films in depth. Proceeds chronologically, exploring three stage musicals and three films at a time, within four historical categories: breakthrough musicals of the 1920s and '30s; classic "book musicals" of the '40s and '50s; modernist and concept musicals of the '60s and '70s; and post modern and cutting-edge works of the '80s and '90s. Attention given to the role of music in relation to script, characterization, and dramatic structure. Final papers involve comparison of one stage and one film work, selected in consultation with the instructor. Oral presentations required and in-class performances encouraged.
*M. Marks*

**21M.284 Film Music**
Subject meets with CMS.925
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A

Surveys styles and dramatic functions of music for silent films of the 1910s-20s, and music in sound films from the 1930s to the present. Close attention given to landmark scores by American and European composers, including Korngold, Steiner, Rozsa, Prokofiev, Copland, Herrmann, Rota, Morricone, and Williams. Subsidiary topics include new trends in contemporary film-scoring, pop scores, the impact of electronics, and specialized genres (e.g., animation). Students taking the graduate version complete different assignments. Some background in the study of film and/or music is expected.
*M. Marks*

**21M.289 Studies in Western Classical Genres**
Prereq: 21M.301 or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-A

Can be repeated for credit.

Explores topics concerned with specific types of classical music, such as repertories for instrumental soloists and/or small ensembles, orchestral works, solo songs, choral works, or compositions for theater, film, or new media. Topics vary and may require additional prerequisites or specialized skills such as score-reading or playing an instrument. Examples include the English madrigal, Baroque chamber music, Beethoven's symphonies, French art song, Wagner's 'Ring' cycle, American choral music, Stravinsky's theater works, and the Hollywood film score. May be repeated for credit with permission of instructor.
*Staff*

**21M.291 Music of India**
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A

Focuses on Hindustani classical music of North India, and also involves learning about the ancient foundations of the rich classical traditions of music and dance of all Indian art and culture. Practice of the ragas and talas through the learning of songs, dance, and drumming compositions. Develops insights through listening, readings, and concert attendance.
*G. Ruckert*

**21M.292 Music of Indonesia**
Prereq: None
U (Fall)
3-0-9 units. HASS-A

Provides an introduction to the fascinating, intricate music of Indonesia with a special focus on Bali. Students explore diverse musical traditions, engaging deeply with musical structures and techniques through analysis, composition, and extensive hands-on music-making. They also study the music’s cultural, political, and historical significance through listening, reading, class discussion, and creative, open-ended projects. Limited to 15.
*L. Tilley*
21M.293 Music of Africa
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Studies musical traditions of sub-Saharan Africa, with focus on West Africa. Explores a variety of musical practices and their cultural contexts through listening, reading and writing assignments with an emphasis on class discussion. Includes in-class instruction in drumming, song and dance of Senegal, Ghana, and South Africa, as well as live lecture-demonstrations by guest performers from throughout sub-Saharan Africa. Limited to 15; preference to majors, minors, concentrators. Admittance may be controlled by lottery.

P. Tang

21M.294 Popular Musics of the World
Prereq: None
U (Spring)
3-0-9 units. HASS-A
Focuses on popular music created for and transmitted by mass media. Studies various popular music genres from around the world through listening and reading assignments, while considering issues of musical change, syncretism, Westernization, globalization, the impact of recording industries, and the post-colonial era. Case studies include bhangra, Afro-pop, reggae, and global hip-hop. Limited to 25; preference to majors, minors, concentrators. Admittance may be controlled by lottery.

P. Tang

21M.295 American Popular Music
Prereq: None
U (Spring)
3-0-9 units. HASS-A
Surveys the development of popular music in the US, and in a cross-cultural milieu, relative to the history and sociology of the last two hundred years. Examines the ethnic mixture that characterizes modern music, and how it reflects many rich traditions and styles (minstrelsy, music-hall, operetta, Tin Pan Alley, blues, rock, electronic media, etc.). Provides a background for understanding the musical vocabulary of current popular music styles. Limited to 20.

W. Marshall

21M.296 Studies in Jazz and Popular Music
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Can be repeated for credit.
Studies of selected topics in popular music and/or jazz. Topics vary. Examples include Duke Ellington, The Beatles, Bob Dylan, and the 1980s. May be repeated for credit with permission of instructor.

T. Neff

21M.299 Studies in World Music
Prereq: 21M.030 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A
Can be repeated for credit.
Studies of selected topics in ethnomusicology (the study of music in culture). Topics vary. Examples include the social lives of musical instruments, music and storytelling, fieldwork methodologies, music and politics, and rhythms of the world. May be repeated for credit with permission of instructor.

Staff

Composition/Theory

21M.301 Harmony and Counterpoint I
Prereq: None
U (Fall, Spring)
3-3-6 units. HASS-A
Covers basic writing skills in music of the common-practice period (Bach to Brahms). Regular written assignments lead to the composition of short pieces. Classwork includes analysis of representative works from the literature. Keyboard laboratory and sight-singing choir in addition to regular class meetings. Students should have experience reading music. Limited to 20 per section.

C. Shadle

21M.302 Harmony and Counterpoint II
Prereq: 21M.301 or permission of instructor
U (Fall, Spring)
3-2-7 units. HASS-A
A continuation of 21M.301, including chromatic harmony and modulation, a more extensive composition project, keyboard laboratory, and musicianship laboratory. Limited to 20 per section.

C. Shadle
21M.303 Writing in Tonal Forms I
Prereq: 21M.302
U (Fall, Spring)
3-1-8 units. HASS-A

Written and analytic exercises based on 18th- and 19th-century small forms and harmonic practice found in music such as the chorale preludes of Bach; minuets and trios of Haydn, Mozart, and Beethoven; and the songs and character pieces of Schubert and Schumann. Musicianship laboratory is required. Limited to 20 per section.
C. Shadle

21M.304 Writing in Tonal Forms II
Prereq: 21M.303
U (Spring)
3-1-8 units. HASS-A

Further written and analytic exercises in tonal music, focusing on larger or more challenging forms. For example, students might compose a sonata-form movement for piano or a two-part invention in the style of Bach. Students have opportunities to write short works that experiment with the expanded tonal techniques of the late 19th and early 20th centuries. Musicianship laboratory is required. Limited to 20.
C. Shadle

21M.310 Techniques of 20th-Century Composition
Prereq: 21M.302 or permission of instructor
U (Fall)
3-0-9 units. HASS-A

Students complete written and analytical exercises based on compositional forms and practices from the first half of the 20th century. Areas covered include compositions based upon artificial scales and modes, as in Debussy, Bartok, and Stravinsky; compositions based on atonal pitch organizations, as with Schoenberg and Webern; compositions based on rhythmic process, timbral exploration, and/or non-Western influences. Basic instrumentation will be taught, and compositions will be performed in class.
C. Shadle

21M.340 Jazz Harmony and Arranging
Prereq: 21M.301, 21M.226, or permission of instructor
U (Fall, Spring)
3-0-9 units. HASS-A

Basic harmony and theory of mainstream jazz and blues; includes required listening in jazz, writing and analysis work, and two full-scale arrangements. Serves as preparation for more advanced work in jazz with application to rock and pop music. Performance of student arrangements. Limited to 15.
M. Harvey

21M.341 Jazz Composition
Prereq: 21M.226, 21M.340, or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A

Jazz writing using tonal, modal, and extended compositional approaches as applied to the blues, the 32-bar song form, and post-bop structural designs. Consideration given to a variety of styles and to the ways improvisation informs the compositional process. Study of works by Ellington, Mingus, Parker, Russell, Golson, Coleman, Coltrane, Hancock, Tyner, Davis, and others. Performance of student compositions. Limited to 15.
M. Harvey

21M.342 Composing for Jazz Orchestra
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A

Explores composition and arrangement for the large jazz ensembles from 1920s foundations to current postmodern practice. Consideration given to a variety of styles and to the interaction of improvisation and composition. Study of works by Basie, Ellington, Evans, Gillespie, Golson, Mingus, Morris, Nelson, Williams, and others. Open rehearsals, workshops, and performances of student compositions by the MIT Festival Jazz Ensemble and the Aardvark Jazz Orchestra. Limited to 15.
M. Harvey
**21M.351 Music Composition**
Subject meets with 21M.505
Prereq: 21M.304, 21M.310, or permission of instructor
U (Spring)
3-0-9 units. HASS-A
Can be repeated for credit.

Directed composition of original writing involving voices and/or instruments. Includes a weekly seminar in composition for the presentation and discussion of work in progress. Students are expected to produce at least one substantive work and perform it in public by the end of the term. Contemporary compositions and major works from 20th-century music literature are studied. Students taking the graduate version complete different assignments.

*K. Makan*

**21M.355 Musical Improvisation**
Prereq: Permission of instructor
U (Spring)
3-0-9 units. HASS-A

Students study concepts and practice techniques of improvisation in solo and ensemble contexts. Examines relationships between improvisation, composition, and performance based in traditional and experimental approaches. Topics, with occasional guest lectures, may include jazz, non-western music, and western concert music, as well as improvisation with film, spoken word, theater, and dance. Enrollment limited to 15; open by audition to instrumental or vocal performers.

*M. Harvey*

**21M.359 Studies in Musical Composition, Theory and Analysis**
Prereq: 21M.051 or permission of instructor
U (Fall)
3-0-9 units. HASS-A
Can be repeated for credit.

Explores techniques associated with musical composition and/or analysis. Written exercises in the form of music (composition) and/or prose (papers) may be required, depending on the topic. Topics vary each year; examples include fugue, contemporary aesthetics of composition, orchestration, music analysis, or music and mathematics. May be repeated for credit with permission of instructor. Limited to 18.

*W. Cutter*

**21M.361 Electronic Music Composition I**
Prereq: None
U (Fall, Spring)
2-1-9 units. HASS-A

Students develop basic skills in composition through weekly assignments focusing on sampling and audio processing. Source materials include samples of urban/natural environments, electronically generated sounds, inherent studio/recording noise, and pre-existing recordings. Audio processing includes digital signal processing (DSP) and analog devices. Covers compositional techniques, including mixing, algorithms, studio improvisation, and interaction. Students critique each other's work and give informal presentations on recordings drawn from sound art, experimental electronica, conventional and non-conventional classical electronic works, and popular music. Covers technology, math, and acoustics in varying detail. Limited to 12 per section; preference to Music majors, minors, and concentrators.

*P. Whincop*

**21M.362 Electronic Music Composition II**
Prereq: 21M.361 or permission of instructor
U (Spring)
2-2-8 units. HASS-A

Explores sophisticated synthesis techniques, from finely tuned additive to noise filtering and distortion, granular synthesis to vintage emulation. Incorporates production techniques and use of multimedia, with guest lecturers/performers. Considers composing environments such as Max/MSP/Jitter, SPEAR, SoundHack, and Mathematica. Assignments include diverse listening sessions, followed by oral or written presentations, weekly sound studies, critiques, and modular compositions/soundscapes. Prior significant computer music experience preferred. Consult instructor for technical requirements. Limited to 10.

*P. Whincop*
21M.370 Digital Instrument Design (New)
Prereq: None
U (Spring)
3-6-3 units. HASS-A

Covers aesthetic and technical challenges in the creation of physical interfaces for musical performance. Will engage in the design and creation of musical interfaces, and learn how to incorporate new technologies in their artistic practice. Topics covered include user experience design for artistic performance, musical human-computer interaction (HCI), hardware and software standards for digital musical systems, embedded programming and sound synthesis, analog and digital sensors, rapid prototyping and digital manufacturing, and creating performance practices around custom hardware. Students design and build their own digital musical instrument, and present a performance with the instrument as their final project. Limited to 18.

I. Hattwick

21M.380 Music and Technology
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 units. HASS-A
Can be repeated for credit.

Explores various technologies in relation to musical analysis, composition, performance, culture, and quantitative methods. Topics vary each term and may include development and impact on society, generative and algorithmic music, recording techniques or procedural sound design. May involve hands-on components such as laptop music ensemble, new instrument building, or comparing the theory and practice of audio recording. Limited to 16.

M. Schumaker

21M.383 Computational Music Theory and Analysis (New)
Prereq: 6.009 and 21M.301
U (Spring)
3-0-9 units. HASS-A

Covers major approaches to computational music theory and musicology in the symbolic (score-based) domain. Covers corpus studies, algorithms for music theory, musical search and similarity, encoding, feature extraction and machine learning, music generation, and computational music perception. Programming assignments given in Python using the MIT-created music21 toolkit. Culminates in an original final project. Enrollment limited.

M. Cuthbert

21M.385[J] Interactive Music Systems
Same subject as 6.809[J]
Prereq: (6.009 and 21M.301) or permission of instructor
U (Fall, Spring)
3-0-9 units. HASS-A

Explores audio synthesis, musical structure, human computer interaction (HCI), and visual presentation for the creation of interactive musical experiences. Topics include audio synthesis; mixing and looping; MIDI sequencing; generative composition; motion sensors; music games; and graphics for UI, visualization, and aesthetics. Includes weekly programming assignments in python. Teams build an original, dynamic, and engaging interactive music system for their final project. Limited to 18.

E. Egozy, L. Kaelbling

21M.387 Fundamentals of Music Processing
Prereq: 6.003, 6.01, and 21M.051
U (Fall)
3-0-9 units. HASS-A

Analyzes recorded music in digital audio form using advanced signal processing and optimization techniques to understand higher-level musical meaning. Covers fundamental tools like windowing, feature extraction, discrete and short-time Fourier transforms, chromagrams, and onset detection. Addresses analysis methods including dynamic time warping, dynamic programming, self-similarity matrices, and matrix factorization. Explores a variety of applications, such as event classification, audio alignment, chord recognition, structural analysis, tempo and beat tracking, content-based audio retrieval, and audio decomposition. Enrollment limited.

E. Egozy

Performance
Students may combine or repeat any of the 6-unit subjects listed below for 12 units (one full subject) of credit toward the Humanities, Arts, and Social Sciences (HASS) General Institute Requirement (GIR). See the HASS Requirement website (https://registrar.mit.edu/registration-academics/academic-requirements/hass-requirement/substitutions-within-hass-requirement) for details.

21M.401 MIT Concert Choir
Prereq: None
U (Fall, Spring)
0-4-2 units
Can be repeated for credit.

Rehearsals and performance of primarily large-scale works for chorus, soloists, and orchestra—from the Passions and Masses of J. S. Bach to oratorios of our own time. Open to graduate and undergraduate students by audition.

W. Cutter
21M.405 MIT Chamber Chorus
Prereq: None
U (Fall, Spring)
3.0-3 units
Can be repeated for credit.
Rehearsal and performance of choral repertoire for small chorus, involving literature from the Renaissance to contemporary periods. Limited to 32 by audition.
W. Cutter

21M.410 Vocal Repertoire and Performance
Subject meets with 21M.515
Prereq: None. Coreq: Participation in ensemble for vocalists
U (Spring)
3.0-3 units
Can be repeated for credit.
For the singer and/or pianist interested in collaborative study of solo vocal performance. Historical study of the repertoire includes listening assignments of representative French, German, Italian, and English works as sung by noted vocal artists of the genre. Topics include diction as facilitated by the study of the International Phonetic Alphabet; performance and audition techniques; and study of body awareness and alignment through the Alexander Technique and yoga. Admission by audition; Emerson Vocal Scholars contact department.
A. Boyles

21M.421 MIT Symphony
Prereq: None
U (Fall, Spring)
0-4.2 units
Can be repeated for credit.
Rehearsals prepare works for concerts and recordings. Analyses of musical style, structure, and performance practice are integrated into rehearsals as a means of enriching musical conception and the approach to performance. Likewise, additional scores of particular structural or stylistic interest are read whenever time permits. Admission by audition.
A. Boyles

21M.423 Conducting and Score-Reading
Prereq: 21M.302 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3.0-3 units
Can be repeated for credit.
Introduces ensemble conducting as a technical and artistic discipline. Incorporates ear training, score-reading skills and analysis, rehearsal technique, and studies of various philosophies. Attendance of rehearsals and specific concerts required. Opportunities include conducting students, professional musicians, and MIT Symphony Orchestra (when possible). Instrumental proficiency required, although vocalists with keyboard abilities will be accepted. May be repeated once for credit with permission of instructor.
A. Boyles

21M.426 MIT Wind Ensemble
Prereq: None
U (Fall, Spring)
0-4.2 units
Can be repeated for credit.
Designed for advanced instrumentalists who are committed to the analysis, performance, and recording of woodwind, brass, and percussion literature from the Renaissance through the 21st century. The repertoire consists primarily of music for small and large wind ensembles. May include ensemble music from Gabrieli to Grainger, Schuller, Mozart, Dvorak, and various mixed media including strings. Performance of newly commissioned works. Opportunities for solo work and work with recognized professional artists and composers. Admission by audition.
F. Harris

21M.442 MIT Festival Jazz Ensemble
Prereq: None
U (Fall, Spring)
0-4.2 units
Can be repeated for credit.
Designed for instrumentalists dedicated to the analysis, performance, and recording of traditional and contemporary jazz ensemble compositions. Instrumentation includes saxophones, trumpets, trombones, piano, guitar or vibraphone, bass, percussion and occasionally french horn, double reeds, and strings. Provides opportunities to work with professional jazz artists and perform commissioned works by recognized jazz composers. Experience in improvisation preferred but not required. Admission by audition.
F. Harris
21M.445 Chamber Music Society
Prereq: None
U (Fall, Spring)
0–4–2 units
Can be repeated for credit.

Study of chamber music literature through analysis, rehearsal, and performance. Weekly seminars and coaching. Open to string, piano, brass, woodwind players, and singers. Admission by audition.

M. Thompson, D. Deveau, J. Rife

21M.450 MIT Balinese Gamelan
Prereq: Permission of instructor
U (Spring)
0–3–3 units
Can be repeated for credit.

A performing ensemble dedicated to the traditional music of Bali. Members of the ensemble study structures and techniques used on various Balinese gamelan instruments and learn to perform gamelan pieces. No previous experience required. Limited to 25 by audition.

Fall: Consult N. Paschal. Spring: Sta

21M.451 Studio Accompanying for Pianists
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Open by audition to pianists who wish to explore and develop their talents as accompanists. Pianists are paired with a music scholarship recipient and attend that student’s private lesson each week. Accompanists prepare independently, rehearse with the student partner, and provide accompaniment at a juried recital or masterclass each term. Under supervision of music faculty and private lesson instructors, pianists may work with one or two scholarship students each term at 3 units each or one student in 21M.480/21M.512 for 6 units. Subject satisfies the performance requirement for pianists receiving music scholarships.

D. Deveau

21M.460 MIT Senegalese Drum Ensemble
Prereq: None
U (Fall, Spring)
0–3–3 units
Can be repeated for credit.

A performance ensemble focusing on the sabar drumming tradition of Senegal, West Africa. Study and rehearse Senegalese drumming techniques and spoken word. Perform in conjunction with MIT Rambax drumming group. No previous experience necessary, but prior enrollment in 21M.030 or 21M.293 strongly recommended. Limited to 30 by audition.

L. Toure

21M.470 MIT Laptop Ensemble (New)
Prereq: None
U (Fall, Spring)
3–0–3 units
Can be repeated for credit.

The MIT Laptop Ensemble is a forum for the exploration of emerging digital musical practices, giving ensemble members hands-on experience with compositional and performance strategies based on current research. Concerts by the ensemble include repertoire drawn both from historical electronic and computer music compositions, as well as new compositions by invited composers. Also includes opportunities for ensemble members to compose for and conduct the ensemble. Weekly rehearsals focus on concepts drawn from a variety of 20th- and 21st-century practices, including experimental and improvised music, telematic performance, gestural controllers, multimedia performance, live coding, and interactive music systems. No previous experience required. Admission by audition.

I. Hattwick

21M.480 Advanced Music Performance
Subject meets with 21M.512
Prereq: None
U (Fall, Spring)
1–2–3 units
Can be repeated for credit.

Designed for students who demonstrate considerable technical and musical skills and who wish to develop them through intensive private study. Students must take a weekly lesson, attend a regular performance seminar, and participate in a departmental performing group. Full-year commitment required. Information about lesson fees, scholarships, and auditions available in Music Section Office. Students taking the graduate version complete different assignments. Admission by audition.

M. Thompson, D. Deveau
21M.490 Emerson Scholar Solo Recital
Subject meets with 21M.525
Prereq: Permission of instructor
U (Spring)
1-0-5 units
Can be repeated for credit.

Solo 50-minute recital prepared with a private teacher and approved by the Emerson Private Studies Committee based on evidence of readiness shown in the Fall Term performances. See Music and Theater Arts website for application deadlines and conditions. Restricted to Emerson Scholars.
M. Thompson, D. Deveau, J. Rife

Advanced/Special Subjects

21M.500 Advanced Seminar in Music
Prereq: Permission of instructor
U (Fall)
3-0-9 units. HASS-A
Can be repeated for credit.

Seminar that develops analytic and research skills in music history/culture or theory/composition. Topics vary, but are organized around a particular methodology, musical topic, or collection of works, that allow for application to a variety of interests and genres. Strong emphasis on student presentations, discussion, and a substantial writing project. May be repeated for credit with permission from instructor.
E. Richmond Pollock

21M.505 Music Composition
Subject meets with 21M.351
Prereq: 21M.304, 21M.310, or permission of instructor
G (Spring)
3-0-9 units
Can be repeated for credit.

Directed composition of original writing involving voices and/or instruments. Includes a weekly seminar in composition for the presentation and discussion of work in progress. Students are expected to produce at least one substantive work and perform it in public by the end of the term. Contemporary compositions and major works from 20th-century music literature are studied. Students taking the graduate version complete different assignments.
K. Makan

21M.512 Advanced Music Performance
Subject meets with 21M.480
Prereq: None
G (Fall, Spring)
1-2-3 units
Can be repeated for credit.

Designed for students who demonstrate considerable technical and musical skills and who wish to develop them through intensive private study. Students must take a weekly lesson, attend a regular performance seminar, and participate in a departmental performing group. Full-year commitment required. Information about lesson fees, scholarships, and auditions available in Music Section Office. Students taking the graduate version complete different assignments. Admission by audition.
D. Deveau, M. Thompson

21M.515 Vocal Repertoire and Performance
Subject meets with 21M.410
Prereq: None
G (Spring)
3-0-3 units
Can be repeated for credit.

For the singer and/or pianist interested in collaborative study of solo vocal performance. Historical study of the repertoire includes listening assignments of representative French, German, Italian, and English works as sung by noted vocal artists of the genre. Topics include diction as facilitated by the study of the International Phonetic Alphabet; performance and audition techniques; and study of body awareness and alignment through the Alexander Technique and yoga. Admission by audition. Emerson Vocal Scholars contact department.
A. Boyles

21M.525 Emerson Scholars Solo Recital
Subject meets with 21M.490
Prereq: None
G (Spring)
1-2-3 units
Can be repeated for credit.

Emerson Scholars may receive credit for a solo spring recital that has been prepared with and approved by the private teacher and the Emerson Private Studies Committee. Approval based on evidence of readiness shown in first term master classes. Restricted to Emerson Scholars.
M. Thompson, D. Deveau
21M.531 Independent Study in Music
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Open to qualified students who wish to pursue independent studies or projects with members of the Music Section. Projects require prior approval by the Music and Theater Arts Chair.
Consult Music Section Office

21M.533 Independent Study in Music
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Open to qualified students who wish to pursue independent studies or projects with members of the Music Section. Projects require prior approval by the Music and Theater Arts Chair.
Consult Music Section Office

21M.553, 21M.554 Special Subject in Music
Prereq: Permission of instructor
U (Fall, IAP)
Units arranged
Can be repeated for credit.
Study of musical topics not covered in the regular subject listings, particularly experimental subjects offered by permanent or visiting faculty.
Consult Music Office

Music and Media

21M.580(J] Musical Aesthetics and Media Technology
Same subject as MAS.825[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-3-6 units
See description under subject MAS.825[J].
T. Machover

21M.581[J] Projects in Media and Music
Same subject as MAS.826[J]
Prereq: MAS.825[J]
G (Spring)
3-3-6 units
Can be repeated for credit.
See description under subject MAS.826[J].
T. Machover

Theater Arts

The subjects listed below are arranged in three sections: Introductory, Intermediate, and Advanced Subjects.

Introductory Subjects

21M.600 Introduction to Acting
Prereq: None
U (Fall, Spring)
4-0-5 units. HASS-A
Explores the actor's tools: body, voice, mind, imagination, and the essential self. Through studio exercises, students address issues of honesty and creativity in the theatrical moment, and begin to have a sense of their strengths and limitations as communicating theatrical artists. Provides an opportunity for students to discover their relationship to "the other" in the acting partner, the group, the environment, and the audience. Limited to 20 per section.
A. Kohler

21M.601 Drawing for Designers
Prereq: None
U (Fall, Spring)
3-0-6 units. HASS-A
Explores drawing as a fundamental component of the design process. In-class drawing exercises focus on developing the hand-to-eye relationship and pre-visualization skills essential to any designer. Studies the use drawing as a route to understanding space and form and achieving accuracy through expression. By drawing figures, landscapes and/or still life compositions in a variety of media, students investigate the figure/ground relationship while dealing with tone, line, and composition, which are all requisite elements of design. Provides exposure to designers who have used drawing as a central component of their work. Students create a portfolio that includes in-class drawings, studies done outside of class, and one research-based written project. Lab fee required.
Limited to 20.
S. Brown
**21M.603 Introduction to Design for the Theater**
Prereq: None
U (Fall)
3-0-9 units. HASS-A

Introduces the fundamental skills and concepts of scenography through a series of individual design projects structured to explore the relationship of the performer to the environment, the interrelation of lighting and stage design, and the evolution of visual narrative. Develops a basic visual literacy for the theater by honing skills in drawing, model building, 3-D modeling, digital image manipulation, and color theory. Projects complimented by study of artworks and theories by Cindy Sherman, Sol LeWitt, Alan Kaprow, Robert Wilson, Bertolt Brecht, Caspar Neher, and others. Lab fee required. Enrollment may be limited.

*S. Brown*

**21M.604[J] Playwriting Fundamentals**
Same subject as 21W.754[J]
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A

Introduces the craft of writing for the theater, with special attention to the basics of dramatic structure. Through weekly assignments and in-class exercises, students explore character, conflict, language and plasticity in scenes and short plays. In workshop format, students present individual work for feedback and heavily revise their work based on that response. Readings include a variety of plays.

*K. Urban*

**21M.605 Voice and Speech for the Actor**
Prereq: None
U (Fall, Spring)
4-0-5 units. HASS-A
Can be repeated for credit.

Concentrates upon freeing the natural voice through awareness of physical, vocal and, at times, emotional habits and the willingness and desire to experience change. Teaches progression of contemporary approaches to voice through in-class vocal exercises. Students use sonnets or poems as vehicles to explore the components of language and the need to communicate and reveal oneself through the voice. Designed for students interested in theater or developing their voices for presentations and professional speaking. Limited to 18; preference to Theater majors, minors, and concentrators who have pre-registered.

*K. Eastley, O. D'Ambrosio*

**21M.606 Introduction to Stagecraft**
Prereq: None
U (Fall, Spring)
4-3-2 units. HASS-A

Provides a foundation in theater technology, examining the creation of a theatrical production from conception to performance. Explores the realization of an artistic and structural vision for a play, taking into account all facets of technical theater: history of productions, types of technical roles, design, drafting, carpentry, costume, lighting, rigging, stage management, sound, and video. Students serve on the production team responsible for building, installing and/or running the department’s show that semester. Limited to 18.

*S. Rodemann*

**21M.607 Playwriting Methods (New)**
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A

Builds understanding of the methods playwrights use to transform an idea - drawn from their own lives, news and current events, even the plays of other writers - into a reality. Students use a variety of inspiration to write their own new scenes and short plays. Examines how research can help develop an idea for a new play and discusses ways to adapt a classic text for the contemporary stage. Writers also conduct personal interviews and use the transcript as source material for a new scene. Enrollment limited.

*K. Urban*

**21M.608 Screenwriting**
Prereq: None
U (Spring)
3-0-9 units. HASS-A

Explores the fundamentals of screenplay writing. Presents skills to create compelling characters and stories in different dramatic genres (comedy, drama). In addition to their own writing, students read a selection of screenplays and watch short films that form the basis of class discussion early in the term. Class is modeled on a professional development workshop in which participants, over the course of the term, write a short screenplay, including a final draft. Enrollment limited.

*K. Urban*
21M.611 Foundations of Theater Practice
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A; CI-H

Introduces the ideas, processes, and aesthetic issues that comprise the creation of the theatrical event. Guest artists and faculty members reveal how practitioners approach the narrative of a play in each discipline (directing, design, acting, dramaturgy, playwriting). Readings and in-class exercises help students understand and experience the basic creative impulse in each area, as well as how these areas join to form a theatrical whole.

J. Sonenberg

21M.623 Physical Improvisation (New)
Prereq: None
U (Fall, Spring)
4-2-6 units. HASS-A
Can be repeated for credit.

Explores the realities of the body in space and motion - interacting with gravity, momentum, inertia, alignment, negative space, one's imagination, one's body, other bodies, the present room and rooms from memory, geometry, stillness, and more. By releasing tension and abandoning the notion of pre-planning, students experience a natural, spontaneous flow of movement, opening themselves up to, and diving into, whatever might happen. Develops alertness in order to work in an energetic state of physical disorientation, self-correcting what doesn't work and reinforcing what does on the spot, discovering physical/emotional truths and shared moments that leave students aware, centered, incredibly present, and sharply alive. Enrollment limited.

D. Safer

21M.624 Acting with the Camera
Prereq: None
U (Fall)
4-0-8 units. HASS-A

Studio workshop explores the discipline of acting for the camera through in-class exercises that focus on the creative challenges inherent to both filming and being filmed. Investigates the performer in the history of cinema, television, and multimedia stage performance through readings, screenings, and experimentation with the theory and practice of performing for and with the camera. Culminates in student-written, edited, directed, and acted short films. Instruction in written and oral communication provided. Limited to 20.

A. Kohler

21M.645 Motion Theater
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A

Examines the theatrical event from the perspective of composition in a performance workshop. Studio exercises address the process of developing a theatrical work through an internalized understanding of compositional principles in theater. Examines physical action in time and space. Includes outside readings, videos, short essays, and in-class discussions. Provides the performer, director, choreographer, designer or writer opportunities to engage with large and small group ensembles in creation of theatrical events. Topics include image, motion, shape, repetition, gesture, and spatial relationship. Preference to majors, minors, concentrators. Admittance may be controlled by lottery.

J. Scheib

21M.690 Sport as Performance
Prereq: None
U (Fall)
3-0-9 units. HASS-A

Seminar investigates the aesthetics of sport as theatrical performance and explores the performance of race, gender, class, nation, and sexuality in sport. Readings drawn from theatre/performance studies, anthropology, sociology, ethnic studies, gender studies, history, and kinesiology. Topics include barnstorming, Olympics, Title IX, Native American mascots, and a variety of sports ranging from football to figure skating. Limited to 18.

C. Conceison

Intermediate Subjects

21M.700 China on Stage
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-A; CI-H
Credit cannot also be received for 21M.701

Explores the role theater productions have played in shaping Chinese society, politics, and cultural exchange during the past century. Topics include censorship, audience reception, and current translingual and cross-cultural trends. Examines plays in English translation, videos, photographs, archival materials, and English-language books and articles about Chinese theater. Enrollment limited.

C. Conceison
21M.701 China on Stage
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Credit cannot also be received for 21M.700
Explores the role theater productions have played in shaping Chinese society, politics, and cultural exchange during the past century. Topics include censorship, audience reception, and current translational and cross-cultural trends. Examines plays in English translation, videos, photographs, archival materials, and English-language books and articles about Chinese theater. Enrollment limited.
C. Conceison

21M.702 Live Solo Performance: Monodrama and Composition (New)
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Studies the theatrical canon of monodramas and solo performances to hone individual acting skills. Goes on to explore each student’s original artistic voice by presenting strategies in composing and staging work, thus introducing them to experiments with performing the self in society. Each student creates their own original performance piece by the end of the term. Enrollment limited.
A. Kohler

21M.704 Music Theater Workshop
Prereq: 21M.600 or permission of instructor
U (Spring)
3-0-6 units. HASS-A
Introduces applications of music in theater and performance. Encourages experimentation with different genres of singing, acting, and movement by exploring an array of historical and contemporary styles and techniques. Students develop and perform their own original songs and textual materials, gaining a theoretical and practical understanding of the actor’s contribution to the dynamic form of musical theater. Previous experience in musical theater not required.
A. Kohler

21M.705 Acting Intensive
Prereq: 21M.600 or permission of instructor
U (Spring)
4-0-8 units. HASS-A
Can be repeated for credit.
Gives students who have begun the process of bringing themselves to a dramatic moment the opportunity to apply their skills to scripted material. Studio work in this class further develops the completeness, spontaneity, and honesty of expression of the actor’s body, imagination, and voice; and introduces written material and the problems of synthesizing the self, the moment, and the scripted word. Weekly rehearsals with a scene partner. Enrollment may be limited.
J. Sonenberg, A. Kohler

21M.706 Asian American Theater
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-1-8 units. HASS-A
Explores the history and impact of Asian American theater. Readings include plays and materials about cultural and political issues, family, and identity. Course includes short formal and creative writing assignments and scene work resulting in a collaborative final performance. Limited to 18.
C. Conceison

21M.710 Script Analysis
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-A; CI-H
Focuses on reading a play’s script critically and theatrically, with a view to mounting a coherent production. Through careful, intensive analysis of a variety of plays from different periods and aesthetics, a pattern emerges for discerning what options exist for interpreting a script from the distinct perspectives of the playwright, the actor, the designer, and the director. Students discuss the consequences of those options for production. Enrollment limited.
D. Gammons
21M.711 Production Seminar
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-A

Pursues detailed study of a particular playtext or theme and is related to some planned production activity during the following IAP. Seminar activities may include guest speakers from various disciplines who approach some aspect of the playtext or theme from the perspective of their fields; various theatrical practitioners; and critical and scholarly presentations by seminar members. Participation in the IAP production is not required.

J. Scheib

21M.712 Choreography: Making Dances (New)
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4-2-6 units. HASS-A

Laboratory-style class explores and invents techniques used to create dances. Students practice techniques focused on how and where to begin making a dance - sampling some of the endless ways to start a process, such as from the body, an idea, text, or a song - and then how to build up from there. Students make dances that are more than just a collection of moves, but events that do something, say something, or ask something. Builds a clear understanding of how a dance has an arc, a clear beginning, middle, and end, so that by doing it or watching it, both participants and audience end up somewhere new. Develops an understanding of, and facility with, a wide variety of topics used to explore, start and generate movement, dance and performative events involving bodies moving through space. Enrollment limited.

D. Safer

21M.714 Contemporary American Theater
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A; CI-H

Examines the exciting terrain of contemporary American writing for the theater, focusing on what is known in New York as “Off Broadway,” “downtown,” or “indie theater.” Students read work by influential playwrights from earlier generations alongside plays by new voices currently in production in Boston, New York, and across the country. Students also examine the changing institution of American theater, reading a selection of plays in order to determine what constellation of issues and concerns they engage. Discussions unpack how these plays reflect, challenge and re-construct the idea of America in the 21st century. Enrollment limited.

K. Urban

21M.715 Topics in Theater Arts
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Multidisciplinary seminar provides opportunity for study in performance theory and practice. Topics vary from term to term; may be taught by visiting faculty. May be repeated for credit if content differs.

Staff

21M.732 Costume Design
Prereq: Permission of instructor
U (Spring)
3-0-9 units. HASS-A

Studio workshop designed for students who possess a basic understanding of the principles of design and seek a more intensive study of costume. Students develop designs through a collaborative creative process that incorporates production dramaturgy and script analysis, and map those findings to a scenographically charged directorial concept. Fosters period research, conceptual design, and rendering skills through practical studio exercises. Instruction in life drawing, visual presentation, and basic costume construction provides the tools for applying conceptual design skills in performance. Lab fee required.

S. Brown

21M.733 Set Design
Prereq: Permission of instructor
U (Spring)
4-0-8 units. HASS-A

Investigates the creation of set design for live performance. Students develop designs related to current production projects at MIT. Focuses on developing the designer’s communication tools, particularly in the areas of visual research, 3-D digital model making, and design presentation. Examines the relationship of set design to theater architecture, emerging media technologies and dramaturgies of the 20th and 21st centuries. In addition to creating their own designs, students research, write about, and present the work and practice of a set designer. Lab fee required.

S. Brown
21M.734 Lighting Design
Prereq: Permission of instructor
U (Fall)
4-0-8 units. HASS-A

Explores the history, concepts and techniques of sculpting space with light within a contemporary context. Students experiment with a wide range of approaches, tools, and skills to develop their own creative vision. Focuses on discrete forms that include live performance, installation, architecture, and developments in applied technologies. Studio projects alternate between conceptual studies and realized designs reflective of students' own unique interests and talents. Enrollment may be limited.

J. Higgason

21M.735 Technical Design for Performance
Prereq: 21M.606 or permission of instructor
Acad Year 2019-2020: U (Fall, Spring)
Acad Year 2020-2021: Not offered
4-0-8 units. HASS-A

Studio examines the role of the technical designer as an integral member of an ensemble. Focusing on the artistic process, students develop their own unique approaches to stage design, lighting, sound, video design and other new media applications for the performing arts. They also explore an array of pre-production research and rehearsal techniques and analyze dramatic texts. Introduces theoretical and practical aspects of technical design, from the budgeting of time and selection of materials, to use of new technologies. Culminates in a public showing of final design projects for an invited audience.

C. Frederickson

21M.737 Interactive Design and Projection for Live Performance
Prereq: None
U (Spring)
3-4-5 units. HASS-A

Studies design, history, artistic purposes, and programming techniques involved in the development of interactive performance design systems for controlling video projection, media, and lighting for live performances. Includes readings, viewings of historical and contemporary works, and in class-practice and performance. Students use motion-sensing input devices, such as the Kinect, infrared-light tracking, accelerometers, live video, and generative graphics, to create interactive design systems. Enrollment limited.

J. Higgason

21M.785[J] Playwrights Lab
Same subject as 21W.769[J]
Subject meets with 21M.789
Prereq: 21M.604[J] or permission of instructor
U (Spring)
4-0-8 units. HASS-A
Can be repeated for credit.

Continued work in the development of play scripts for the theater. Writers work on one-act plays in weekly workshop meetings in addition to individual script meetings with the instructor. All students see their work presented as a stage reading during the MTA Playwrights Lab. Students taking graduate version complete additional assignments. Limited to 10.

K. Urban

21M.789 Playwrights Lab
Subject meets with 21M.785[J], 21W.769[J]
Prereq: 21M.604[J] or permission of instructor
G (Spring)
4-0-8 units
Can be repeated for credit.

Continued work in the development of play scripts for the theater. Writers work on one-act plays in weekly workshop meetings in addition to individual script meetings with the instructor. All students see their work presented as a stage reading during the MTA Playwrights Lab. Students taking graduate version complete additional assignments. Enrollment is limited to 10.

K. Urban

21M.790 Director's Craft
Subject meets with 21M.791
Prereq: 21M.600 and (21M.710 or permission of instructor)
U (Spring)
3-0-9 units. HASS-A

Explores several models of directing, each with its unique structures, philosophy, terminology, and techniques. Develops an individual voice for each student and clarity in his/her directorial point of view. Class sessions concentrate on how a point of view is arrived at through analysis of material and the way the results are rendered with the basic tools of theater. All points of view are honored as long as they can be actively supported by the work. Provides instruction and practice in oral and written communication. Students taking graduate version complete additional assignments.

J. Sonenberg
21M.791 Director's Craft
Subject meets with 21M.790
Prereq: 21M.600 and (21M.710 or permission of instructor)
G (Spring)
3-0-6 units
Explores several models of directing, each with its unique structures, philosophy, terminology, and techniques. Exploration is intended to lead to the development of an individual voice for each student and clarity in his/her directorial point of view. Class sessions concentrate on how a point of view is arrived at through analysis of material and the way the results are rendered with the basic tools of theater. All points of view are honored as long as they can be actively supported by the work. Students taking graduate version complete additional assignments.
J. Sonenberg

Advanced Subjects

21M.801 All the Worlds a Stage: Socio-Political Perspectives in Global Performance
Subject meets with 21M.800
Prereq: None
G (Spring)
3-0-9 units
Investigates repertoire from international creators of theater, opera, performance art, and dance. Explores diverse storytelling and directorial points of view, examining the contexts which inform approaches to performance making. Discusses specific cultural and political shifts that have inspired the work of international artists, such as Marina Abramovic (Serbia), Pina Bausch (Germany), Nora Chipaumire (Zimbabwe), Ping Chong (US/Canada), Peter Sellars (US), and The Yes Men (US). Weekly readings, screenings and guest artists provide the foundation for an understanding of the role of director as an artist who finds inspiration in the contradictions of the world. Students taking graduate version complete additional assignments.
C. Brathwaite

21M.803 Performance and Design Workshop
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer; partial term)
0-3-0 units
Provides directed practice in the disciplines of performance practice, including design, acting, directing, technical theater, dramaturgy and other creative fields. Students test and refine their skills by participating in the creation of produced plays, intensive workshops, installations and other design or performance projects in dance, film, music theater, opera, and other performing arts events. Students work closely with faculty, peers and guest artists. Students seeking to design individual performance and design workshops must be supervised by a theater arts faculty member, and obtain his or her written approval.
Staff

21M.806 Applied Performance and Design Production
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer; partial term)
0-6-0 units
Provides opportunities for applied practice in the disciplines of performance, including acting, directing, playwriting, design, technical theater, dramaturgy, and management. Students test and refine their skills in the prototyping of design projects, installations, plays, dance, film, music theater, opera, and other performing arts events. They also apply theory and practice while tracing the research and rehearsal process through production and public presentation in the theater or in the studio. Students seeking to design an applied project must be supervised by a theater arts faculty member, and obtain his or her written approval.
Staff
21M.809 Performance and Design Intensive
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
0-9-0 units
Multidisciplinary, term-long, independent study geared toward the development of significant artistic and technical projects in performance and design. Students pursue projects in an array of fields and are invited to propose artistic and research projects as actors, directors, designers, dramaturges, and/or technical designers. Often in conjunction with Theater Arts-produced productions, proposals for intensives must be vetted and supervised by a member of the Theater Arts faculty with whom the student will work over the course of term.

21M.830 Acting: Techniques and Style
Subject meets with 21M.835
Prereq: 21M.600 or permission of instructor
U (Fall)
4-0-8 units. HASS-A
Can be repeated for credit.
Refines the student actor’s use of the language of the stage with work on text and physical presentation. Explores issues of style, including the understanding and honoring, in performance, of the specific requirements from several different periods of the Western theatrical tradition. Periods may differ from term to term. Students taking graduate version complete additional assignments.

21M.835 Acting: Techniques and Style
Subject meets with 21M.830
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
4-0-8 units
Can be repeated for credit.
Refines the student actor’s use of the language of the stage with work on text and physical presentation. Explores issues of style, including the understanding and honoring, in performance, of the specific requirements from several different periods of the Western theatrical tradition. Periods may differ from term to term. Students taking graduate version complete additional assignments.

21M.840 Performance Media
Subject meets with 21M.841
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-A
Integrates media and communication technologies in performing arts. Studio exercises provide a forum for experimentation. Contemporary and historical techniques for media integration examined through readings, viewing videos and short written essays. Technologies examined include digital imaging, composite and live feed digital video, and web-based performance. Engages the designer, director, choreographer, performer, visual artist or programmer in the practice of integrating media into live art events. Equipment is provided. Students taking graduate version complete additional assignments.
J. Higgason, J. Scheib

21M.841 Performance Media
Subject meets with 21M.840
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
4-0-8 units
Integrates media and communication technologies in performing arts. Studio exercises provide a forum for experimentation. Contemporary and historical techniques for media integration examined through readings, viewing videos and short written essays. Technologies examined include digital imaging, composite and live feed digital video, and web-based performance. Engages the designer, director, choreographer, performer, visual artist or programmer in the practice of integrating media into live art events. Equipment is provided. Students taking graduate version complete additional assignments.
J. Higgason, J. Scheib
21M.842 Live Cinema Performance
Subject meets with 21M.843
Prereq: None
U (Spring)
3-2-7 units. HASS-A

Interdisciplinary studio merges the disciplines of the performer, designer, cinematographer, director, playwright and technician, and examines the deep integration of live theatrical and cinematic idioms. Studio exercises, readings, field trips and in-class presentations provide the opportunity to study the history and theory surrounding the development of genre, and to engage the practice from both sides of the camera. Includes guest artists, lectures, and master classes. Students regularly test what they develop in studio on the stage. Each class focuses on a particular dramatist, theme, or artistic genre and culminates in a full-length collaboration that will be presented in the final week of class for an invited audience. Students taking graduate version complete additional assignments. Enrollment limited.
J. Scheib

21M.843 Live Cinema Performance
Subject meets with 21M.842
Prereq: None
G (Spring)
3-2-7 units

Interdisciplinary studio merges the disciplines of the performer, designer, cinematographer, director, playwright and technician, and examines the deep integration of live theatrical and cinematic idioms. Studio exercises, readings, field trips and in-class presentations provide the opportunity to study the history and theory surrounding the development of genre, and to engage the practice from both sides of the camera. Includes guest artists, lectures, and master classes. Students regularly test what they develop in studio on the stage. Each class focuses on a particular dramatist, theme, or artistic genre and culminates in a full-length collaboration that will be presented in the final week of class for an invited audience. Students taking graduate version complete additional assignments. Enrollment limited.
J. Scheib

21M.846 Topics in Performance Studies
Subject meets with 21M.847
Prereq: None
U (Fall)
3-0-9 units. HASS-A
Can be repeated for credit.

Multidisciplinary lecture/workshop engages students in a variety of approaches to the study and practice of performance as an area of aesthetic and social interaction. Special attention paid to the use of diverse media in performance. Interdisciplinary approaches to study encourage students to seek out material histories of performance and practice. May be repeated for credit if topics differ.
C. Conceison

21M.847 Topics in Performance Studies
Subject meets with 21M.846
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

See description under 21M.846. Assignments differ.
C. Conceison

21M.848 Performance Studies: Advanced Theories of Sport
Prereq: 21M.690 and permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-A

Seminar explores connections between athletics and theatre, performance studies, sociology, anthropology, and history. Focuses on performance of nation, race, and gender in sport, and how sport performs in society. Specific topics selected based on the research focus of each student. Enrollment limited.
C. Conceison

21M.851 Independent Study in Performance and Design
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer; second half of term)
Units arranged

Multidisciplinary independent study provides opportunity for individual practica in the performing arts. While opportunities may include directed theoretical research and practice in production and performance with permanent and visiting faculty, students are encouraged to propose independent programs of study to a member of the theater arts faculty. Permission of supervising faculty member required.
Theater Arts Staff
21M.861 Topics in Performance Technique
Prereq: None
U (Fall)
3-0-9 units
Can be repeated for credit.

Explores elements of technique in a variety of performance disciplines. Topics vary from term to term; may be taught by visiting faculty. May be repeated for credit if content differs. Enrollment may be limited.

K. Mancuso

21M.862 Topics in Performance Practice
Prereq: None
U (Fall, Spring)
4-0-8 units
Can be repeated for credit.

Class explores elements of performance in a studio setting. Topics vary from term to term; may be taught by visiting faculty. May be repeated for credit if content differs. Enrollment may be limited.

J. Higgason

21M.863 Advanced Topics in Theater Arts
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Can be repeated for credit.

Advanced multidisciplinary studio workshop provides opportunity for advanced study in the performing arts. Topics vary from term to term; may be taught by visiting faculty. May be repeated for credit if content differs.

Staff

21M.864 Research in Theater
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Offers directed research in the spheres of theory, history, performance studies, dramaturgy, etc. Permission of the supervising member of the Theater Arts faculty required.

Consult Staff

21M.865 Research in Theater
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Offers directed research of advanced theatrical subjects occurring in either the performance or theoretical spheres. May be repeated for credit with permission.

Staff

21M.THT Pre-Thesis Tutorial
Prereq: Permission of instructor
U (Fall, IAP, Spring)
1-0-5 units
Can be repeated for credit.

Definition of and early-stage work on thesis project leading to 21M.THU Undergraduate Thesis in Music or Theater Arts. Taken during the first term, or during IAP, of the student's two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Limited to Music or Theater Arts Majors.

Consult Music & Theater Arts Headquarters

21M.THU Undergraduate Thesis
Prereq: 21M.THT or permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Completion of work on senior major thesis in Music or Theater Arts under supervision of a faculty tutor. Includes oral presentation of thesis project early in the term, assembling and revising final text and meeting at the close with a committee of Music or Theater Arts faculty evaluators to discuss successes and limitations of the project. Limited to Music or Theater Arts majors.

Consult Music and Theater Arts Headquarters

21M.UR Undergraduate Research in Music and Theater Arts
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Individual participation in ongoing Music and Theater Arts research projects. For students in the Undergraduate Research Opportunities Program.

Staff
21M.URG Undergraduate Research in Music
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Individual participation in an ongoing music research project. For students in the Undergraduate Research Opportunities Program.

Staff
NAVAL SCIENCE (NS)

ROTC subjects do not carry academic credit at MIT, but they can be counted toward the PE requirement. Up to two points per year with a maximum of four points.

Naval Science

NS.100 Naval Science Leadership Seminar
Subject meets with NS.200, NS.300, NS.400
Prereq: None
U (Fall, Spring)
0-2-2 units

Leadership seminar addresses professional issues of military leadership, ethics, foreign policy, internal affairs and naval warfare doctrine. Subject matter centers on preparation for commissioned service in the US Naval Forces by examining the role of the junior officer in the employment of naval power. Mostly student originated, the periods include panel discussions, practical applications, guest lecturers from academia, and speakers currently serving in deployed naval forces.

S. Langel

NS.11 Introduction to Naval Science
Prereq: None
U (Fall)
3-0-3 units

Introduction to naval science. General introduction to the US Navy and Marine Corps. Emphasizes organizational structure, warfare components, and assigned roles/missions of US Navy/USMC. Covers all aspects of naval service from its relative position within DOD, to specific warfare communities/career paths. Also includes basic elements of leadership/Navy core values. Designed to give student initial exposure to many elements of naval culture. Provides students with conceptual framework and working vocabulary. Completion of MIT NROTC Orientation Program strongly recommended.

B. Butcher

NS.12 Seapower and Maritime Affairs
Prereq: None
U (Spring)
3-0-6 units

A study of the US Navy and the influence of sea power upon history. Incorporates both a historical and political science process to explore the major events, attitudes, personalities, and circumstances which have imbued the US Navy with its proud history and rich tradition. Deals with issues of national imperatives in peacetime as well as war, varying maritime philosophies which were interpreted into naval strategies/doctrines, budgetary concerns which shaped force realities, and the pursuit of American diplomatic objectives, concluding with the current search for direction in the post-Cold War era and beyond.

B. Butcher

NS.200 Naval Science Leadership Seminar
Subject meets with NS.100, NS.300, NS.400
Prereq: None
U (Fall, Spring)
0-2-2 units

Leadership seminar addresses professional issues of military leadership, ethics, foreign policy, internal affairs and naval warfare doctrine. Subject matter centers on preparation for commissioned service in the US Naval Forces by examining the role of the junior officer in the employment of naval power. Mostly student originated, the periods include panel discussions, practical applications, guest lecturers from academia, and speakers currently serving in deployed naval forces.

S. Langel

NS.21 Leadership and Management
Prereq: None
U (Fall)
3-0-6 units

Explores leadership from the military perspective taught by professors of military science from the Army, Navy and Air Force. Survey of basic principles for successfully managing and leading people, particularly in public service and the military. Develops skills in topics such as oral and written communication techniques, planning, team building, motivation, ethics, decision-making, and managing change. Relies heavily on interactive experiential classes with case studies, student presentations, role plays, and discussion. Also appropriate for non-management science majors.

J. Hollenbach
NS.22 Navigation
Prereq: None
U (Spring)
3-0-6 units
Comprehensive study of the theory, principles, and procedures of piloting and maritime navigation, including mathematics of navigation, practical work involving navigational instruments, sight reduction by <em>pro forma</em> and computerized methods, charts, publications, and voyage planning. CORTRAMID cruise recommended.
A. Goodwin

NS.300 Naval Science Leadership Seminar
Subject meets with NS.100, NS.200, NS.400
Prereq: None
U (Fall, Spring)
0-2-4 units
Leadership seminar addresses professional issues of military leadership, ethics, foreign policy, internal affairs and naval warfare doctrine. Subject matter centers on preparation for commissioned service in the US Naval Forces by examining the role of the junior officer in the employment of naval power. Mostly student originated, the periods include panel discussions, practical applications, guest lecturers from academia, and speakers currently serving in deployed naval forces.
S. Langel

NS.31 Naval Ships Systems I: Engineering
Prereq: None
U (Fall)
3-0-6 units
Lecture series on technological fundamentals of applied and planned naval ships Systems from an engineering viewpoint. Topics include stability, propulsion, ship control and systems.
C. Philbin

NS.32 Naval Ship Systems II Weapons
Prereq: NS.31 or permission of instructor
U (Spring)
3-0-6 units
Overview of the properties and behavior of electromagnetic radiation pertaining to maritime applications. Topics include communications, radar detection, electro-optics, tracking and guidance systems. Sonar and underwater sound propagation also discussed. Examples taken from systems found on naval ships and aircraft. Selected readings on naval weapons and fire control systems. Physics I (GIR) and Calculus II (GIR) recommended.
C. Philbin

NS.33 Evolution of Warfare
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-6 units
Traces development of warfare from dawn of recorded history to present, focusing on the impact of major military theorists, strategists, tacticians, and technological developments. Seeks to understand the relationships between military training, weaponry, strategies and tactics, and the societies and cultures that produce and then are defended by those military structures. By examining the association between a society and its military, students acquire basic sense of strategy, develop an understanding of military alternatives, and see the impact of historical precedents on military thoughts and actions.
S. Langel

NS.400 Naval Science Leadership Seminar
Subject meets with NS.100, NS.200, NS.300
Prereq: None
U (Fall, Spring)
0-2-4 units
Leadership seminar addresses professional issues of military leadership, ethics, foreign policy, internal affairs and naval warfare doctrine. Subject matter centers on preparation for commissioned service in the US Naval Forces by examining the role of the junior officer in the employment of naval power. Mostly student originated, the periods include panel discussions, practical applications, guest lecturers from academia, and speakers currently serving in deployed naval forces.
S. Langel

NS.41 Navigation and Naval Operations
Prereq: Recommended first class cruise and NS.22
U (Fall)
3-0-6 units
Comprehensive study of tactical and strategic considerations to the employment of naval forces, including communications, tactical formations and dispositions, relative motion, maneuvering board, and nautical rules of the road.
A. Goodwin
**NS.42 Leadership and Ethics**  
Prereq: NS.21  
U (Spring)  
3-0-6 units

Analyzes ethical decision-making and leadership principles. Students read and discuss texts written by such philosophers as Aristotle, Kant, and Mill to gain familiarity with the realm of ethical theory. Students then move on to case studies in which they apply these theories to resolve moral dilemmas. Provides a basic background in the duties and responsibilities of a junior division and watch officer; strong emphasis on the junior officer’s responsibilities in training, counseling, and career development. Student familiarization with equal opportunity and drug/alcohol rehabilitation programs. Principles of leadership reinforced through leadership case studies.  
*M. Savageaux*

**NS.43 Fundamentals of Maneuver Warfare**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-6 units

Introduces the United States Marine Corps’ historical operating concepts as well as the employment of current doctrine known as “maneuver warfare.” Utilizes historical examples from past military campaigns, as well as the current Marine Corps' doctrine and philosophy, to increase the student’s critical thinking and decision-making ability. Aims to create future leaders capable of identifying and solving complex problems in future operating environments across the spectrum of conflict. Module one outlines the fundamental concepts, themes, and historical conflicts involving and relating to maneuver warfare. Module two articulates and describes the Marine Corps’ current warfighting doctrine. Module three describes the Marine Corps’ future operating concept and advancement of warfighting doctrine.  
*S. Langel*
NUCLEAR SCIENCE AND ENGINEERING
(COURSE 22)

Undergraduate Subjects

22.00 Introduction to Modeling and Simulation  
Engineering School-Wide Elective Subject.  
Offered under: 1.021, 3.021, 10.333, 22.00  
Prereq: 3.016B, 18.03, or permission of instructor  
U (Spring)  
4.0-8 units. REST  
See description under subject 3.021.  
M. Buehler, R. Gomez-Bombarelli

22.01 Introduction to Nuclear Engineering and Ionizing Radiation  
Prereq: None  
U (Fall)  
4-1-7 units. REST  
Provides an introduction to nuclear science and its engineering applications. Describes basic nuclear models, radioactivity, nuclear reactions and kinematics. Covers the interaction of ionizing radiation with matter, with an emphasis on radiation detection, radiation shielding, and radiation effects on human health. Presents energy systems based on fission and fusion nuclear reactions, as well as industrial and medical applications of nuclear science.  
M. Short

22.011 Nuclear Engineering: Science, Systems and Society  
Prereq: None  
U (Spring)  
1-0-2 units  
Introduction to the basic physics of nuclear energy and radiation, with an emphasis on the unique attributes and challenges of nuclear energy as a low-carbon solution. Discusses peaceful applications of ionizing radiation, such as reactors for materials science research, nuclear medicine, and security initiatives. Explores fission energy, establishing the scientific, engineering, and economic basis for power reactors. Describes the latest advances in nuclear reactor technology. Introduces magnetic fusion energy research, with lectures covering the scientific and engineering basis of tokamaks, the state-of-the-art in world fusion experiments, and the MIT vision for a high-magnetic field fusion reactor. Uses radiation detection equipment to explore radioactivity in everyday life. Subject can count toward the 9-unit discovery-focused credit limit for first year students.  
A. White, M. Short, J. Buongiorno, J. Parsons

22.014 Ethics for Engineers  
Engineering School-Wide Elective Subject.  
Offered under: 1.082, 2.900, 6.904, 10.01, 16.676, 22.014  
Subject meets with 6.9041, 20.005  
Prereq: None  
U (Fall, Spring)  
2-0-4 units  
See description under subject 10.01.  
D. Doneson, B. L. Trout

22.02 Introduction to Applied Nuclear Physics  
Prereq: 8.03 or permission of instructor  
U (Spring)  
5-0-7 units. REST  
Covers basic concepts of nuclear physics with emphasis on nuclear structure and interactions of radiation with matter. Topics include elementary quantum theory; nuclear forces; shell structure of the nucleus; alpha, beta and gamma radioactive decays; interactions of nuclear radiations (charged particles, gammas, and neutrons) with matter; nuclear reactions; fission and fusion.  
M. Li

22.022 Quantum Theory of Radiation Interactions  
Subject meets with 22.51  
Prereq: 22.02  
U (Spring)  
3-0-9 units  
Introduces elements of applied quantum mechanics and statistical physics. Starting from the experimental foundation of quantum mechanics, develops the basic principles of interaction of electromagnetic radiation with matter. Introduces quantum theory of radiation, time-dependent perturbation theory, transition probabilities and cross sections. Applications are to controlling coherent and decoherent dynamics with examples from quantum information processing. Students taking graduate version complete additional assignments.  
P. Cappellaro
22.03 Introduction to Nuclear Design
Prereq: None
U (Fall)
2-3-1 units
Focuses on design thinking, rapid prototyping, overcoming fixation, and optimizing solutions within design constraints as applied to ideas relevant to nuclear science and engineering. Includes hands-on introductions to modern, rapid prototyping tools (laser cutter, 3D printer) in the context of a nuclear design problem, followed by discovery-based labs illustrating nuclear concepts. Culminates in a student-directed nuclear making experience. Enrollment limited; preference to Course 22 majors and minors.
M. Short, Z. Hartwig

22.033 Nuclear Systems Design Project
Subject meets with 22.33
Prereq: None
U (Fall)
3-0-12 units
Group design project involving integration of nuclear physics, particle transport, control, heat transfer, safety, instrumentation, materials, environmental impact, and economic optimization. Provides opportunity to synthesize knowledge acquired in nuclear and non-nuclear subjects and apply this knowledge to practical problems of current interest in nuclear applications design. Past projects have included using a fusion reactor for transmutation of nuclear waste, design and implementation of an experiment to predict and measure pebble flow in a pebble bed reactor, and development of a mission plan for a manned Mars mission including the conceptual design of a nuclear powered space propulsion system and power plant for the Mars surface, a lunar/Martian nuclear power station and the use of nuclear plants to extract oil from tar sands. Students taking graduate version complete additional assignments.
Z. Hartwig, M. Bucci, K. Shirvan

22.039 Integration of Reactor Design, Operations, and Safety
Subject meets with 22.39
Prereq: 22.05 and 22.06
U (Fall)
3-2-7 units
Covers the integration of reactor physics and engineering sciences into nuclear power plant design, focusing on designs projected to be used in the first half of this century. Topics include materials issues in plant design and operations, aspects of thermal design, fuel depletion and fission-product poisoning, and temperature effects on reactivity. Addresses safety considerations in regulations and operations, such as the evolution of the regulatory process, the concept of defense in depth, general design criteria, accident analysis, probabilistic risk assessment, and risk-informed regulations. Students taking graduate version complete additional assignments.
E. Bagglietto

22.04[J] Social Problems of Nuclear Energy
Same subject as STS.084[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Surveys the major social challenges for nuclear energy. Topics include the ability of nuclear power to help mitigate climate change; challenges associated with ensuring nuclear safety; the effects of nuclear accidents; the management of nuclear waste; the linkages between nuclear power and nuclear weapons, the consequences of nuclear war; and political challenges to the safe and economic regulation of the nuclear industry. Weekly readings presented from both sides of the debate, followed by in-class discussions. Instruction and practice in oral and written communication provided. Limited to 18.
R. S. Kemp

22.05 Neutron Science and Reactor Physics
Prereq: 18.03, 22.01, and (1.000, 2.086, 6.0002, or 12.010)
U (Fall)
5-0-7 units
Introduces fundamental properties of the neutron. Covers reactions induced by neutrons, nuclear fission, slowing down of neutrons in infinite media, diffusion theory, the few-group approximation, point kinetics, and fission-product poisoning. Emphasizes the nuclear physics bases of reactor design and its relationship to reactor engineering problems.
B. Forget


**22.051 Systems Analysis of the Nuclear Fuel Cycle**
Subject meets with 22.251  
Prereq: 22.05  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-2-7 units  
Studies the relationship between technical and policy elements of the nuclear fuel cycle. Topics include uranium supply, enrichment, fuel fabrication, in-core reactivity and fuel management of uranium and other fuel types, used fuel reprocessing, and waste disposal. Presents principles of fuel cycle economics and the applied reactor physics of both contemporary and proposed thermal and fast reactors. Examines nonproliferation aspects, disposal of excess weapons plutonium, and transmutation of long lived radioisotopes in spent fuel. Several state-of-the-art computer programs relevant to reactor core physics and heat transfer are provided for student use in problem sets and term papers. Students taking graduate version complete additional assignments.  
*C. Forsberg*

**22.054[J] Materials Performance in Extreme Environments**
Same subject as 3.154[J]  
Prereq: 3.032 and 3.044  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-2-7 units  
See description under subject 3.154[J].  
*Staff*

**22.055 Radiation Biophysics**
Subject meets with 22.55[J], HST.560[J]  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units  
Provides a background in sources of radiation with an emphasis on terrestrial and space environments and on industrial production. Discusses experimental approaches to evaluating biological effects resulting from irradiation regimes differing in radiation type, dose and dose-rate. Effects at the molecular, cellular, organism, and population level are examined. Literature is reviewed identifying gaps in our understanding of the health effects of radiation, and responses of regulatory bodies to these gaps is discussed. Students taking graduate version complete additional assignments.  
*Staff*

**22.06 Engineering of Nuclear Systems**
Prereq: 2.005  
U (Spring)  
4-0-8 units  
Using the basic principles of reactor physics, thermodynamics, fluid flow and heat transfer, students examine the engineering design of nuclear power plants. Emphasizes light-water reactor technology, thermal limits in nuclear fuels, thermal-hydraulic behavior of the coolant, nuclear safety and dynamic response of nuclear power plants.  
*K. Shirvan*

**22.061 Fusion Energy**
Prereq: 22.01 or permission of instructor  
U (Spring)  
4-1-7 units  
Surveys the fundamental science and engineering required to generate energy from controlled nuclear fusion. Topics include nuclear physics governing fusion fuel choice and fusion reactivity, physical conditions required to achieve net fusion energy, plasma physics of magnetic confinement, overview of fusion energy concepts, material challenges in fusion systems, superconducting magnet engineering, and fusion power conversion to electricity. Includes in-depth visits at the MIT Plasma Science and Fusion Center and active learning laboratories to reinforce lecture topics.  
*Z. Hartwig*

**22.071 Electronics, Signals, and Measurement**
Prereq: 18.03  
U (Spring)  
3-3-6 units. REST  
Provides the knowledge necessary for reading schematics and designing, building, analyzing, and testing fundamental analog and digital circuits. Students construct interactive examples and explore the practical uses of electronics in engineering and experimental science, including signals and measurement fundamentals. Uses state-of-the-art hardware and software for data acquisition, analysis, and control. Suitable for students with little or no previous background in electronics. Limited to 20.  
*A. White*
22.072 Corrosion: The Environmental Degradation of Materials
Subject meets with 22.72
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units
Applies thermodynamics and kinetics of electrode reactions to aqueous corrosion of metals and alloys. Application of advanced computational and modeling techniques to evaluation of materials selection and susceptibility of metal/alloy systems to environmental degradation in aqueous systems. Discusses materials degradation problems in marine environments, oil and gas production, and energy conversion and generation systems, including fossil and nuclear. Students taking graduate version complete additional assignments.
M. Li

22.074 Radiation Damage and Effects in Nuclear Materials
Subject meets with 3.31[J], 22.74[J]
Prereq: Permission of instructor
U (Fall)
3-0-9 units
Studies the origins and effects of radiation damage in structural materials for nuclear applications. Radiation damage topics include formation of point defects, defect diffusion, defect reaction kinetics and accumulation, and differences in defect microstructures due to the type of radiation (ion, proton, neutron). Radiation effects topics include detrimental changes to mechanical properties, phase stability, corrosion properties, and differences in fission and fusion systems. Term project required. Students taking graduate version complete additional assignments.
M. Short, B. Yildiz

22.078 Principles of Nuclear Chemical Engineering and Waste Management
Subject meets with 22.78
Prereq: Permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Introduces scientific and engineering aspects of chemical engineering and waste management applied to reactors and the fuel cycle. Includes chemical behavior in reactors (normal and accident), spent nuclear fuel aging, separation processes in reprocessing (aqueous, pyro, and molten salt), and waste treatment processes. Addresses management of radioactive wastes, including waste forms, classification, fundamental principles, governing equations for radionuclide transport in the environment, performance assessment of geological waste disposal systems, and implications of advanced fuel cycles. Students taking graduate version complete additional assignments.
C. Forsberg

22.081[J] Introduction to Sustainable Energy
Same subject as 2.650[J], 10.291[J]
Subject meets with 1.818[J], 2.65[J], 10.391[J], 11.371[J], 22.811[J]
Prereq: Permission of instructor
U (Fall)
3-1-8 units
Assessment of current and potential future energy systems. Covers resources, extraction, conversion, and end-use technologies, with emphasis on meeting 21st-century regional and global energy needs in a sustainable manner. Examines various renewable and conventional energy production technologies, energy end-use practices and alternatives, and consumption practices in different countries. Investigates their attributes within a quantitative analytical framework for evaluation of energy technology system proposals. Emphasizes analysis of energy propositions within an engineering, economic and social context. Students taking graduate version complete additional assignments. Limited to juniors and seniors.
M. W. Golay
22.09 Principles of Nuclear Radiation Measurement and Protection
Subject meets with 22.90
Prereq: 22.01
U (Fall)
2-6-4 units. Institute LAB

Combines lectures, demonstrations, and experiments. Review of radiation protection procedures and regulations; theory and use of alpha, beta, gamma, and neutron detectors; applications in imaging and dosimetry; gamma-ray spectroscopy; design and operation of automated data acquisition experiments using virtual instruments. Meets with graduate subject 22.90, but homework assignments and examinations differ. Instruction and practice in written communication provided.
A. Danagoulian, G. Kohse

22.091, 22.093 Independent Project in Nuclear Science and Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

For undergraduates who wish to conduct a one-term project of theoretical or experimental nature in the field of nuclear engineering, in close cooperation with individual staff members. Topics and hours arranged to fit students' requirements. Projects require prior approval by the Course 22 Undergraduate Office. 22.093 is graded P/D/F.
M. Short

22.099 Topics in Nuclear Science and Engineering
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Provides credit for work on material in nuclear science and engineering outside of regularly scheduled subjects. Intended for study abroad with a student exchange program or an approved one-term or one-year study abroad program. Credit may be used to satisfy specific SB degree requirements. Requires prior approval. Consult department.
Consult Undergraduate Officer

22.S092-22.S094 Special Subject in Nuclear Science and Engineering
Prereq: None
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in nuclear science and engineering that is not covered in the regular curriculum.
M. Short

22.S095 Special Subject in Nuclear Science and Engineering
Prereq: None
U (Fall, IAP; partial term)
Units arranged [P/D/F]
Can be repeated for credit.

Seminar or lecture on a topic in nuclear science and engineering that is not covered in the regular curriculum.
Contact: Professor Michael Short

22.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units

See description under subject 2.EPE.
Staff

22.EPW UPOP Engineering Practice Workshop
Engineering School-Wide Elective Subject.
Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW
Prereq: None
U (Fall, IAP)
1-0-0 units

See description under subject 2.EPW. Enrollment limited.
Staff

22.THT Undergraduate Thesis Tutorial
Prereq: None
U (Fall)
1-0-2 units

A series of lectures on prospectus and thesis writing. Students select a thesis topic and a thesis advisor who reviews and approves the prospectus for thesis work in the spring term.
N. Louriero
22.THU Undergraduate Thesis  
Prereq: 22.THT  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.

Program of research, leading to the writing of an SB thesis, to be arranged by the student and appropriate MIT faculty member. See department undergraduate headquarters.  
M. Short

22.UR Undergraduate Research Opportunities Program  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.

The Undergraduate Research Opportunities Program is an excellent way for undergraduate students to become familiar with the Department of Nuclear Engineering. Student research as a UROP project has been conducted in areas of fission reactor studies, utilization of fusion devices, applied radiation research, and biomedical applications. Projects include the study of engineering aspects for both fusion and fission energy sources.  
M. Short

22.URG Undergraduate Research Opportunities Program  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.

The Undergraduate Research Opportunities Program is an excellent way for undergraduate students to become familiar with the department of Nuclear Science and Engineering. Student research as a UROP project has been conducted in areas of fission reactor studies, utilization of fusion devices, applied radiation physics research, and biomedical applications. Projects include the study of engineering aspects for fusion and fission energy sources, and utilization of radiations.  
M. Short

Graduate Subjects

22.11 Applied Nuclear Physics  
Prereq: 22.02 or permission of instructor  
G (Fall; first half of term)  
2-0-4 units  
Can be repeated for credit.

Introduction to nuclear structure, reactions, and radioactivity. Review of quantization, the wave function, angular momentum and tunneling. Simplified application to qualitative understanding of nuclear structure. Stable and unstable isotopes, radioactive decay, decay products and chains. Nuclear reactions, cross-sections, and fundamental forces, and the resulting phenomena.  
B. Yildiz

22.12 Radiation Interactions, Control, and Measurement  
Prereq: 8.02 or permission of instructor  
G (Fall; second half of term)  
2-0-4 units  
Can be repeated for credit.

A. Danagoulian

22.13 Nuclear Energy Systems  
Prereq: 2.005, 22.01, or permission of instructor  
G (Spring; first half of term)  
2-0-4 units  
Can be repeated for credit.

Introduction to generation of energy from nuclear reactions. Characteristics of nuclear energy. Fission cross-sections, criticality, and reaction control. Basic considerations of fission reactor engineering, thermal hydraulics, and safety. Nuclear fuel and waste characteristics. Fusion reactions and the character and conditions of energy generation. Plasma physics and approaches to achieving terrestrial thermonuclear fusion energy.  
M. Bucci
22.14 Materials in Nuclear Engineering
Prereq: Chemistry (GIR) or permission of instructor
G (Spring; second half of term)
2-0-4 units
Can be repeated for credit.

Introduces the fundamental phenomena of materials science with special attention to radiation and harsh environments. Materials lattices and defects and the consequent understanding of strength of materials, fatigue, cracking, and corrosion. Coulomb collisions of charged particles; their effects on structured materials; damage and defect production, knock-ons, transmutation, cascades and swelling. Materials in fission and fusion applications: cladding, waste, plasma-facing components, blankets.

J. Li

22.15 Essential Numerical Methods
Prereq: 12.010 or permission of instructor
G (Fall; first half of term)
2-0-4 units
Can be repeated for credit.

Introduces computational methods for solving physical problems in nuclear applications. Ordinary and partial differential equations for particle orbit, and fluid, field, and particle conservation problems; their representation and solution by finite difference numerical approximations. Iterative matrix inversion methods. Stability, convergence, accuracy and statistics. Particle representations of Boltzmann’s equation and methods of solution such as Monte-Carlo and particle-in-cell techniques.

N. Louriero

22.16 Nuclear Technology and Society
Prereq: 22.01 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-0-4 units
Can be repeated for credit.

Introduces the societal context and challenges for nuclear technology. Major themes include economics and valuation of nuclear power, interactions with government and regulatory frameworks; safety, quantification of radiation hazards, and public attitudes to risk. Covers policies and methods for limiting nuclear-weapons proliferation, including nuclear detection, materials security and fuel-cycle policy.

R. S. Kemp

22.211 Nuclear Reactor Physics I
Prereq: 22.05
G (Spring)
3-0-9 units

Provides an overview of reactor physics methods for core design and analysis. Topics include nuclear data, neutron slowing down, homogeneous and heterogeneous resonance absorption, calculation of neutron spectra, determination of group constants, nodal diffusion methods, Monte Carlo simulations of reactor core reload design methods.

B. Forget

22.212 Nuclear Reactor Analysis II
Prereq: 22.211
G (Fall)
3-2-7 units

Addresses advanced topics in nuclear reactor physics with an additional focus towards computational methods and algorithms for neutron transport. Covers current methods employed in lattice physics calculations, such as resonance models, critical spectrum adjustments, advanced homogenization techniques, fine mesh transport theory models, and depletion solvers. Also presents deterministic transport approximation techniques, such as the method of characteristics, discrete ordinates methods, and response matrix methods.

K. Smith

22.213 Nuclear Reactor Physics III
Prereq: 22.211
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Covers numerous high-level topics in nuclear reactor analysis methods and builds on the student’s background in reactor physics to develop a deep understanding of concepts needed for time-dependent nuclear reactor core physics, including coupled nonlinear feedback effects. Introduces numerical algorithms needed to solve real-world time-dependent reactor physics problems in both diffusion and transport. Additional topics include iterative numerical solution methods (e.g., CG, GMRES, JFNK, MG), nonlinear accelerator methods, and numerous modern time-integration techniques.

K. Smith
22.251 Systems Analysis of the Nuclear Fuel Cycle
Subject meets with 22.051
Prereq: 22.05
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-2-7 units
Study of the relationship between the technical and policy elements of the nuclear fuel cycle. Topics include uranium supply, enrichment, fuel fabrication, in-core reactivity and fuel management of uranium and other fuel types, used fuel reprocessing and waste disposal. Principles of fuel cycle economics and the applied reactor physics of both contemporary and proposed thermal and fast reactors are presented. Nonproliferation aspects, disposal of excess weapons plutonium, and transmutation of long lived radioisotopes in spent fuel are examined. Several state-of-the-art computer programs relevant to reactor core physics and heat transfer are provided for student use in problem sets and term papers. Students taking graduate version complete additional assignments.
C. Forsberg

Nuclear Reactor Engineering

22.312 Engineering of Nuclear Reactors
Prereq: (2.001 and 2.005) or permission of instructor
G (Fall)
3-0-9 units
Engineering principles of nuclear reactors, emphasizing power reactors. Power plant thermodynamics, reactor heat generation and removal (single-phase as well as two-phase coolant flow and heat transfer), and structural mechanics. Engineering considerations in reactor design.
J. Buongiorno

22.313[J] Thermal Hydraulics in Power Technology
Same subject as 2.59[J], 10.536[J]
Prereq: 2.006, 10.302, 22.312, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-2-7 units
E. Baglietto, M. Bucci

22.315 Applied Computational Fluid Dynamics and Heat Transfer
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Focuses on the application of computational fluid dynamics to the analysis of power generation and propulsion systems, and on industrial and chemical processes in general. Discusses simulation methods for single and multiphase applications and their advantages and limitations in industrial situations. Students practice breaking down an industrial problem into its modeling challenges, designing and implementing a plan to optimize and validate the modeling approach, performing the analysis, and quantifying the uncertainty margin.
E. Baglietto

22.33 Nuclear Engineering Design
Subject meets with 22.033
Prereq: 22.312
G (Fall)
3-0-15 units
Group design project involving integration of nuclear physics, particle transport, control, heat transfer, safety, instrumentation, materials, environmental impact, and economic optimization. Provides opportunity to synthesize knowledge acquired in nuclear and non-nuclear subjects and apply this knowledge to practical problems of current interest in nuclear applications design. Past projects have included using a fusion reactor for transmutation of nuclear waste, design and implementation of an experiment to predict and measure pebble flow in a pebble bed reactor, and development of a mission plan for a manned Mars mission including the conceptual design of a nuclear powered space propulsion system and power plant for the Mars surface. Students taking graduate version complete additional assignments.
M. Short, A. White
22.38 Probability and Its Applications To Reliability, Quality Control, and Risk Assessment
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Staff

22.39 Integration of Reactor Design, Operations, and Safety
Subject meets with 22.039
Prereq: 22.211 and 22.312
G (Fall)
3-2-7 units
Integration of reactor physics and engineering sciences into nuclear power plant design focusing on designs that are projected to be used in the first half of this century. Topics include materials issues in plant design and operations, aspects of thermal design, fuel depletion and fission-product poisoning, and temperature effects on reactivity. Safety considerations in regulations and operations such as the evolution of the regulatory process, the concept of defense in depth, general design criteria, accident analysis, probabilistic risk assessment, and risk-informed regulations. Students taking graduate version complete additional assignments.
E. Baglietto, K. Shirvan

Same subject as 2.62[J], 10.392[J]
Subject meets with 2.60[J], 10.390[J]
Prereq: 2.006, (2.051 and 2.06), or permission of instructor
G (Spring)
4-0-8 units
See description under subject 2.62[J].
A. F. Ghoniem, W. Green

Radiation Interactions and Applications

22.51 Quantum Theory of Radiation Interactions
Subject meets with 22.022
Prereq: 22.11
G (Spring)
3-0-9 units
Introduces elements of applied quantum mechanics and statistical physics. Starting from the experimental foundation of quantum mechanics, develops the basic principles of interaction of electromagnetic radiation with matter. Introduces quantum theory of radiation, time-dependent perturbation theory, transition probabilities and cross sections. Applications are to controlling coherent and decoherent dynamics with examples from quantum information processing. Students taking graduate version complete additional assignments.
P. Cappellaro

22.55[J] Radiation Biophysics
Same subject as HST.560[J]
Subject meets with 22.055
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Provides a background in sources of radiation with an emphasis on terrestrial and space environments and on industrial production. Discusses experimental approaches to evaluating biological effects resulting from irradiation regimes differing in radiation type, dose and dose-rate. Effects at the molecular, cellular, organism, and population level are examined. Literature is reviewed identifying gaps in our understanding of the health effects of radiation, and responses of regulatory bodies to these gaps is discussed. Students taking graduate version complete additional assignments.

Staff

Same subject as HST.584[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-12 units
See description under subject HST.584[J].
L. Wald, K. Setsompop
**Plasmas and Controlled Fusion**

**22.611[J] Introduction to Plasma Physics I**
Same subject as 8.613[J]
Prereq: (6.013 or 8.07) and (18.04 or Coreq: 18.075)
G (Fall)
3-0-9 units

*I. Hutchinson*

**22.612[J] Introduction to Plasma Physics II (New)**
Same subject as 8.614[J]
Prereq: 22.611[J]
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

See description under subject 8.614[J].  
*Staff*

**22.615 MHD Theory of Fusion Systems**
Prereq: 22.611[J]
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Discussion of MHD equilibria in cylindrical, toroidal, and noncircular configurations. MHD stability theory including the Energy Principle, interchange instability, ballooning modes, second region of stability, and external kink modes. Description of current configurations of fusion interest.  
*N. Louriero*

**22.617 Plasma Turbulence and Transport**
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Introduces plasma turbulence and turbulent transport, with a focus on fusion plasmas. Covers theory of mechanisms for turbulence in confined plasmas, fluid and kinetic equations, and linear and nonlinear gyrokinetic equations; transport due to stochastic magnetic fields, magnetohydrodynamic (MHD) turbulence, and drift wave turbulence; and suppression of turbulence, structure formation, intermittency, and stability thresholds. Emphasis on comparing experiment and theory. Discusses experimental techniques, simulations of plasma turbulence, and predictive turbulence-transport models.  
*Staff*

**22.62 Fusion Energy**
Prereq: 22.611[J]
G (Spring)
3-0-9 units

Basic nuclear physics and plasma physics for controlled fusion. Fusion cross sections and consequent conditions required for ignition and energy production. Principles of magnetic and inertial confinement. Description of magnetic confinement devices: tokamaks, stellarators and RFPs, their design and operation. Elementary plasma stability considerations and the limits imposed. Plasma heating by neutral beams and RF. Outline design of the ITER “burning plasma” experiment and a magnetic confinement reactor.  
*I. Hutchinson*

**22.63 Engineering Principles for Fusion Reactors**
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

*D. Whyte, Z. Hartwig*
22.64[J] Ionized Gases (New)
Same subject as 16.55[J]
Prereq: 8.02 or permission of instructor
G (Fall)
3-0-9 units
See description under subject 16.55[J].
C. Guerra Garcia

22.67[J] Principles of Plasma Diagnostics
Same subject as 8.670[J]
Prereq: 22.611[J]
G (Fall)
Not offered regularly; consult department
4-4-4 units
Introduction to the physical processes used to measure the properties of plasmas, especially fusion plasmas. Measurements of magnetic and electric fields, particle flux, refractive index, emission and scattering of electromagnetic waves and heavy particles; their use to deduce plasma parameters such as particle density, pressure, temperature, and velocity, and hence the plasma confinement properties. Discussion of practical examples and assessments of the accuracy and reliability of different techniques.
A. White

Nuclear Materials

22.71[J] Modern Physical Metallurgy
Same subject as 3.40[J]
Subject meets with 3.14
Prereq: 3.022 and 3.032
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 3.40[J].
C. Tasan

22.72 Corrosion: The Environmental Degradation of Materials
Subject meets with 22.072
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Applies thermodynamics and kinetics of electrode reactions to aqueous corrosion of metals and alloys. Application of advanced computational and modeling techniques to evaluation of materials selection and susceptibility of metal/alloy systems to environmental degradation in aqueous systems. Discusses materials degradation problems in marine environments, oil and gas production, and energy conversion and generation systems, including fossil and nuclear.
M. Li

22.73[J] Defects in Materials
Same subject as 3.33[J]
Prereq: 3.21 and 3.22
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
See description under subject 3.33[J].
J. Li

22.74[J] Radiation Damage and Effects in Nuclear Materials
Same subject as 3.31[J]
Subject meets with 22.074
Prereq: 3.21, 22.14, or permission of instructor
G (Fall)
3-0-9 units
Studies the origins and effects of radiation damage in structural materials for nuclear applications. Radiation damage topics include formation of point defects, defect diffusion, defect reaction kinetics and accumulation, and differences in defect microstructures due to the type of radiation (ion, proton, neutron). Radiation effects topics include detrimental changes to mechanical properties, phase stability, corrosion properties, and differences in fission and fusion systems. Term project required. Students taking graduate version complete additional assignments.
M. Short, B. Yildiz
22.75[J] Properties of Solid Surfaces
Same subject as 3.30[J]
Prereq: 3.20, 3.21, or permission of instructor
G (Spring)
3-0-9 units
Covers fundamental principles needed to understand and measure the microscopic properties of the surfaces of solids, with connections to structure, electronic, chemical, magnetic and mechanical properties. Reviews the theoretical aspects of surface behavior, including stability of surfaces, restructuring, and reconstruction. Examines the interaction of the surfaces with the environment, including absorption of atoms and molecules, chemical reactions and material growth, and interaction of surfaces with other point defects within the solids (space charges in semiconductors). Discusses principles of important tools for the characterization of surfaces, such as surface electron and x-ray diffraction, electron spectroscopies (Auger and x-ray photoelectron spectroscopy), scanning tunneling, and force microscopy.
B. Yildiz

22.78 Principles of Nuclear Chemical Engineering and Waste Management
Subject meets with 22.078
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Introduces scientific and engineering aspects of chemical engineering and waste management applied to reactors and the fuel cycle. Includes chemical behavior in reactors (normal and accident), spent nuclear fuel aging, separation processes in reprocessing (aqueous, pyro, and molten salt), and waste treatment processes. Addresses management of radioactive wastes, including waste forms, classification, fundamental principles, governing equations for radionuclide transport in the environment, performance assessment of geological waste disposal systems, and implications of advanced fuel cycles. Students taking graduate version complete additional assignments.
C. Forsberg

Systems, Policy, and Economics

22.811[J] Sustainable Energy
Same subject as 1.818[J], 2.65[J], 10.391[J], 11.371[J]
Subject meets with 2.650[J], 10.291[J], 22.081[J]
Prereq: Permission of instructor
G (Fall)
3-1-8 units
Assessment of current and potential future energy systems. Covers resources, extraction, conversion, and end-use technologies, with emphasis on meeting 21st-century regional and global energy needs in a sustainable manner. Examines various energy technologies in each fuel cycle stage for fossil (oil, gas, synthetic), nuclear (fission and fusion) and renewable (solar, biomass, wind, hydro, and geothermal) energy types, along with storage, transmission, and conservation issues. Emphasizes analysis of energy propositions within an engineering, economic and social context. Students taking graduate version complete additional assignments.
M. W. Golay

22.813[J] Energy Technology and Policy: From Principles to Practice
Same subject as 5.00[J], 6.929[J], 10.579[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-6 units
See description under subject 5.00[J]. Limited to 100.
J. Deutch

22.814[J] Nuclear Weapons and International Security
Same subject as 17.474[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
Examines the historical, political, and technical contexts for nuclear policy making, including the development of nuclear weapons by states, the evolution of nuclear strategy, the role nuclear weapons play in international politics, the risks posed by nuclear arsenals, and the policies and strategies in place to mitigate those risks. Equal emphasis is given to political and technical considerations affecting national choices. Considers the issues surrounding new non-proliferation strategies, nuclear security, and next steps for arms control.
R. S. Kemp, V. Narang
General

22.90 Nuclear Science and Engineering Laboratory
Subject meets with 22.09
Prereq: Permission of instructor
G (Fall)
2-6-4 units
See description under subject 22.09.
A. Danagoulian, G. Kohse

22.901 Independent Project in Nuclear Science and Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.
For graduate students who wish to conduct a one-term project of theoretical or experimental nature in the field of nuclear engineering, in close cooperation with individual faculty members. Topics and hours arranged to fit students' requirements. Projects require prior approval.
J. Li

22.911 Seminar in Nuclear Science and Engineering
Prereq: None
G (Fall, Spring)
2-0-1 units
Can be repeated for credit.
Restricted to graduate students engaged in doctoral thesis research.
C. Forsberg, P. Cappellaro, M. Li, N. Gomes Loureiro

22.912 Seminar in Nuclear Science and Engineering
Prereq: None
G (Spring)
Not offered regularly; consult department
2-0-1 units
Can be repeated for credit.
Restricted to graduate students engaged in doctoral thesis research.
C. Forsberg, I. Hutchinson, P. Cappellaro

22.921 Nuclear Power Plant Dynamics and Control
Prereq: None
Acad Year 2019-2020: G (IAP)
Acad Year 2020-2021: Not offered
1-0-2 units
Introduction to reactor dynamics, including subcritical multiplication, critical operation in absence of thermal feedback effects and effects of xenon, fuel and moderator temperature, etc. Derivation of point kinetics and dynamic period equations. Techniques for reactor control including signal validation, supervisory algorithms, model-based trajectory tracking, and rule-based control. Overview of light-water reactor start-up. Lectures and demonstrations with use of the MIT Research Reactor. Open to undergraduates with permission of instructor.
J. A. Bernard

22.93 Teaching Experience in Nuclear Science & Engineering
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged
For qualified graduate students interested in teaching as a career. Classroom, laboratory, or tutorial teaching under the supervision of a faculty member. Students selected by interview. Credits for this subject may not be used toward master's or engineer's degrees. Enrollment limited by availability of suitable teaching assignments.
D. Whyte

22.94 Research in Nuclear Science and Engineering
Prereq: Permission of research supervisor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For research assistants in Nuclear Science and Engineering who have not completed the NSE doctoral qualifying exam. Hours arranged with and approved by the research supervisor. Units may not be used towards advanced degree requirements.
J. Li
22.95 Internship in Nuclear Science and Engineering
Prereq: None
G (IAP, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For Nuclear Science and Engineering students participating in research or curriculum-related off-campus experiences. Before enrolling, students must have an offer from a company or organization. Upon completion, the student must submit a final report or presentation to the approved MIT supervisor, usually the student’s thesis supervisor or a member of the thesis committee. Subject to departmental approval. Consult the NSE Academic Office for details on procedures and restrictions. Limited to students participating in internships consistent with NSE policies relating to research-related employment.

Consult J. Li

22.S902-22.S905 Special Subject in Nuclear Science and Engineering
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Seminar or lecture on a topic in nuclear science and engineering that is not covered in the regular curriculum. 22.S905 is graded P/D/F.

J. Li

22.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research, leading to the writing of an SM, NE, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member. Consult department graduate office.

J. Li
PHYSICS (COURSE 8)

Undergraduate Subjects

8.01 Physics I
Prereq: None
U (Fall)
3-2-7 units. PHYSICS I
Credit cannot also be received for 8.011, 8.012, 8.01L, ES.801
Introduces classical mechanics. Space and time: straight-line kinematics; motion in a plane; forces and static equilibrium; particle dynamics, with force and conservation of momentum; relative inertial frames and non-inertial force; work, potential energy and conservation of energy; kinetic theory and the ideal gas; rigid bodies and rotational dynamics; vibrational motion; conservation of angular momentum; central force motions; fluid mechanics. Subject taught using the TEAL (Technology-Enabled Active Learning) format which features students working in groups of three, discussing concepts, solving problems, and doing table-top experiments with the aid of computer data acquisition and analysis.
J. Formaggio, P. Dourmashkin

8.011 Physics I
Prereq: None
U (Spring)
5-0-7 units. PHYSICS I
Credit cannot also be received for 8.01, 8.012, 8.01L, ES.801
Introduces classical mechanics. Space and time: straight-line kinematics; motion in a plane; forces and equilibrium; experimental basis of Newton’s laws; particle dynamics; universal gravitation; collisions and conservation laws; work and potential energy; vibrational motion; conservative forces; inertial forces and non-inertial frames; central force motions; rigid bodies and rotational dynamics. Designed for students with previous experience in 8.01; the subject is designated as 8.01 on the transcript.
P. Jarillo-Herrero

8.012 Physics I
Prereq: None
U (Fall)
5-0-7 units. PHYSICS I
Credit cannot also be received for 8.01, 8.011, 8.01L, ES.801
Elementary mechanics, presented in greater depth than in 8.01. Newton’s laws, concepts of momentum, energy, angular momentum, rigid body motion, and non-inertial systems. Uses elementary calculus freely; concurrent registration in a math subject more advanced than 18.01 is recommended. In addition to covering the theoretical subject matter, students complete a small experimental project of their own design. Freshmen admitted via AP or Math Diagnostic for Physics Placement results.
M. Soljacic

8.01L Physics I
Prereq: None
U (Fall, IAP)
3-2-7 units. PHYSICS I
Credit cannot also be received for 8.01, 8.011, 8.012, ES.801
Introduction to classical mechanics (see description under 8.01). Includes components of the TEAL (Technology-Enabled Active Learning) format. Material covered over a longer interval so that the subject is completed by the end of the IAP. Substantial emphasis given to reviewing and strengthening necessary mathematics tools, as well as basic physics concepts and problem-solving skills. Content, depth, and difficulty is otherwise identical to that of 8.01. The subject is designated as 8.01 on the transcript.
P. Jarillo-Herrero

8.02 Physics II
Prereq: Calculus I (GIR) and Physics I (GIR)
U (Fall, Spring)
3-2-7 units. PHYSICS II
Credit cannot also be received for 8.021, 8.022, ES.802, ES.8022
Introduction to electromagnetism and electrostatics: electric charge, Coulomb’s law, electric structure of matter; conductors and dielectrics. Concepts of electrostatic field and potential, electrostatic energy. Electric currents, magnetic fields and Ampere’s law. Magnetic materials. Time-varying fields and Faraday’s law of induction. Basic electric circuits. Electromagnetic waves and Maxwell’s equations. Subject taught using the TEAL (Technology Enabled Active Learning) studio format which utilizes small group interaction and current technology to help students develop intuition about, and conceptual models of, physical phenomena.
J. Belcher, I. Cisse
8.021 Physics II
Prereq: Calculus I (GIR), Physics I (GIR), and permission of instructor
U (Fall)
5-0-7 units. PHYSICS II
Credit cannot also be received for 8.02, 8.022, ES.802, ES.8022
Introduction to electromagnetism and electrostatics: electric charge, Coulomb's law, electric structure of matter; conductors and dielectrics. Concepts of electrostatic field and potential, electrostatic energy. Electric currents, magnetic fields and Ampere's law. Magnetic materials. Time-varying fields and Faraday's law of induction. Basic electric circuits. Electromagnetic waves and Maxwell's equations. Designed for students with previous experience in 8.02; the subject is designated as 8.02 on the transcript. Enrollment limited.
J. Checkelsky

8.022 Physics II
Prereq: Physics I (GIR); Coreq: Calculus II (GIR)
U (Fall, Spring)
5-0-7 units. PHYSICS II
Credit cannot also be received for 8.02, 8.021, ES.802, ES.8022
Parallel to 8.02, but more advanced mathematically. Some knowledge of vector calculus assumed. Maxwell's equations, in both differential and integral form. Electrostatic and magnetic vector potential. Properties of dielectrics and magnetic materials. In addition to the theoretical subject matter, several experiments in electricity and magnetism are performed by the students in the laboratory.
D. Harlow

8.03 Physics III
Prereq: Calculus II (GIR) and Physics II (GIR)
U (Fall, Spring)
5-0-7 units. REST
Mechanical vibrations and waves; simple harmonic motion, superposition, forced vibrations and resonance, coupled oscillations, and normal modes; vibrations of continuous systems; reflection and refraction; phase and group velocity. Optics; wave solutions to Maxwell's equations; polarization; Snell's Law, interference, Huygens's principle, Fraunhofer diffraction, and gratings.
Y.-J. Lee, R. Comin

8.033 Relativity
Prereq: Calculus II (GIR) and Physics II (GIR)
U (Fall)
5-0-7 units. REST
Einstein's postulates; consequences for simultaneity, time dilation, length contraction, and clock synchronization; Lorentz transformation; relativistic effects and paradoxes; Minkowski diagrams; invariants and four-vectors; momentum, energy, and mass; particle collisions. Relativity and electricity; Coulomb's law; magnetic fields. Brief introduction to Newtonian cosmology. Introduction to some concepts of general relativity; principle of equivalence. The Schwarzschild metric; gravitational red shift; particle and light trajectories; geodesics; Shapiro delay.
S. Vitale

8.04 Quantum Physics I
Prereq: 8.03 and (18.03 or 18.032)
U (Spring)
5-0-7 units. REST
Credit cannot also be received for 8.04
Experimental basis of quantum physics: photoelectric effect, Compton scattering, photons, Franck-Hertz experiment, the Bohr atom, electron diffraction, deBroglie waves, and wave-particle duality of matter and light. Introduction to wave mechanics: Schroedinger's equation, wave functions, wave packets, probability amplitudes, stationary states, the Heisenberg uncertainty principle, and zero-point energies. Solutions to Schroedinger's equation in one dimension: transmission and reflection at a barrier, barrier penetration, potential wells, the simple harmonic oscillator. Schroedinger's equation in three dimensions: central potentials and introduction to hydrogenic systems.
V. Vuletic, M. Vogelsberger

8.04 Special Subject: Quantum Physics I
Prereq: 8.03 and (18.03 or 18.032)
U (Fall)
2-0-10 units. REST
Credit cannot also be received for 8.04
Experimental version of 8.04, which offers a combination of online and in-person instruction. See description of 8.04. Licensed by the Committee on Curricula as an acceptable alternative to 8.04 for Fall 2017.
R. Ashoori
PHYSICS (COURSE 8)

8.044 Statistical Physics I
Prereq: 8.03 and 18.03
U (Spring)
5-0-7 units

Introduction to probability, statistical mechanics, and thermodynamics. Random variables, joint and conditional probability densities, and functions of a random variable. Concepts of macroscopic variables and thermodynamic equilibrium, fundamental assumption of statistical mechanics, microcanonical and canonical ensembles. First, second, and third laws of thermodynamics. Numerous examples illustrating a wide variety of physical phenomena such as magnetism, polyatomic gases, thermal radiation, electrons in solids, and noise in electronic devices. Concurrent enrollment in 8.04 is recommended.

N. Fakhri

8.05 Quantum Physics II
Prereq: 8.04
U (Fall)
5-0-7 units
Credit cannot also be received for 8.051


Fall: Staff
Spring: W. Detmold

8.051 Quantum Physics II
Prereq: 8.04 and permission of instructor
U (Spring)
2-0-10 units
Credit cannot also be received for 8.05


Fall: Staff
Spring: W. Detmold

8.06 Quantum Physics III
Prereq: 8.05
U (Spring)
5-0-7 units

Continuation of 8.05. Units: natural units, scales of microscopic phenomena, applications. Time-independent approximation methods: degenerate and nondegenerate perturbation theory, variational method, Born-Oppenheimer approximation, applications to atomic and molecular systems. The structure of one- and two-electron atoms: overview, spin-orbit and relativistic corrections, fine structure, variational approximation, screening, Zeeman and Stark effects. Charged particles in a magnetic field: Landau levels and integer quantum hall effect. Scattering: general principles, partial waves, review of one-dimension, low-energy approximations, resonance, Born approximation. Time-dependent perturbation theory. Students research and write a paper on a topic related to the content of 8.05 and 8.06.

B. Zwiebach
8.07 Electromagnetism II
Prereq: 8.03 and 18.03
U (Fall)
4-0-8 units

A. Guth

8.08 Statistical Physics II
Prereq: 8.044 and 8.05
U (Spring)
4-0-8 units


Fall: Staff
Spring: L. Fu

8.09 Classical Mechanics III
Subject meets with 8.309
Prereq: 8.223
U (Fall)
4-0-8 units

Covers Lagrangian and Hamiltonian mechanics, systems with constraints, rigid body dynamics, vibrations, central forces, Hamilton-Jacobi theory, action-angle variables, perturbation theory, and continuous systems. Provides an introduction to ideal and viscous fluid mechanics, including turbulence, as well as an introduction to nonlinear dynamics, including chaos. Students taking graduate version complete different assignments.
I. Stewart

Undergraduate Laboratory and Special Project Subjects

8.13 Experimental Physics I
Prereq: 8.04
U (Fall, Spring)
0-6-12 units. Institute LAB

Four fundamental laboratory experiments are carried out each term, covering most aspects of modern physics relating to names such as Rutherford, Franck-Hertz, Hall, Ramsauer, Doppler, Fraunhofer, Faraday, Mossbauer, Compton, and Stern-Gerlach. Stresses basic experimental techniques and data analysis, and written and oral presentation of experiment results.
J. Conrad, J. Formaggio, A. Levine, K. Perez

8.14 Experimental Physics II
Prereq: 8.05 and 8.13
U (Spring)
0-6-12 units

Four fundamental laboratory experiments are carried out each term, covering most aspects of modern physics relating to names such as Rutherford, Franck-Hertz, Hall, Ramsauer, Doppler, Fraunhofer, Faraday, Mossbauer, Compton, and Stern-Gerlach. Stresses basic experimental techniques and data analysis, and written and oral presentation of experiment results. 8.14 requires knowledge of quantum mechanics at the 8.05 level.
G. Roland

8.18 Research Problems in Undergraduate Physics
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for undergraduates to engage in experimental or theoretical research under the supervision of a staff member. Specific approval required in each case.
Consult N. Mavalvala

8.19 Readings in Physics
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Supervised reading and library work. Choice of material and allotment of time according to individual needs. For students who want to do work not provided for in the regular subjects. Specific approval required in each case.
Consult N. Mavalvala
**Undergraduate Elective Subjects**

8.20 Introduction to Special Relativity  
Prereq: Calculus I (GIR) and Physics I (GIR)  
U (IAP)  
2-0-7 units. REST  
Introduces the basic ideas and equations of Einstein’s special theory of relativity. Topics include Lorentz transformations, length contraction and time dilation, four vectors, Lorentz invariants, relativistic energy and momentum, relativistic kinematics, Doppler shift, space-time diagrams, relativity paradoxes, and some concepts of general relativity. Intended for freshmen and sophomores. Not usable as a restricted elective by Physics majors. Credit cannot be received for 8.20 if credit for 8.033 is or has been received in the same or prior terms.  
S. Vitale

8.21 Physics of Energy  
Prereq: Calculus II (GIR), Chemistry (GIR), and Physics II (GIR)  
U (Spring)  
5-0-7 units. REST  
A comprehensive introduction to the fundamental physics of energy systems that emphasizes quantitative analysis. Focuses on the fundamental physical principles underlying energy processes and on the application of these principles to practical calculations. Applies mechanics and electromagnetism to energy systems; introduces and applies basic ideas from thermodynamics, quantum mechanics, and nuclear physics. Examines energy sources, conversion, transport, losses, storage, conservation, and end uses. Analyzes the physics of side effects, such as global warming and radiation hazards. Provides students with technical tools and perspective to evaluate energy choices quantitatively at both national policy and personal levels.  
R. Jaffe

8.223 Classical Mechanics II  
Prereq: Calculus II (GIR) and Physics I (GIR)  
U (IAP)  
2-0-4 units  
A broad, theoretical treatment of classical mechanics, useful in its own right for treating complex dynamical problems, but essential to understanding the foundations of quantum mechanics and statistical physics. Generalized coordinates, Lagrangian and Hamiltonian formulations, canonical transformations, and Poisson brackets. Applications to continuous media. The relativistic Lagrangian and Maxwell’s equations.  
Staff, M. Evans

8.224 Exploring Black Holes: General Relativity and Astrophysics  
Prereq: 8.033 or 8.20  
U (Spring)  
Not offered regularly; consult department  
3-0-9 units  
Study of physical effects in the vicinity of a black hole as a basis for understanding general relativity, astrophysics, and elements of cosmology. Extension to current developments in theory and observation. Energy and momentum in flat space-time; the metric; curvature of space-time near rotating and nonrotating centers of attraction; trajectories and orbits of particles and light; elementary models of the Cosmos. Weekly meetings include an evening seminar and recitation. The last third of the term is reserved for collaborative research projects on topics such as the Global Positioning System, solar system tests of relativity, descending into a black hole, gravitational lensing, gravitational waves, Gravity Probe B, and more advanced models of the cosmos. Subject has online components that are open to selected MIT alumni. Alumni wishing to participate should contact Professor Bertschinger at edbert@mit.edu. Limited to 40.  
E. Bertschinger

8.225[J] Einstein, Oppenheimer, Feynman: Physics in the 20th Century  
Same subject as STS.042[J]  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall)  
3-0-9 units. HASS-H  
See description under subject STS.042[J]. Enrollment limited.  
D. I. Kaiser

8.226 Forty-three Orders of Magnitude  
Prereq: (8.04 and 8.044) or permission of instructor  
Acad Year 2019-2020: U (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units  
Examines the widespread societal implications of current scientific discoveries in physics across forty-three orders of magnitude in length scale. Addresses topics ranging from climate change to nuclear nonproliferation. Students develop their ability to express concepts at a level accessible to the public and to present a well-reasoned argument on a topic that is a part of the national debate. Requires diverse writing assignments, including substantial papers. Enrollment limited.  
J. Conrad
8.231 Physics of Solids I
Prereq: 8.044; Coreq: 8.05
U (Fall)
4-0-8 units
Introduction to the basic concepts of the quantum theory of solids. Topics: periodic structure and symmetry of crystals; diffraction; reciprocal lattice; chemical bonding; lattice dynamics, phonons, thermal properties; free electron gas; model of metals; Bloch theorem and band structure, nearly free electron approximation; tight binding method; Fermi surface; semiconductors, electrons, holes, impurities; optical properties, excitons; and magnetism.
S. Todadri

8.241 Introduction to Biological Physics
Subject meets with 20.315, 20.415
Prereq: Physics II (GIR) and (5.60 or 8.044)
U (Spring)
4-0-8 units
Introduces the main concepts of biological physics, with a focus on biophysical phenomena at the molecular and cellular scales. Presents the role of entropy and diffusive transport in living matter; challenges to life resulting from the highly viscous environment present at microscopic scales, including constraints on force, motion and transport within cells, tissues, and fluids; principles of how cellular machinery (e.g., molecular motors) can convert electro-chemical energy sources to mechanical forces and motion. Also covers polymer physics relevant to DNA and other biological polymers, including the study of configurations, fluctuations, rigidity, and entropic elasticity.
I. Cisse

8.251 String Theory for Undergraduates
Prereq: 8.033, 8.044, and 8.05
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units
Credit cannot also be received for 8.821
Introduction to the main concepts of string theory, i.e., quantum mechanics of a relativistic string. Develops aspects of string theory and makes it accessible to students familiar with basic electromagnetism and statistical mechanics, including the study of D-branes and string thermodynamics. Meets with 8.821 when offered concurrently.
H. Liu

8.276 Nuclear and Particle Physics
Prereq: 8.033 and 8.04
U (Spring)
Not offered regularly; consult department
4-0-8 units
Presents a modern view of the fundamental structure of matter. Starting from the Standard Model, which views leptons and quarks as basic building blocks of matter, establishes the properties and interactions of these particles. Explores applications of this phenomenology to both particle and nuclear physics. Emphasizes current topics in nuclear and particle physics research at MIT. Intended for students with a basic knowledge of relativity and quantum physics concepts.
M. Williams

8.277 Introduction to Particle Accelerators
Prereq: (6.013 or 8.07) and permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Principles of acceleration: beam properties; linear accelerators, synchrotrons, and storage rings. Accelerator technologies: radio frequency cavities, bending and focusing magnets, beam diagnostics. Particle beam optics and dynamics. Special topics: measures of accelerators performance in science, medicine and industry; synchrotron radiation sources; free electron lasers; high-energy colliders; and accelerators for radiation therapy. May be repeated for credit for a maximum of 12 units.
W. Barletta

8.282[J] Introduction to Astronomy
Same subject as 12.402[J]
Prereq: Physics I (GIR)
U (Spring)
3-0-6 units. REST
Quantitative introduction to physics of the solar system, stars, interstellar medium, the galaxy, and universe, as determined from a variety of astronomical observations and models. Topics: planets, planet formation; stars, the Sun, "normal" stars, star formation; stellar evolution, supernovae, compact objects (white dwarfs, neutron stars, and black holes), pulsars, binary x-ray sources; star clusters, globular and open clusters; interstellar medium, gas, dust, magnetic fields, cosmic rays; distance ladder; galaxies, normal and active galaxies, jets; gravitational lensing; large scaling structure; Newtonian cosmology, dynamical expansion and thermal history of the universe; cosmic microwave background radiation; big bang nucleosynthesis. No prior knowledge of astronomy necessary. Not usable as a restricted elective by Physics majors.
A. Frebel
8.284 Modern Astrophysics
Prereq: 8.04; Coreq: 8.05
U (Spring)
3-0-9 units
Applications of physics (Newtonian, statistical, and quantum mechanics) to fundamental processes that occur in celestial objects. Includes main-sequence stars, collapsed stars (white dwarfs, neutron stars, and black holes), pulsars, supernovae, relativistic, the interstellar medium, galaxies, and as time permits, active galaxies, quasars, and cosmology. Observational data discussed. No prior knowledge of astronomy is required.

N. Weinberg

8.286 The Early Universe
Prereq: Physics II (GIR) and 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. REST

Introduction to modern cosmology. First half deals with the development of the big bang theory from 1915 to 1980, and latter half with the recent impact of particle theory. Topics: special relativity and the Doppler effect, Newtonian cosmological models, introduction to non-Euclidean spaces, thermal radiation and early history of the universe, big bang nucleosynthesis, introduction to grand unified theories and other recent developments in particle theory, baryogenesis, the inflationary universe model, and the evolution of galactic structure.

A. Guth

8.287J Observational Techniques of Optical Astronomy
Same subject as 12.410J
Prereq: 8.282J, 12.409, or other introductory astronomy course
U (Fall)
3-4-8 units. Institute LAB

See description under subject 12.410J. Limited to 18; preference to Course 8 and Course 12 majors and minors.

R. Binzel, A. Bosh

8.290J Extrasolar Planets: Physics and Detection Techniques
Same subject as 12.425J
Subject meets with 12.625
Prereq: 8.03 and 18.03
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
2-1-9 units. REST

See description under subject 12.425J.

S. Seager

8.292J Fluid Physics
Same subject as 12.330J
Prereq: 5.60, 8.044, or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

A physics-based introduction to the properties of fluids and fluid systems, with examples drawn from a broad range of sciences, including atmospheric physics and astrophysics. Definitions of fluids and the notion of continuum. Equations of state and continuity, hydrostatics and conservation of momentum; ideal fluids and Euler’s equation; viscosity and the Navier-Stokes equation. Energy considerations, fluid thermodynamics, and isentropic flow. Compressible versus incompressible and rotational versus irrotational flow; Bernoulli’s theorem; steady flow, streamlines and potential flow. Circulation and vorticity. Kelvin’s theorem. Boundary layers. Fluid waves and instabilities. Quantum fluids.

Staff

8.295 Practical Work Experience
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 units
Can be repeated for credit.

For Course 8 students participating in off-campus work experiences in physics. Before registering for this subject, students must have an employment offer from a company or organization and must identify a Physics supervisor. Upon completion of the work, student must submit a letter from the employer describing the work accomplished, along with a substantive final report from the student approved by the MIT supervisor. Subject to departmental approval. Consult departmental academic office.

Consult N. Mavalvala

8.298 Selected Topics in Physics
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Presentation of topics of current interest, with content varying from year to year.

Consult I. Stewart
8.299 Physics Teaching
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For qualified undergraduate students interested in gaining some experience in teaching. Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview.

Consult N. Mavalvala

8.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject.
Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 8.EPE, 10.EPE, 15.EPE, 16.EPE, 20.EPE, 22.EPE
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 units

See description under subject 2.EPE.
Staff

8.504 Special Subject: Quantum Physics I
Prereq: 8.03 and (18.03 or 18.032)
U (Fall)
2-0-10 units. REST
Credit cannot also be received for 8.04

Experimental version of 8.04, which offers a combination of online and in-person instruction. See description of 8.04. Licensed by the Committee on Curricula as an acceptable alternative to 8.04 for Fall 2017.
R. Ashoori

8.510 Special Subject: Physics
Prereq: None
U (Spring)
Units arranged
Can be repeated for credit.

Opportunity for group study of subjects in physics not otherwise included in the curriculum.
A. Adams, K. Ellenbogen

8.530 Special Subject: Physics
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (IAP)
Units arranged

Opportunity for group study of subjects in physics not otherwise included in the curriculum.
A. Bernstein, J. Walsh

8.550 Special Subject: Physics
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for group study of subjects in physics not otherwise included in the curriculum.
E. Bertschinger

8.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Research opportunities in physics. For further information, contact the departmental UROP coordinator.
N. Mavalvala

8.THU Undergraduate Physics Thesis
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of an S.B. thesis; to be arranged by the student under approved supervision.
Information: N. Mavalvala

Graduate Subjects

8.309 Classical Mechanics III
Subject meets with 8.09
Prereq: None
G (Fall)
4-0-8 units

Covers Lagrangian and Hamiltonian mechanics, systems with constraints, rigid body dynamics, vibrations, central forces, Hamilton-Jacobi theory, action-angle variables, perturbation theory, and continuous systems. Provides an introduction to ideal and viscous fluid mechanics, including turbulence, as well as an introduction to nonlinear dynamics, including chaos. Students taking graduate version complete different assignments.
I. Stewart
8.311 Electromagnetic Theory I
Prereq: 8.07
G (Spring)
4-0-8 units
Basic principles of electromagnetism: experimental basis, electrostatics, magnetic fields of steady currents, motional emf and electromagnetic induction, Maxwell’s equations, propagation and radiation of electromagnetic waves, electric and magnetic properties of matter, and conservation laws. Subject uses appropriate mathematics but emphasizes physical phenomena and principles.
J. Belcher

Same subject as 18.369[J]
Prereq: 8.07, 18.303, or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
See description under subject 18.369[J].
S. G. Johnson

8.321 Quantum Theory I
Prereq: 8.05
G (Fall)
4-0-8 units
H. Liu

8.322 Quantum Theory II
Prereq: 8.07 and 8.321
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units
S. Todadri

8.323 Relativistic Quantum Field Theory I
Prereq: 8.321
G (Spring)
4-0-8 units
T. Slatyer

8.324 Relativistic Quantum Field Theory II
Prereq: 8.322 and 8.323
G (Fall)
4-0-8 units
The second term of the quantum field theory sequence. Develops in depth some of the topics discussed in 8.323 and introduces some advanced material. Topics: perturbation theory and Feynman diagrams, scattering theory, Quantum Electrodynamics, one loop renormalization, quantization of non-abelian gauge theories, the Standard Model of particle physics, other topics.
T. Slatyer
8.325 Relativistic Quantum Field Theory III
Prereq: 8.324
G (Spring)
4-0-8 units
The third and last term of the quantum field theory sequence. Its aim is the proper theoretical discussion of the physics of the standard model. Topics: quantum chromodynamics; Higgs phenomenon and a description of the standard model; deep-inelastic scattering and structure functions; basics of lattice gauge theory; operator products and effective theories; detailed structure of the standard model; spontaneously broken gauge theory and its quantization; instantons and theta-vacua; topological defects; introduction to supersymmetry.
W. Taylor

8.333 Statistical Mechanics I
Prereq: 8.044 and 8.05
G (Fall)
4-0-8 units
First part of a two-subject sequence on statistical mechanics. Examines the laws of thermodynamics and the concepts of temperature, work, heat, and entropy. Postulates of classical statistical mechanics, microcanonical, canonical, and grand canonical distributions; applications to lattice vibrations, ideal gas, photon gas. Quantum statistical mechanics; Fermi and Bose systems. Interacting systems: cluster expansions, van der Waal’s gas, and mean-field theory.
M. Kardar

8.334 Statistical Mechanics II
Prereq: 8.333
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
4-0-8 units
Staff

Same subject as 6.946[J], 12.620[J]
Prereq: Physics I (GIR), 18.03, and permission of instructor
G (Fall)
3-3-6 units
See description under subject 12.620[J].
J. Wisdom, G. J. Sussman

8.361 Quantum Theory of Many-Particle Systems
Prereq: 8.322 and 8.333
G (Fall)
Not offered regularly; consult department
3-0-9 units
Introduces general many-body theory applicable to low temperature, nuclear, and solid-state physics. Reviews occupation number representation and classical Mayer expansion. Perturbation theory: diagrammatic expansions and linked-cluster theorem for zero or finite temperature systems of fermions or bosons. Green’s functions: analytic properties, equations of motion, relation to observables, approximations, linear response theory, and random phase approximation. Superconductivity: electron-phonon interaction, instability of normal state, BCS ground state, perturbation theory.
Staff

8.370[J] Quantum Computation
Same subject as 2.111[J], 18.435[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units
See description under subject 18.435[J].
I. Chuang, A. Harrow, S. Lloyd, P. Shor

8.371[J] Quantum Information Science
Same subject as 6.443[J], 18.436[J]
Prereq: 18.435[J]
G (Spring)
3-0-9 units
Examines quantum computation and quantum information. Topics include quantum circuits, the quantum Fourier transform and search algorithms, the quantum operations formalism, quantum error correction, Calderbank-Shor-Steane and stabilizer codes, fault tolerant quantum computation, quantum data compression, quantum entanglement, capacity of quantum channels, and quantum cryptography and the proof of its security. Prior knowledge of quantum mechanics required.
I. Chuang, A. Harrow

8.381, 8.382 Selected Topics in Theoretical Physics
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Topics of current interest in theoretical physics, varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Staff
8.391 Pre-Thesis Research
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]
Can be repeated for credit.
Advanced problems in any area of experimental or theoretical physics, with assigned reading and consultations.
Staff

8.392 Pre-Thesis Research
Prereq: Permission of instructor
G (Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Advanced problems in any area of experimental or theoretical physics, with assigned reading and consultations.
Staff

8.395[J] Teaching College-Level Science and Engineering
Same subject as 1.95[J], 5.95[J], 7.59[J], 18.094[J]
Subject meets with 2.978
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-0-2 units
See description under subject 5.95[J].
J. Rankin

8.398 Selected Topics in Graduate Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
Presentation of topics of current interest with content varying from year to year.
Consult N. Mavalvala

8.399 Physics Teaching
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.
For qualified graduate students interested in gaining some experience in teaching. Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview.
Consult C. Paus

Physics of Atoms, Radiation, Solids, Fluids, and Plasmas

8.421 Atomic and Optical Physics I
Prereq: 8.05
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
The first of a two-term subject sequence that provides the foundations for contemporary research in selected areas of atomic and optical physics. The interaction of radiation with atoms: resonance; absorption, stimulated and spontaneous emission; methods of resonance, dressed atom formalism, masers and lasers, cavity quantum electrodynamics; structure of simple atoms, behavior in very strong fields; fundamental tests: time reversal, parity violations, Bell's inequalities; and experimental methods.
M. Zwierlein

8.422 Atomic and Optical Physics II
Prereq: 8.05
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
The second of a two-term subject sequence that provides the foundations for contemporary research in selected areas of atomic and optical physics. Non-classical states of light—squeezed states; multi-photon processes, Raman scattering; coherence—level crossings, quantum beats, double resonance, superradiance; trapping and cooling—light forces, laser cooling, atom optics, spectroscopy of trapped atoms and ions; atomic interactions—classical collisions, quantum scattering theory, ultracold collisions; and experimental methods.
Staff

8.431[J] Nonlinear Optics
Same subject as 6.634[J]
Prereq: 6.013 or 8.07
G (Spring)
3-0-9 units
See description under subject 6.634[J].
J. G. Fujimoto
8.481, 8.482 Selected Topics in Physics of Atoms and Radiation
Prereq: 8.321
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Presentation of topics of current interest, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Staff

8.511 Theory of Solids I
Prereq: 8.231
G (Fall)
3-0-9 units
L. Levitov

8.512 Theory of Solids II
Prereq: 8.511
G (Spring)
3-0-9 units
L. Levitov

8.513 Many-Body Theory for Condensed Matter Systems
Prereq: 8.033, 8.05, 8.08, and 8.231
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Concepts and physical pictures behind various phenomena that appear in interacting many-body systems. Visualization occurs through concentration on path integral, mean-field theories and semiclassical picture of fluctuations around mean-field state. Topics covered: interacting boson/fermion systems, Fermi liquid theory and bosonization, symmetry breaking and nonlinear sigma-model, quantum gauge theory, quantum Hall theory, mean-field theory of spin liquids and quantum order, string-net condensation and emergence of light and fermions.
X-G. Wen

8.514 Strongly Correlated Systems in Condensed Matter Physics
Prereq: 8.322 and 8.333
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Study of condensed matter systems where interactions between electrons play an important role. Topics vary depending on lecturer but may include low-dimension magnetic and electronic systems, disorder and quantum transport, magnetic impurities (the Kondo problem), quantum spin systems, the Hubbard model and high-temperature superconductors. Topics are chosen to illustrate the application of diagrammatic techniques, field-theory approaches, and renormalization group methods in condensed matter physics.
S. Todadri

8.581, 8.582 Selected Topics in Condensed Matter Physics
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.
Presentation of topics of current interest, with contents varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Staff

8.590[J] Topics in Biophysics and Physical Biology
Same subject as 7.74[J], 20.416[J]
Prereq: None
G (Fall)
2-0-4 units
See description under subject 20.416[J].
I. Cisse, N. Fakhri, M. Guo
8.591[J] Systems Biology
Same subject as 7.81[J]
Subject meets with 7.32
Prereq: (18.03 and 18.05) or permission of instructor
G (Fall)
3-0-9 units
Introduction to cellular and population-level systems biology with an emphasis on synthetic biology, modeling of genetic networks, cell-cell interactions, and evolutionary dynamics. Cellular systems include genetic switches and oscillators, network motifs, genetic network evolution, and cellular decision-making. Population-level systems include models of pattern formation, cell-cell communication, and evolutionary systems biology. Students taking graduate version explore the subject in more depth.
J. Gore

8.592[J] Statistical Physics in Biology
Same subject as HST.452[J]
Prereq: 8.333 or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
M. Kardar, L. Mirny

8.593[J] Biological Physics
Same subject as HST.450[J]
Prereq: 8.044 recommended but not necessary
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units
Designed to provide seniors and first-year graduate students with a quantitative, analytical understanding of selected biological phenomena. Topics include experimental and theoretical basis for the phase boundaries and equation of state of concentrated protein solutions, with application to diseases such as sickle cell anemia and cataract. Protein-ligand binding and linkage and the theory of allosteric regulation of protein function, with application to proteins as stores as transporters in respiration, enzymes in metabolic pathways, membrane receptors, regulators of gene expression, and self-assembling scaffolds. The physics of locomotion and chemoreception in bacteria and the biophysics of vision, including the theory of transparency of the eye, molecular basis of photo reception, and the detection of light as a signal-to-noise discrimination.
G. Benedek

8.613[J] Introduction to Plasma Physics I
Same subject as 22.611[J]
Prereq: (6.013 or 8.07) and (18.04 or Coreq: 18.075)
G (Fall)
3-0-9 units
See description under subject 22.611[J].
I. Hutchinson

8.614[J] Introduction to Plasma Physics II (New)
Same subject as 22.612[J]
Prereq: 22.611[J]
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Linear waves and instabilities in magnetized plasma; solutions of Vlasov-Maxwell equations in homogeneous and inhomogeneous plasmas; conservation principles for energy and momentum; quasi-linear theory and nonlinear stabilization; solitons and coherent nonlinear phenomena; collisions and discrete particle effects; fluctuations in a stable plasma; Fokker-Planck equation and transport phenomena. A subject description tailored to fit the background and interests of the attending students distributed shortly before and at the beginning of the subject.
Staff
8.624 Plasma Waves
Prereq: 22.611[J]
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Comprehensive theory of electromagnetic waves in a magnetized plasma. Wave propagation in cold and hot plasmas. Energy flow. Absorption by Landau and cyclotron damping and by transit time magnetic pumping (TTMP). Wave propagation in inhomogeneous plasma: accessibility, WKB theory, mode conversion, connection formulae, and Budden tunneling. Applications to RF plasma heating, wave propagation in the ionosphere and laser-plasma interactions. Wave propagation in toroidal plasmas, and applications to ion cyclotron (ICRF), electron cyclotron (ECRH), and lower hybrid (LHH) wave heating. Quasi-linear theory and applications to RF current drive in tokamaks. Extensive discussion of relevant experimental observations.

M. Porkolab

8.641 Physics of High-Energy Plasmas I
Prereq: 22.611[J]
G (Fall)
Not offered regularly; consult department
3-0-9 units

Physics of High-Energy Plasmas I and II address basic concepts of plasmas, with temperatures of thermonuclear interest, relevant to fusion research and astrophysics. Microscopic transport processes due to interparticle collisions and collective modes (e.g., microinstabilities). Relevant macroscopic transport coefficients (electrical resistivity, thermal conductivities, particle “diffusion”). Runaway and slide-away regimes. Magnetic reconnection processes and their relevance to experimental observations. Radiation emission from inhomogeneous plasmas. Conditions for thermonuclear burning and ignition (D-T and “advanced” fusion reactions, plasmas with polarized nuclei). Role of “impurity” nuclei. “Finite-β” (pressure) regimes and ballooning modes. Convective modes in configuration and velocity space. Trapped particle regimes. Nonlinear and explosive instabilities. Interaction of positive and negative energy modes. Each subject can be taken independently.

Staff

8.642 Physics of High-Energy Plasmas II
Prereq: 22.611[J]
G (Fall)
Not offered regularly; consult department
3-0-9 units

Physics of High-Energy Plasmas I and II address basic concepts of plasmas, with temperatures of thermonuclear interest, relevant to fusion research and astrophysics. Microscopic transport processes due to interparticle collisions and collective modes (e.g., microinstabilities). Relevant macroscopic transport coefficients (electrical resistivity, thermal conductivities, particle “diffusion”). Runaway and slide-away regimes. Magnetic reconnection processes and their relevance to experimental observations. Radiation emission from inhomogeneous plasmas. Conditions for thermonuclear burning and ignition (D-T and “advanced” fusion reactions, plasmas with polarized nuclei). Role of “impurity” nuclei. “Finite-β” (pressure) regimes and ballooning modes. Convective modes in configuration and velocity space. Trapped particle regimes. Nonlinear and explosive instabilities. Interaction of positive and negative energy modes. Each subject can be taken independently.

Staff

8.670[J] Principles of Plasma Diagnostics
Same subject as 22.67[J]
Prereq: 22.611[J]
G (Fall)
Not offered regularly; consult department
4-4-4 units
See description under subject 22.67[J].

A. White

8.681, 8.682 Selected Topics in Fluid and Plasma Physics
Prereq: 22.611[J]
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Presentation of topics of current interest, with content varying from year to year. Subject not routinely offered; given when interest is indicated.

Consult M. Porkolab
**Nuclear and Particle Physics**

8.701 Introduction to Nuclear and Particle Physics  
Prereq: None. Coreq: 8.321  
G (Fall)  
3-0-9 units  
The phenomenology and experimental foundations of particle and nuclear physics; the fundamental forces and particles, composites. Interactions of particles with matter, and detectors. SU(2), SU(3), models of mesons and baryons. QED, weak interactions, parity violation, lepton-nucleon scattering, and structure functions. QCD, gluon field and color. W and Z fields, electro-weak unification, the CKM matrix. Nucleon-nucleon interactions, properties of nuclei, single- and collective- particle models. Electron and hadron interactions with nuclei. Relativistic heavy ion collisions, and transition to quark-gluon plasma.  
M. Williams

8.711 Nuclear Physics  
Prereq: 8.321 and 8.701  
G (Spring)  
4-0-8 units  
O. Hen

8.712 Advanced Topics in Nuclear Physics  
Prereq: 8.711 or permission of instructor  
G (Fall, Spring)  
Not offered regularly; consult department  
3-0-9 units  
Can be repeated for credit.  
Subject for experimentalists and theorists with rotation of the following topics: (1) Nuclear chromodynamics-- introduction to QCD, structure of nucleons, lattice QCD, phases of hadronic matter; and relativistic heavy ion collisions. (2) Medium-energy physics-- nuclear and nucleon structure and dynamics studied with medium- and high-energy probes (neutrinos, photons, electrons, nucleons, pions, and kaons). Studies of weak and strong interactions.  
Staff

8.781, 8.782 Selected Topics in Nuclear Theory  
Prereq: 8.323  
G (Fall, Spring)  
Not offered regularly; consult department  
3-0-9 units  
PRESENTS TOPICS OF CURRENT INTEREST IN NUCLEAR STRUCTURE AND REACTION THEORY, WITH CONTENT VARYING FROM YEAR TO YEAR. SUBJECT NOT ROUTINELY OFFERED; GIVEN WHEN SUFFICIENT INTEREST IS INDICATED.  
Consult E. Farhi

8.811 Particle Physics  
Prereq: 8.701  
G (Fall)  
3-0-9 units  
L. Winslow

8.812 Graduate Experimental Physics  
Prereq: 8.701  
G (IAP)  
Not offered regularly; consult department  
1-8-3 units  
Provides practical experience in particle detection with verification by (Feynman) calculations. Students perform three experiments; at least one requires actual construction following design. Topics include Compton effect, Fermi constant in muon decay, particle identification by time-of-flight, Cerenkov light, calorimeter response, tunnel effect in radioactive decays, angular distribution of cosmic rays, scattering, gamma-gamma nuclear correlations, and modern particle localization.  
U. Becker
**8.821 String Theory**  
Prereq: 8.324  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  
Credit cannot also be received for 8.251  

An introduction to string theory. Basics of conformal field theory; light-cone and covariant quantization of the relativistic bosonic string; quantization and spectrum of supersymmetric 10-dimensional string theories; T-duality and D-branes; toroidal compactification and orbifolds; 11-dimensional supergravity and M-theory. Meets with 8.251 when offered concurrently.  

H. Liu

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**8.831 Supersymmetric Quantum Field Theories**  
Prereq: Permission of instructor  
Acad Year 2019-2020: G (Fall)  
Acad Year 2020-2021: Not offered  
3-0-9 units  
Can be repeated for credit.  

Topics selected from the following: SUSY algebras and their particle representations; Weyl and Majorana spinors; Lagrangians of basic four-dimensional SUSY theories, both rigid SUSY and supergravity; supermultiplets of fields and superspace methods; renormalization properties, and the non-renormalization theorem; spontaneous breakdown of SUSY; and phenomenological SUSY theories. Some prior knowledge of Noether's theorem, derivation and use of Feynman rules, l-loop renormalization, and gauge theories is essential.  

J. Thaler

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**8.841 Electroweak Interactions**  
Prereq: 8.324  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units  

An introduction to the standard model of electroweak interactions and beyond; neutrino interactions and masses; the CKM matrix; lepton scattering off of nucleons and nuclei; the search for the Higgs boson; supersymmetric extension of the standard model. Topics vary with instructor.  

Staff

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**8.851 Effective Field Theory**  
Prereq: 8.324  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units  
Credit cannot also be received for 8.851  

Covers the framework and tools of effective field theory, including: identifying degrees of freedom and symmetries; power counting expansions (dimensional and otherwise); field redefinitions, bottom-up and top-down effective theories; fine-tuned effective theories; matching and Wilson coefficients; reparameterization invariance; and advanced renormalization group techniques. Main examples are taken from particle and nuclear physics, including the Soft-Collinear Effective Theory.  

I. Stewart

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**8.851 Special Subject: Effective Field Theory**  
Prereq: 8.324 and permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
2-0-10 units  
Credit cannot also be received for 8.851  

Experimental version of 8.851, which offers a combination of online and in-person instruction. See description of 8.851. Licensed for Spring 2019 by the Committee on Graduate Programs as an acceptable alternative to 8.851. Limited to 15.  

I. Stewart

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**8.861 Advanced Topics in Superfluidity**  
Prereq: 8.324  
Acad Year 2019-2020: G (Fall)  
Not offered regularly; consult department  
3-0-9 units  

Basic pairing theory, effective field theory and spontaneous symmetry breaking; well-established applications to liquid helium 3 as a warm-up; research will be explored including anisotropic superconductivity in heavy fermion systems and cuprates; color superconductivity in high-density QCD; and pairing in fermion systems with mismatched Fermi surfaces, including ultracold atom systems. Additional ideas needed to discuss the fractional quantum Hall effect will be reviewed, emphasizing its connection to conventional superfluidity, and pointing toward aspects of anyon behavior potentially relevant for quantum information processing.  

Staff
8.871 Selected Topics in Theoretical Particle Physics
Prereq: 8.323
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Can be repeated for credit.

Presents topics of current interest in theoretical particle physics, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
F. Wilczek

8.872 Selected Topics in Theoretical Particle Physics
Prereq: 8.323
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall, Spring)
3-0-9 units
Can be repeated for credit.

Presents topics of current interest in theoretical particle physics, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
W. Taylor

8.881, 8.882 Selected Topics in Experimental Particle Physics
Prereq: 8.811
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 units
Can be repeated for credit.

Presents topics of current interest in experimental particle physics, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Staff

Space Physics and Astrophysics

8.901 Astrophysics I
Prereq: Permission of instructor
G (Spring)
3-0-9 units

S. Hughes

8.902 Astrophysics II
Prereq: 8.901
G (Fall)
3-0-9 units

M. McDonald
8.913 Plasma Astrophysics I
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

For students interested in space physics, astrophysics, and plasma physics in general. Magnetospheres of rotating magnetized planets, ordinary stars, neutron stars, and black holes. Pulsar models: processes for slowing down, particle acceleration, and radiation emission; accreting plasmas and x-ray stars; stellar winds; heliosphere and solar wind-relevant magnetic field configuration, measured particle distribution in velocity space and induced collective modes; stability of the current sheet and collisionless processes for magnetic reconnection; theory of collisionless shocks; solitons; Ferroaro-Rosenbluth sheet; solar flare models; heating processes of the solar corona; Earth's magnetosphere (auroral phenomena and their interpretation, bowshock, magnetotail, trapped particle effects); relationship between gravitational (galactic) plasmas and electromagnetic plasmas. 8.913 deals with heliospheric, 8.914 with extra-heliospheric plasmas.

B. Coppi

8.914 Plasma Astrophysics II
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

For students interested in space physics, astrophysics, and plasma physics in general. Magnetospheres of rotating magnetized planets, ordinary stars, neutron stars, and black holes. Pulsar models: processes for slowing down, particle acceleration, and radiation emission; accreting plasmas and x-ray stars; stellar winds; heliosphere and solar wind-relevant magnetic field configuration, measured particle distribution in velocity space and induced collective modes; stability of the current sheet and collisionless processes for magnetic reconnection; theory of collisionless shocks; solitons; Ferroaro-Rosenbluth sheet; solar flare models; heating processes of the solar corona; Earth's magnetosphere (auroral phenomena and their interpretation, bowshock, magnetotail, trapped particle effects); relationship between gravitational (galactic) plasmas and electromagnetic plasmas. 8.913 deals with heliospheric, 8.914 with extra-heliospheric plasmas.

8.921 Stellar Structure and Evolution
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Observable stellar characteristics; overview of observational information. Principles underlying calculations of stellar structure. Physical processes in stellar interiors; properties of matter and radiation; radiative, conductive, and convective heat transport; nuclear energy generation; nucleosynthesis; and neutrino emission. Protostars; the main sequence, and the solar neutrino flux; advanced evolutionary stages; variable stars; planetary nebulae, supernovae, white dwarfs, and neutron stars; close binary systems; and abundance of chemical elements.

Staff

8.942 Cosmology
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

Thermal backgrounds in space. Cosmological principle and its consequences: Newtonian cosmology and types of "universes"; survey of relativistic cosmology; horizons. Overview of evolution in cosmology; radiation and element synthesis; physical models of the "early stages." Formation of large-scale structure to variability of physical laws. First and last states. Some knowledge of relativity expected. 8.962 recommended though not required.

K. Masui

8.952 Particle Physics of the Early Universe
Prereq: 8.323; Coreq: 8.324
G (Spring)
Not offered regularly; consult department
3-0-9 units

Basics of general relativity, standard big bang cosmology, thermodynamics of the early universe, cosmic background radiation, primordial nucleosynthesis, basics of the standard model of particle physics, electroweak and QCD phase transition, basics of group theory, grand unified theories, baryon asymmetry, monopoles, cosmic strings, domain walls, axions, inflationary universe, and structure formation.

A. Guth
8.962 General Relativity
Prereq: 8.07, 18.03, and 18.06
G (Spring)
4-0-8 units
The basic principles of Einstein’s general theory of relativity, differential geometry, experimental tests of general relativity, black holes, and cosmology.
A. Guth

8.971 Astrophysics Seminar
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
2-0-4 units
Can be repeated for credit.
Advanced seminar on current topics, with a different focus each term. Typical topics: astronomical instrumentation, numerical and statistical methods in astrophysics, gravitational lenses, neutron stars and pulsars.
Consult D. Chakrabarty

8.972 Astrophysics Seminar
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
2-0-4 units
Can be repeated for credit.
Advanced seminar on current topics, with a different focus each term. Typical topics: gravitational lenses, active galactic nuclei, neutron stars and pulsars, galaxy formation, supernovae and supernova remnants, brown dwarfs, and extrasolar planetary systems. The presenter at each session is selected by drawing names from a hat containing those of all attendees. Offered if sufficient interest is indicated.
Consult D. Chakrabarty

8.981, 8.982 Selected Topics in Astrophysics
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Can be repeated for credit.
Topics of current interest, varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult D. Chakrabarty

8.995 Practical Work Experience
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
For Course 8 students participating in off-campus work experiences in physics. Before registering for this subject, students must have an employment offer from a company or organization, must identify a Physics supervisor, and must receive prior approval from the Physics Department. Upon completion of the work, student must submit a letter from the employer describing the work accomplished, along with a substantive final report from the student approved by the MIT supervisor. Consult departmental academic office.
Consult N. Mavalvala

8.5301 Special Subject: Physics
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
Units arranged
Covers topics in Physics that are not offered in the regular curriculum. Limited enrollment; preference to Physics graduate students.
A. Lightman

8.5421 Special Subject: Physics
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for group study of subjects in physics not otherwise included in the curriculum.
W. Ketterle

8.THG Graduate Physics Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of an SM, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
Consult I. Stewart
Political Philosophy/Social Theory

**17.000[J] Political Philosophy**
Same subject as 24.611[J]
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Can be repeated for credit.

Systematic examination of selected issues in political philosophy. Topic changes each year and subject may be taken repeatedly with permission of instructor.
*B. Zacka*

**17.006[J] Feminist Thought**
Same subject as 24.637[J]
Subject meets with 17.007[J], 24.237[J], WGS.301[J]
Prereq: Permission of instructor, based on previous coursework
G (Spring)
3-0-9 units

Analyzes theories of gender and politics, especially ideologies of gender and their construction; definitions of public and private spheres; gender issues in citizenship, the development of the welfare state, experiences of war and revolution, class formation, and the politics of sexuality. Graduate students are expected to pursue the subject in greater depth through reading and individual research.
*E. Wood*

**17.007[J] Feminist Thought**
Same subject as 24.237[J], WGS.301[J]
Subject meets with 17.006[J], 24.637[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Analyzes theories of gender and politics, especially ideologies of gender and their construction; definitions of public and private spheres; gender issues in citizenship, the development of the welfare state, experiences of war and revolution, class formation, and the politics of sexuality. Graduate students are expected to pursue the subject in greater depth through reading and individual research.
*E. Wood*

**17.01[J] Justice**
Same subject as 24.04[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H; CI-H

See description under subject 24.04[J].
*B. Zacka*

**17.021[J] Philosophy of Law**
Same subject as 24.235[J]
Prereq: One Philosophy subject or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H

See description under subject 24.235[J].
*Staff*

**17.03 Introduction to Political Thought**
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Examines major texts in the history of political thought and considers how they contribute to a broader conversation about freedom, equality, democracy, rights, and the role of politics in human life. Philosophers include Plato, Aristotle, Machiavelli, Hobbes, Locke, Rousseau, Marx, Tocqueville, and Mill.
*Staff*

**17.035[J] Libertarianism in History**
Same subject as 21H.181[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-H

See description under subject 21H.181[J].
*M. Ghachem*

**17.04[J] Modern Conceptions of Freedom**
Same subject as CC.111[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H

See description under subject CC.111[J]. Preference to students in Concourse.
*L. Rabieh*
17.05[J] Humane Warfare: Ancient and Medieval Perspectives on Ethics in War
Same subject as CC.117[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H
See description under subject CC.117[J]. Preference to Concourse students.
L. Rabieh

17.051 Ethics of Energy Policy
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-S
Explores fundamental ethical problems that arise in the context of energy policy. Topics include the ethics of climate change and emissions reduction policies; international and intergenerational justice as central problems of energy policy; the ethics of natural resource depletion and conservation; the ethics of energy consumption decisions by individuals, households and firms; the proper scope of market forms of regulation in the energy policy arena; and conflicts between utilitarian and rights-based frameworks for evaluating energy policies.
Staff

Political Economy

17.100[J] Political Economy I: Theories of the State and the Economy
Same subject as 14.781[J], 15.678[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Critical analysis of liberal, neoclassical, and Marxist perspectives on modern society. Alternative theories of economic growth, historical change, the state, classes, and ideology.
M. Piore, S. Berger

17.115 International Political Economy
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
Provides an introduction to the politics of international economic relations, including a range of analytical "lenses" to view the global economy. Examines the politics of trade policy, international monetary and financial relations, financial crises, foreign direct investment, third-world development and transition economies, the debate over "globalization," and international financial crime.
D. Singer

17.150 The American Political Economy in Comparative Perspective
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Examines the origins and impact of key features of the American political economy in comparative perspective. Considers a range of political-economic topics, including labor markets, finance, taxation, social policy, and the role of money and organized interests. Highlights the distinctive aspects of American political economy in terms of both institutional structure and substantive outcomes (such as poverty and inequality) by comparing the US with other nations, particularly other rich democracies.
K. Thelen

17.154 Varieties of Capitalism and Social Inequality
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Focuses on the advanced democracies of Europe, the United States, and Japan. Explores trajectories of change that bear on issues of economic and social inequality. Examines whether contemporary trends (globalization, deindustrialization) undermine institutional arrangements that once reconciled economic efficiency with high levels of social equality. Considers the extent to which existing theoretical frameworks capture cross-national variation in the dynamics of redistribution in these societies.
K. Thelen, P. Hall
17.156 Welfare and Capitalism in Western Europe
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Considers theoretical models that attempt to capture the distinct paradigms of capitalism and welfare regimes prevalent in Western European economies. Analyzes content and processes of contemporary changes in the political economy and social policy - from a broad view of the challenges, to closer inquiry into specific reforms. Includes a theoretical discussion of how change occurs and trajectories of development.
K. Thelen

17.172 Institutionalism and Institutional Change
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examines several strands of theorizing on the role of institutions in politics and on the dynamics through which institutions evolve and change over time. Explores the core theoretical assumptions that underpin various approaches, assesses their relative strengths and weaknesses, and considers whether distinct lines of theorizing should be considered complementary or competing.
K. Thelen

Same subject as 11.491[J]
Prereq: 11.701
G (Fall)
Not offered regularly; consult department
3-0-9 units
See description under subject 11.491[J].
Staff

17.178 Political Economy of Institutions and Development
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Explores institutional diversity in capitalist development, both historical and contemporary, and various explanations (e.g. economic, institutional, sociological, and political) for the divergent economic organization. Examines dimensions of comparison, including issues in business-government relations, labor relations, vocational training, and multinational corporations. Also considers global production networks, natural resource dependence, diversified business groups, industrial policy, and globalization.
B. Schneider

17.181 Sustainability: Political Economy, Science, and Policy
Subject meets with 17.182
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
Examines alternative conceptions and theoretical underpinnings of sustainable development. Focuses on the sustainability problems of industrial countries, and of developing states and economies in transition. Explores the sociology of knowledge regarding sustainability, the economic and technological dimensions, and institutional imperatives. Considers implications for political constitution of economic performance. 17.181 fulfills undergraduate public policy requirement in the major and minor. Graduate students are expected to explore the subject in greater depth through reading and individual research.
N. Choucri

17.182 Sustainability: Political Economy, Science, and Policy
Subject meets with 17.181
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examines alternative conceptions and theoretical underpinnings of sustainable development. Focuses on the sustainability problems of industrial countries, and of developing states and economies in transition. Explores the sociology of knowledge regarding sustainability, the economic and technological dimensions, and institutional imperatives. Considers implications for political constitution of economic performance. 17.181 fulfills undergraduate public policy requirement in the major and minor. Graduate students are expected to explore the subject in greater depth through reading and individual research.
N. Choucri
17.195 Globalization
Subject meets with 17.196
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

Analyzes changes in the international economy and their effects in the politics, economy, and society of advanced and emerging countries. Topics to be explored include: the independence of national governments; wage inequality; unemployment; industrial production outside national borders and its consequences for innovation, efficiency, and jobs; fairness in trade; and mass culture versus local values. 17.195 fulfills undergraduate public policy requirement in the major and minor. Students taking graduate version are expected to complete additional assignments.
S. Berger

17.196 Globalization
Subject meets with 17.195
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Analyzes changes in the international economy and their effects in the politics, economy, and society of advanced and emerging countries. Topics include the independence of national governments; wage inequality; unemployment; industrial production outside national borders and its consequences for innovation, efficiency, and jobs; fairness in trade; and mass culture versus local values. 17.195 fulfills undergraduate public policy requirement in the major and minor. Students taking graduate version are expected to complete additional assignments.
S. Berger

17.198 Current Topics in Comparative Political Economy
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Analyzes and compares approaches in current political economy literatures. Weekly topics are selected by instructor and participants. Examples include the organization of interests, industrial policy, growth and inequality, resource "curse", late development. Topics vary each year depending on the research interests of the seminar participants. The subject is for graduate students in social sciences with previous coursework in political economy.
S. Berger

American Politics

17.20 Introduction to the American Political Process
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-S; CI-H

Provides a substantive overview of US politics and an introduction to the discipline of political science. Surveys the institutional foundations of US politics as well as the activities of political elites, organizations, and ordinary citizens. Explores the application of general political science concepts and analytic frameworks to specific episodes and phenomena in US politics. Enrollment limited.
D. Caughey

17.200 American Political Behavior I
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Analyzes mass political behavior within the American political system. Examines political ideology, party identification, public opinion, voting behavior, media effects, racial attitudes, mass-elite relations, and opinion-policy linkages. Surveys and critiques the major theoretical approaches and empirical research in the field of political behavior.
A. Berinsky

17.202 American Political Institutions
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Analyzes the institutions of the American political system, with primary emphasis on the national level. Examines American federalism, political parties, national political institutions, and the policymaking process. Focuses on core works in contemporary American politics and public policy. Critiques both research methodologies and the explicit and implicit theoretical assumptions of such work.
D. Caughey
17.210 American Political Behavior II
Prereq: 17.200
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Analyzes mass political behavior within the American political system. Goes beyond the topics covered in 17.200, to explore additional areas and research frontiers in political behavior. Examines recent research on political ideology, party identification, public opinion, voting behavior, media effects, racial attitudes, mass-elite relations, and opinion-policy linkages. Introduces new topics such as personality, emotion, networks, polarization, opinion on war.
A. Berinsky

17.245 Constitutional Law: Structures of Power and Individual Rights
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

Examines American constitutional law in historical and modern context. Focuses closely on the constitutional text and Supreme Court case law. Explores the allocation of decision-making authority among government institutions, including the distribution of power across the branches of the federal government and between the federal and state governments. Examines the guarantees of individual rights and liberties stemming from the due process, equal protection, and other clauses in the Bill of Rights and post Civil War amendments.
Staff

17.251 Congress and the American Political System I
Subject meets with 17.252
Prereq: 17.20 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Focuses on both the internal processes of the House and Senate and on the place of Congress in the American Political System. Attention to committee behavior, leadership patterns, and informal organization. Considers relations between Congress and other branches of government, as well as relations between the two houses of Congress itself. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
C. Stewart

17.252 Congress and the American Political System II
Subject meets with 17.251
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Focuses on both the internal processes of the House and Senate and on the place of Congress in the American political system. Attention to committee behavior, leadership patterns, and informal organization. Considers relations between Congress and other branches of government, as well as relations between the two houses of Congress itself. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
C. Stewart

17.261 Congress and the American Political System II
Subject meets with 17.262
Prereq: 17.251 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S

Analyzes the development of the Congress by focusing on the competing theoretical lenses through which legislatures have been studied. Particularly compares sociological and economic models of legislative behavior, applying those models to floor decision making, committee behavior, political parties, relations with other branches of the federal government, and elections. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
C. Stewart

17.262 Congress and the American Political System II
Subject meets with 17.261
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Analyzes the development of the US Congress by focusing on the competing theoretical lenses through which legislatures have been studied. Particularly compares sociological and economic models of legislative behavior, applying those models to floor decision-making, committee behavior, political parties, relations with other branches of the Federal government, and elections. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
C. Stewart
17.263 Electoral Politics, Public Opinion, and Democracy
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Considers the role of elections in American politics. Issues explored include empirical and theoretical models of electoral competition, the effect of elections on public policy, and proposals to improve elections. Special emphasis is given to mass voting behavior, political parties, the media, and campaign finance. Subject focuses on US elections, but provides some contrasts with other countries, especially the United Kingdom. 
A. Berinsky

17.266 Public Opinion
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Provides an introduction to the scholarly literature devoted to public opinion. Surveys the major theoretical approaches and empirical research in the field of political behavior. Topics include mass-elite relations, racial politics, political ideology, public opinion and war, public opinion and public policy and media effects. Primarily focuses on American public opinion, though research on comparative public opinion is also covered. 
A. Berinsky

17.264 Electoral Politics
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

Analyzes elections in light of theories about voters, parties, and candidates. Topics include election laws and reforms, and the formation of governments. Focus is mainly on US elections, though other democracies are also examined. Familiarity with statistics recommended but not required. Open to qualified undergraduates. 
D. Caughey

17.265 Public Opinion and American Democracy
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

Introduces students to public opinion in politics and public policymaking. Surveys theories of political psychology and political behavior. Examines empirical research on public understanding of and attitudes towards important issues, including war, economic and social policies, and moral questions. 
A. Berinsky

17.267 Democracy in America
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-S

Examines the functioning of democracy in the US beginning with the theoretical foundations of democratic representation. Explores how the views of the public influence policy making. Examines factors, such as malapportionment, that lead to non-majoritarian outcomes. Reviews evidence on how well policy outcomes reflect public opinion, and whether certain groups are over or under-represented in the policy process. Discusses reforms that might make our democracy more responsive to the American public. 
D. Caughey

17.269 Race, Ethnicity, and American Politics
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Explores the role of race and ethnicity in modern American politics. Focuses on social science approaches to measuring the effects of race, both at the individual level and more broadly. Topics include race and representation, measurement of racial and ethnic identities, voting rights and electoral districting, protest and other forms of political participation, and the meaning and measurement of racial attitudes. 
A. White
17.270 American Political Development
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units
Examines the evolution of American national political processes over time: how political culture, governing institutions, and structures of political linkage (parties and organized interests) shape political conflict and public policy. Topics include the evolution of electoral politics and the party system, eras of political reform and state expansion (Populist, Progressive, New Deal, and Great Society), major wars and their effects, and the adaptation of government institutions to crisis and complexity in society and in the economy. Open to undergraduates with permission of instructor.
D. Caughey

17.275 Public Opinion Research Design and Training Seminar
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Studies the basic skills required to design, use, and interpret opinion surveys and survey experiments. Acts as both a reading subject on survey analysis and a practicum on collecting and analyzing observational and experimental survey data. Culminates in a group project involving a survey experiment on a particular topic chosen by the class and the instructor.
A. Berinsky

17.276 Public Opinion Research Training Lab
Prereq: (17.266 and 17.800) or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Follows 17.266. Offers practical training in public opinion research and provides students with an opportunity to conduct their own survey research. As a group, students design a national sample survey and field the survey. Students analyze the survey results and examine literatures related to the content of the survey. Ideal for second and third year PhD students and advanced undergraduates, though others are welcome.
A. Berinsky

Same subject as 21H.213[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
Examines the relationship between war and domestic politics in the US since the start of 20th century. Students engage in historical and social scientific research to analyze the ways that overseas military commitments shaped US political institutions, and how domestic politics has in turn structured US engagements abroad. Moving chronologically from World War I to the Iraq War, subject draws on materials across the disciplines, including political documents, opinion polls, legal decisions, and products of American popular culture.
A. Berinsky, C. Capozzola

Public Policy

17.30[J] Making Public Policy
Same subject as 11.002[J]
Prereq: None
U (Fall)
4-0-8 units. HASS-S; CI-H
See description under subject 11.002[J].
Staff

17.303[J] Methods of Policy Analysis
Same subject as 11.003[J]
Prereq: 11.002[J]; Coreq: 14.01
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
See description under subject 11.003[J].
Staff
17.307 American Public Policy for Washington Interns
Prereq: Permission of instructor
U (Fall, Spring; partial term)
3-0-9 units. HASS-S

Examines US policymaking process, with special attention to making of policy for science and technology. Subject spans the second half of Spring and first half of Fall terms. Spring term attends to origins and development of American policymaking institutions and their roles in settling controversial policy questions. Fall term focuses on development of representative policies in the US, such as pollution controls, biotechnical engineering, and telecommunications. Selection and participation in Washington Summer Internship program required. Fulfills undergraduate public policy requirement in the major and minor.

C. Stewart

17.309[J] Science, Technology, and Public Policy
Same subject as IDS.055[J], STS.082[J]
Prereq: None
U (Spring)
4-0-8 units. HASS-S; CI-H
Credit cannot also be received for 17.310[J], IDS.412[J], STS.482[J]

Analysis of issues at the intersection of science, technology, public policy, and business. Cases drawn from antitrust and intellectual property rights; health and environmental policy; defense procurement and strategy; strategic trade and industrial policy; and R&D funding. Structured around theories of political economy, modified to take into account integration of uncertain technical information into public and private decision-making. Meets with 17.310[J].

K. Oye, N. Selin

17.310[J] Science, Technology, and Public Policy
Same subject as IDS.412[J], STS.482[J]
Prereq: Permission of instructor
G (Spring)
4-0-8 units

Credit cannot also be received for 17.309[J], IDS.055[J], STS.082[J]

Analysis of issues at the intersection of science, technology, public policy, and business. Cases drawn from antitrust and intellectual property rights; health and environmental policy; defense procurement and strategy; strategic trade and industrial policy; and R&D funding. Structured around theories of political economy, modified to take into account integration of uncertain technical information into public and private decision-making. Meets with 17.309[J].

K. Oye, N. Selin

17.315 Health Policy
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-S

Analyzes the health policy problems facing America including adequate access to care, the control of health care costs, and the encouragement of medical advances. Considers market and regulatory alternatives as well as international models including Canadian, Swedish, British, and German arrangements. Emphasis on historical development, interest group behavior, public opinion, and organizational influences in shaping and implementing policy.

A. Campbell

17.317 US Social Policy
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
4-0-8 units. HASS-S

Explores historical development and contemporary politics of the American welfare state. Examines interactions among political institutions, elites, the media, and the mass public. Emphasis on reciprocal relationship between policy designs and public opinion/political action. Investigates broad spectrum of government policies that shape well-being, opportunity and political influence, including welfare, social security, health care, education, and tax policy.

A. Campbell

17.320 Social Policy
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Examines the politics of social policy in comparative perspective. Empirical and theoretical overview of the origins, development, and future of social provision in industrialized countries, in the context of broader political and historical trends. Examines concepts such as social citizenship, risk sharing, de-commodification, and welfare regimes, and the challenges of globalization, neo-liberalism, and demographic change. Topics include pensions, health care, poverty alleviation, and family policy. Combines classic work and research frontiers.

A. Campbell
17.381[J] Leadership in Negotiation: Advanced Applications
Same subject as 11.111[J]
Prereq: 11.011 or permission of instructor
U (Spring)
4-0-8 units. HASS-S
See description under subject 11.111[J]. Limited to 36.
B. Verdini

17.391[J] Human Rights at Home and Abroad
Same subject as 11.164[J]
Subject meets with 11.497
Prereq: Permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
2-0-10 units. HASS-S
See description under subject 11.164[J].
B. Rajagopal

17.393[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 1.801[J], 11.021[J], IDS.060[J]
Subject meets with 1.811[J], 11.630[J], 15.663[J], IDS.540[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Reviews and analyzes federal and state regulation of air and water pollution, hazardous waste, green-house gas emissions, and the production and use of toxic chemicals. Analyzes pollution as an economic problem and the failure of markets. Explores the role of science and economics in legal decisions. Emphasizes use of legal mechanisms and alternative approaches (such as economic incentives and voluntary approaches) to control pollution and encourage chemical accident and pollution prevention. Focuses on the major federal legislation, the underlying administrative system, and the common law in analyzing environmental policy, economic consequences, and the role of the courts. Discusses classical pollutants and toxic industrial chemicals, green-house gas emissions, community right-to-know, and environmental justice. Develops basic legal skills: how to read/understand cases, regulations, and statutes. Students taking graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart

Same subject as STS.081[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
2-0-7 units. HASS-S
See description under subject STS.081[J]. Limited to 25.
W. B. Bonvillian

Same subject as 11.167[J], 14.47[J], 15.2191[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Credit cannot also be received for 11.267[J], 15.219[J]
V. Karplus

International Relations/Security Studies

International Relations

17.40 American Foreign Policy: Past, Present, and Future
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S; CI-H
Reasons for America's past wars and interventions. Consequences of American policies. Evaluation of these consequences for the US and the world. History covered includes World Wars I and II, the Korean and Indochina wars, the Cuban Missile Crisis and current conflicts, including those in in Iraq and Afghanistan, and against al Qaeda.
S. Van Evera
17.401 History of International Politics in the Modern World
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

Examines the history of international relations from the late 19th century to recent times. Focuses on the tectonic shifts generated by industrialization, nationalism, and imperialism, with attention to the major wars and crises that dominated the 20th century. Topics include the First World War, the Great Depression, the Second World War and the Cold War, European integration, decolonization, the rise of Asia, the nuclear revolution, the end of the Cold War, and world politics since the 9/11 attacks on the United States. 

Staff

17.407 Chinese Foreign Policy
Prereq: Permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Credit cannot also be received for 17.408

Explores the leading theoretical and methodological approaches to studying China’s interaction with the world since 1949. Readings include books and articles that integrate the study of China’s foreign policy with the field of international relations. Requires basic understanding of Chinese politics or international relations theory. Meets with 17.408 when offered concurrently.
M. T. Fravel

17.408 Chinese Foreign Policy
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Credit cannot also be received for 17.407

Explores the leading theoretical and methodological approaches to studying China’s interaction with the international system since 1949. Readings include books and articles that integrate the study of China’s foreign policy with the field of international relations. Requires basic understanding of Chinese politics or international relations theory. Meets with 17.407 when offered concurrently.
M. T. Fravel

17.41 Introduction to International Relations
Prereq: None
U (Spring)
3-0-9 units. HASS-S; CI-H

Provides an introduction to the causes of international conflict and cooperation. Topics include war initiation, crisis bargaining, international terrorism, nuclear strategy, interstate economic relations, economic growth, international law, human rights, and environmental politics.
R. Nielsen

17.410 Globalization, Migration, and International Relations
Subject meets with 17.411
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Tracing the evolution of international interactions, subject examines the dimensions of globalization in terms of scale and scope. Includes international environmental issues, impacts and expansion of human activities, and the potential implications for global and national policy. Linkages among individuals, nation-states, transnational organizations and firms, international systems, and the global environment. Special focus on models of globalization, challenges of sustainable development, and on evolving types. Institutional responses to globalization and global change. 17.411 fulfills undergraduate public policy requirement in the major and minor. Students taking the graduate version are expected to explore the subject in greater depth through reading and individual research.
N. Choucri

17.411 Globalization, Migration, and International Relations
Subject meets with 17.410
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

Tracing the evolution of international interactions, subject examines the dimensions of globalization in terms of scale and scope. Includes international environmental issues, impacts and expansion of human activities, and the potential implications for global and national policy. Linkages among individuals, nation-states, transnational organizations and firms, international systems, and the global environment. Special focus on models of globalization, challenges of sustainable development, and on evolving types. Institutional responses to globalization and global change. 17.411 fulfills undergraduate public policy requirement in the major and minor. Students taking the graduate version are expected to explore the subject in greater depth through reading and individual research.
N. Choucri
17.418 Field Seminar in International Relations Theory
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Provides an overview of the field of international relations. Each week a different approach to explaining international relations is examined. Surveys major concepts and theories in the field to assist in the preparation for further study in the department's other graduate offerings in international relations.
T. Fravel

17.42 Causes and Prevention of War
Prereq: None
U (Fall)
4-0-8 units. HASS-S; CI-H
Examines the causes of war, with a focus on practical measures to prevent and control war. Topics include causes and consequences of misperception by nations; military strategy and policy as cause of war; religion and war; US foreign policy as a cause of war and peace; and the likelihood and possible nature of great wars in the future. Historical cases include World War I, World War II, the Korean War, the Seven Years' War, the Arab-Israel conflict, other recent Mideast wars, and the Peloponnesian War.
S. Van Evera

17.420 Advances in International Relations Theory
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units
Critical analysis of contending theories of international relations. Focus is on alternative theoretical assumptions, different analytical structures, and a common core of concepts and content. Comparative analysis of realism(s), liberalism(s), institutionalism(s), and new emergent theories. Discussion of connections between theories of international relations and major changes in international relations. Open to undergraduates by permission of instructor.
N. Choucri

17.424 International Political Economy of Advanced Industrial Societies
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Focuses analytically on how interest groups, voters, political parties, electoral institutions, ideas and power politics interact to shape policy outcomes. Topics include globalization, international trade, international monetary and financial relations, and security.
D. Singer

17.426 Empirical Models in International Relations
Prereq: 17.802 or permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Explores statistical methods as applied to international relations, with a primary focus on international security. Discusses methodological issues unique to this subfield. Students examine and critically analyze existing work in the field to gain familiarity with the array of models and methodological choices employed thus far in published research articles. Complements Quantitative Methods I and II by exploring how the methods developed in those subjects have been applied in the field.
R. Nielsen

17.428 American Foreign Policy: Theory and Method
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Examines the causes and consequences of American foreign policy since 1898. Readings cover theories of American foreign policy, historiography of American foreign policy, central historical episodes including the two World Wars and the Cold War, case study methodology, and historical investigative methods. Open to undergraduates by permission of instructor.
S. Van Evera

17.430 Research Seminar in International Relations
Prereq: Permission of instructor
G (Spring)
3-0-9 units
While this seminar provides an overview of recent literature, its principal purpose is to help graduate students develop skills suited to production of research papers and/or dissertations. Begins by reviewing general theoretical and methodological issues, then turns to specific empirical studies that examine the effects of systems structure, national attributes, bargaining processes, institutions, ideas, and norms on security affairs and political economy. The last two sessions of the seminar are devoted to evaluating research proposals generated by all members of the class.
K. Oye
17.432 Causes of War: Theory and Method
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Examines the causes of war. Major theories of war are examined; case study and large-n methods of testing theories of war are discussed; and the case study method is applied to several historical cases. Cases covered include World Wars I and II. Open to undergraduates only by permission of instructor.
S. Van Evera

17.433 International Relations of East Asia
Subject meets with 17.434
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Introduces and analyzes the international relations of East Asia. Examines the sources of conflict and cooperation during and after the Cold War, assessing competing explanations for key events in East Asia's international relations. Readings drawn from international relations theory, political science and history. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
M. T. Fravel

17.434 International Relations of East Asia
Subject meets with 17.433
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Introduces and analyzes the international relations of East Asia. Examines the sources of conflict and cooperation during and after the Cold War, assessing competing explanations for key events in East Asia's international relations. Readings drawn from international relations theory, political science and history. Students taking graduate version are expected to pursue the subject in greater depth through reading and individual research.
M. T. Fravel

17.436 Territorial Conflict
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units
Examines why territorial conflicts arise in the first place, why some of these conflicts escalate to high levels of violence and why other territorial disputes reach settlement, thereby reducing a likely source of violence between states. Readings draw upon political geography and history as well as qualitative and quantitative approaches to political science.
M. T. Fravel

17.445 International Relations Theory in the Cyber Age
Subject meets with 17.446
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
Examines cyber dynamics and processes in international relations from different theoretical perspectives. Considers alternative theoretical and empirical frameworks consistent with characteristic features of cyberspace and emergent transformations at all levels of international interaction. Theories examined include realism and neorealism, institutionalism and liberalism, constructivism, and systems theory and lateral pressure. Highlights relevant features and proposes customized international relations theory for the cyber age. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
N. Choucri

17.446 International Relations Theory in the Cyber Age
Subject meets with 17.445
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examines cyber dynamics and processes in international relations from different theoretical perspectives. Considers alternative theoretical and empirical frameworks consistent with characteristic features of cyberspace and emergent transformations at all levels of international interaction. Theories examined include realism and neorealism, institutionalism and liberalism, constructivism, and systems theory and lateral pressure. Highlights relevant features and proposes customized international relations theory for the cyber age. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
N. Choucri
17.447 Cybersecurity
Subject meets with 17.448
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Focuses on the complexity of cybersecurity in a changing world. Examines national and international aspects of overall cyber ecology. Explores sources and consequences of cyber threats and different types of damages. Considers impacts for and of various aspects of cybersecurity in diverse geostrategic, political, business and economic contexts. Addresses national and international policy responses as well as formal and informal strategies and mechanisms for responding to cyber insecurity and enhancing conditions of cybersecurity. Students taking graduate version expected to pursue subject in greater depth through reading and individual research.
N. Choucri, S. Madnick

17.448 Cybersecurity
Subject meets with 17.447
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Focuses on the complexity of cybersecurity in a changing world. Examines national and international aspects of overall cyber ecology. Explores sources and consequences of cyber threats and different types of damages. Considers impacts for and of various aspects of cybersecurity in diverse geostrategic, political, business and economic contexts. Addresses national and international policy responses as well as formal and informal strategies and mechanisms for responding to cyber insecurity and enhancing conditions of cybersecurity. Students taking graduate version expected to pursue subject in greater depth through reading and individual research.
N. Choucri, S. Madnick

17.450 History, Strategy, and Statecraft: Historical Methods for International Relations
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Examines the different ways scholarly history is practiced, with a focus on the history of foreign policy and international relations. Explores whether a familiarity with historical analysis and methods can improve our understanding of politics, strategy, and statecraft. Familiarizes students with both historical methods and a historical sensibility while also teaching them how to undertake advanced historical research.

Staff

Security Studies

17.468 Foundations of Security Studies
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Develops a working knowledge of the theories and conceptual frameworks that form the intellectual basis of security studies as an academic discipline. Particular emphasis on balance of power theory, organization theory, civil-military relations, and the relationship between war and politics. The reading list includes Jervis, Schelling, Waltz, Blainey, von Clausewitz, and Huntington. Students write a seminar paper in which theoretical insights are systematically applied to a current security issue.
B. Posen

17.472 International Conflict in the Gray Space Between War and Peace (New)
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Examines US strategic, legal, and organizational readiness to deal with intensifying international conflict below the level of armed attack, including covert action, offensive cyber operations, propaganda, and economic coercion. Cases include Ukraine, Stuxnet, and South China Sea operations. Substantial reading ranges across Western, Leninist, and Chinese views of war, covert action history, international law, US strategy, industrial espionage, and the effects of technology on operations.
J. Brenner

17.473 The Politics of Nuclear Proliferation
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Provides an introduction to the politics and theories surrounding the proliferation of nuclear weapons. Introduces the basics of nuclear weapons, nuclear strategy, and deterrence theory. Examines the historical record during the Cold War as well as the proliferation of nuclear weapons to regional powers and the resulting deterrence consequences.
V. Narang
### 17.474[J] Nuclear Weapons and International Security
Same subject as 22.814[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
See description under subject 22.814[J].
*R. S. Kemp, V. Narang*

### 17.478 Great Power Military Intervention
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Examines systematically, and comparatively, great and middle power military interventions, and candidate military interventions, into civil wars since 1991. These civil wars did not easily fit into the traditional category of vital interest. These interventions may therefore tell us something about broad trends in international politics including the nature of unipolarity, the erosion of sovereignty, the security implications of globalization, and the nature of modern western military power.
*B. Posen, R. Petersen*

### 17.480 Understanding Modern Military Operations
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Examines selected past, current, and future sea, air, space, and land battlefields and looks at the interaction in each of these warfare areas between existing military doctrine and weapons, sensors, communications, and information processing technologies. Explores how technological development, whether innovative or stagnant, is influenced in each warfare area by military doctrine.
*O. Cote*

### 17.482 US Military Power
Subject meets with 17.483
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Examines the evolving roles and missions of US General Purpose Forces within the context of modern technological capabilities and Grand Strategy, which is a conceptual system of interconnected political and military means and ends. Topics include US Grand Strategies; the organization of the US military; the defense budget; and the capabilities and limitations of naval, air, and ground forces. Also examines the utility of these forces for power projection and the problems of escalation. Analyzes military history and simple models of warfare to explore how variations in technology and battlefield conditions can drastically alter effectiveness of conventional forces. 17.483 fulfills undergraduate public policy requirement in the major and minor. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
*B. Posen*

### 17.483 US Military Power
Subject meets with 17.482
Prereq: Freshmen need permission of instructor
U (Spring)
3-0-9 units. HASS-S
Examines the evolving roles and missions of US General Purpose Forces within the context of modern technological capabilities and Grand Strategy, which is a conceptual system of interconnected political and military means and ends. Topics include US Grand Strategies; the organization of the US military; the defense budget; and the capabilities and limitations of naval, air, and ground forces. Also examines the utility of these forces for power projection and the problems of escalation. Analyzes military history and simple models of warfare to explore how variations in technology and battlefield conditions can drastically alter effectiveness of conventional forces. 17.483 fulfills undergraduate public policy requirement in the major and minor. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.
*B. Posen*
17.484 Comparative Grand Strategy and Military Doctrine
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units
A comparative study of the grand strategies and military doctrines of the great powers in Europe (Britain, France, Germany, and Russia) from the late 19th to the mid-20th century. Examines strategic developments in the years preceding and during World Wars I and II. What factors have exerted the greatest influence on national strategies? How may the quality of a grand strategy be judged? Exploration of comparative case study methodology also plays a central role. What consequences seem to follow from grand strategies of different types? Open to undergraduates with permission of instructor.
Staff

17.486 Japan and East Asian Security
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Explores Japan’s role in world orders, past, present, and future. Focuses on Japanese conceptions of security; rearmament debates; the relationship of domestic politics to foreign policy; the impact of Japanese technological and economic transformation at home and abroad; alternative trade and security regimes; Japan’s response to 9/11; and relations with Asian neighbors, Russia, and the alliance with the United States.
R. J. Samuels

17.488 Simulating Global Dynamics and War (New)
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Explores the history, tools, and utility of crisis simulations and war games that model international dynamics. Aims to develop toolkits for future worlds exercises and for the production of conference papers and peer-reviewed publications. Students review historical debates about gaming and simulation methods while gaining experience designing and playing different kinds of exercises, including technical operational games, computerized rapid play games, nuclear crisis games, and global dynamics simulations.
R. Samuels, E. Heginbotham

Comparative Politics

17.50 Introduction to Comparative Politics
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S; CI-H
Examines why democracy emerges and survives in some countries rather than in others; how political institutions affect economic development; and how American politics compares to that of other countries. Reviews economic, cultural, and institutional explanations for political outcomes. Includes case studies of politics in several countries. Assignments include several papers of varying lengths and extensive structured and unstructured class participation. Enrollment limited.
C. Lawson

17.506 Ethnic Politics
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Introduces students to the classic works on ethnic politics, familiarizes them with new research and methodological innovations in the study of ethnic politics, and helps them design and execute original research projects related to ethnic politics. Readings drawn from across disciplines, including political science, anthropology, sociology, and economics. Students read across the four subfields within political science. Graduate students specializing in any subfield are encouraged to take this subject, regardless of their previous empirical or theoretical background.
R. Petersen

17.509 Social Movements in Comparative Perspective
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
Explores why people join grassroots political organizations and social movements. Asks what accounts for the ultimate success or failure of these organizations and examines how social movements have altered political parties, political institutions, and social relations. Critically considers a range of theoretical treatments and several movements, including the US civil rights, poor peoples’, pro-life/pro-choice and gay/lesbian movements.
M. Nobles
17.515 Comparative Electoral Politics
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
Subject discusses classic and current issues in electoral politics. Focus is mostly thematic, although the topics will be discussed in the context of different countries and regions. Examples of the topics are: party systems, old and new political cleavages, representation, electoral systems, and immigration and its effect on the party system. Two country-specific case studies explored in depth.

Staff

17.516 Transitional Justice
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Emerging democracies are now confronted with what has been termed "the torturer problem." The questions are old ones: What is to be done about the perpetrator(s) and what is to be done for the abused? Seminar broadly examines the theoretical and empirical approaches to understanding the issues commonly associated with "transitional justice," including its motivations, agents, institutions, and decisions. Cases are drawn from various countries and historical periods, including post-World War II Europe, 19th-century America, and 20th-century Africa and Latin America.

M. Nobles

17.523 Ethnic Conflict in World Politics
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-S
Ethnic and racial conflict appear to be the hallmark of the post-Cold War world. Students explore the rise of ethnic/racial and nationalist sentiments and movements; the basis of ethnic and racial identity; the political claims and goals of such movements, and whether conflict is inevitable. Introduces the dominant theoretical approaches to race, ethnicity, and nationalism, and considers them in light of current events in Africa, Europe, Asia, and the Americas.

M. Nobles

17.524 State, Society, and Political Behavior in Developing Contexts
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Examines the political behavior of citizens in developing countries and the question of why governmental performance remains poor in these contexts, despite citizen efforts, international aid, and civil society initiatives. Evaluates and builds on our current understanding of political behavior and state-society relations when democratic institutions are weak, state capacity is low, and regimes are changing. Explores these questions by drawing on new and old literatures from institutional, sociological, psychological, and political economy perspectives.

L. Tsai

17.53 The Rise of Asia
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Focuses on social, economic, political, and national security problems of India and Japan -- two of the largest economies in a dynamic region with the potential to shape global affairs. Examines each topic and country from the perspectives of history, contemporary issues, and their relations with one another and the United States.

R. Samuels, V. Narang

17.537 Politics and Policy in Contemporary Japan
Subject meets with 17.538
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
Analyzes contemporary Japanese politics, focusing primarily upon the post-World War II period. Includes examination of the dominant approaches to Japanese politics and society, the structure of the party system, the role of political opposition, the policy process, foreign affairs, and interest groups. Attention to defense, foreign, industrial, social, energy, technology policy processes. Graduate students are expected to pursue the subject in greater depth through reading and class presentations. Assignments differ.

R. J. Samuels
17.538 Politics and Policy in Contemporary Japan
Subject meets with 17.537
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Analyzes contemporary Japanese politics, focusing primarily upon the post-World War II period. Includes examination of the dominant approaches to Japanese politics and society, the structure of the party system, the role of political opposition, the policy process, foreign affairs, and interest groups. Attention to defense, foreign, industrial, social, energy, and technology policy processes. Graduate students are expected to pursue the subject in greater depth through reading and class presentations. Assignments differ.
R. J. Samuels

17.55[J] Introduction to Latin American Studies
Same subject as 21A.130[J], 21G.084[J], 21H.170[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S; CI-H

Examines contemporary Latin American culture, politics, and history. Surveys geography, economic development, and race, religion, and gender in Latin America. Special emphasis on the Salvadoran civil war, human rights and military rule in Argentina and Chile, and migration from Central America and Mexico to the United States. Students analyze films, literature, visual art, journalism, historical documents, and social scientific research.
T. Padilla, P. Duong

17.56 The Politics of Crime and Policing
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-S; CI-H

Equipss students to think analytically about the politics of crime and policing. After introducing key concepts, research methods, and sources of data, students read the latest social scientific research on bias and discrimination, police reform, crime prevention, deterrence and incarceration, and social movements related to crime and policing. Other topics include vigilantism, gender-based violence, terrorism, and organized crime. The class is comparative, with emphasis on the United States and Latin America.
R. Bateson

17.561 European Politics
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Examines similarities and differences in politics and political economy in Britain, Germany, and Sweden. Particular focus on the structure of political power within the state, and on important institutions that form the link between state and society, especially political parties and interest organizations.
K. Thelen

17.565 Israel: History, Politics, Culture, and Identity
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Credit cannot also be received for 17.567

Examines Israeli identity using a broad array of materials, including popular music, film, documentaries and art, in addition to academic historical writings. Topics include Israel’s political system and society, ethnic relations, settlement projects, and the Arab minorities in the Jewish state. Students also discuss whether there is a unique Israeli culture and the struggle for Israel’s identity. Limited to 60; preference to students in the MISTI MIT-Israel program.
P. Krause

17.567 Israel: History, Politics, Culture, and Identity
Prereq: None
U (IAP)
3-0-6 units. HASS-S
Credit cannot also be received for 17.565

Examines Israeli identity using a broad array of materials, including popular music, film, documentaries and art, in addition to academic historical writings. Topics include Israel’s political system and society, ethnic relations, settlement projects, and the Arab minorities in the Jewish state. Students also discuss whether there is a unique Israeli culture and the struggle for Israel’s identity. Limited to students in the MISTI MIT-Israel program.
N. Karlinsky
17.568 Comparative Politics and International Relations of the Middle East
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Surveys both classic and cutting-edge work on the politics of the Middle East, broadly defined. Topics include the causes and consequences of political and economic development, authoritarianism and democratization, the influence of social movements, the role of women in Middle Eastern polities, regional inter-state relations, Islamism, terrorism, colonialism and foreign occupation, state-building, resistance and rebellion, and the Arab uprisings.
R. Nielsen, F. Christia

17.569 Russia’s Foreign Policy: Toward the Post-Soviet States and Beyond
Prereq: None
U (Spring)
3-0-9 units. HASS-S

Analyzes Russia’s foreign policy, with a focus on relations with the other post-Soviet states. Frames the discussion with examination of US-Russian and Sino-Russian relations. Looks at legacies of the Soviet collapse, strengths and vulnerabilities of Russia, and the ability of other states to maintain their sovereignty. Topics include the future of Central Asia, the Georgian war, energy politics, and reaction to the European Union’s Eastern Partnership. Readings focus on international relations, historical sources, and contemporary Russian and Western sources.
C. Saivetz

17.571 Engineering Democratic Development in Africa
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Examines the varied relationship between democracy and human development in sub-Saharan Africa. Encourages students to apply engineering thinking to better understand which institutions, practices, and technologies have helped, and which have hindered, the achievement of health, education, infrastructure, and other outcomes. Addresses many of the challenges and dilemmas of democratic practice in poor, diverse, and unequal societies, while inviting students to propose practical interventions.
E. Lieberman

17.572 African Politics
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Introduces the major arguments, hypotheses and debates in the literature on African politics and development, with the goal of helping students develop the skills to become both more intelligent consumers and more effective producers of this literature. Covers both classic contributions to the literature and more recent research.
E. Lieberman

17.578 Elections and Political Representation in the Developing World
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Focuses on the theoretical and empirical study of elections, representation, and governance in non-industrialized democratic societies. Surveys the contemporary literature on topics such as party systems, clientelism, electorally-motivated violence, ethnic politics, and federalism.
D. Hidalgo
17.581 Riots, Rebellions, Revolutions
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S

Examines different types of violent political conflict. Compares and contrasts several social science approaches (psychological, sociological, and political) and analyzes their ability to explain variation in outbreak, duration and outcome of conflict. Examines incidents such as riots in the US during the 1960’s, riots in India, the Yugoslav wars, and the Russian Revolution, in addition to current international events.

R. Petersen

17.582 Civil War
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Surveys the social science literature on civil war. Studies the origins of civil war, discusses variables affecting duration, and examines termination of conflict. Highly interdisciplinary and covers a wide variety of cases. Open to advanced undergraduates with permission of instructor.

F. Christia

17.584 Civil-Military Relations
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Subject consists of five sections. After a general survey of the field, students consider cases of stable civilian control, military rule, and transitions from military to civilian rule. Cases are selected from around the world.

R. Petersen

17.588 Field Seminar in Comparative Politics
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Provides an introduction to the field of comparative politics. Readings include both classic and recent materials. Discusses research design and research methods, in addition to topics such as political culture, social cleavages, the state, and democratic institutions. Emphasis on each issue depends in part on the interests of the students.

C. Lawson

17.590 State Building
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Examines the process of building modern, national states across regions at different levels of development. Focuses on conceptualizing and measuring state power; and on the range of political, economic, and social explanations that account for variation, including the role of technology, war, material endowments, geography, trust, ethnic diversity, and democratic regimes. Evaluates the quality of evidence for different accounts. Theoretical orientation intended for Ph.D. students in political science.

E. Lieberman

17.591 Research Seminar in Applied International Studies
Prereq: Permission of instructor
U (Spring)
3-0-9 units. HASS-S; CI-H

Focuses on research methods in the social sciences as they relate to topics in international studies. Students complete an independent research project on a topic chosen in consultation with the instructor; class presentation required. Limited to 18; preference to Applied International Studies minors.

B. Schneider

Models and Methods

17.800 Quantitative Research Methods I: Regression
Prereq: Permission of instructor
G (Fall)
4-0-8 units

Introduction to statistical research in political science and public policy, with a focus on linear regression. Teaches students how to apply multiple regression models as used in much of political science and public policy research. Also covers elements of probability and sampling theory. Limited to 30; preference to Course 17 PhD students.

T. Yamamoto
17.801 Political Science Scope and Methods
Prereq: None
U (Fall)
3-0-9 units. HASS-S
Introduces principles of empirical and theoretical analysis in political science through research projects currently conducted in the department. Different department faculty lead modules that introduce students to major research questions and different ways of examining those questions. Emphasizes how this research in progress relates to larger themes, and how researchers confront obstacles to inference in political science. Includes substantial instruction and practice in writing (with revision) and oral presentations. Intended primarily for majors and minors.
F. Christia

17.802 Quantitative Research Methods II: Causal Inference
Prereq: 17.800, 17.803, or permission of instructor
G (Spring)
4-0-8 units
Survey of statistical methods for causal inference in political science and public policy research. Covers a variety of causal inference designs, including experiments, matching, regression, panel methods, difference-in-differences, synthetic control methods, instrumental variables, regression discontinuity designs, quantile regression, and bounds. Limited to 30; preference to Course 17 PhD students.
D. Hidalgo

17.803 Political Science Laboratory
Prereq: 17.801 or permission of instructor
U (Spring)
3-6-6 units. Institute LAB
Introduces students to the conduct of political research using quantitative methodologies. The methods are examined in the context of specific political research activities like public opinion surveys, voting behavior, Congressional behavior, comparisons of political processes in different countries, and the evaluation of public policies. Includes instruction and practice in written and oral communication. Students participate in joint class projects and conduct individual projects. Does <em>not</em> count toward HASS Requirement. Enrollment limited; preference to Course 17 majors who have pre-registered.
T. Yamamoto

17.804 Quantitative Research Methods III: Generalized Linear Models and Extensions
Prereq: 17.802 or permission of instructor
G (Fall)
4-0-8 units
Provides a survey of statistical tools for model-based inference in political science and public policy. Topics include generalized linear models for various data types and their extensions, such as discrete choice models, survival outcome models, mixed effects and multilevel models. Covers both frequentist and Bayesian approaches.
T. Yamamoto

17.806 Quantitative Research Methods IV: Advanced Topics
Prereq: 17.804 or permission of instructor
G (Spring)
4-0-8 units
Covers advanced statistical tools that are useful for empirical research in political science and public policy. Possible topics include missing data, survey sampling and experimental designs for field research, machine learning, text mining, clustering, Bayesian methods, spatial statistics, and web scraping.
D. Hidalgo

17.810 Game Theory and Political Theory
Subject meets with 17.811
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
Introduces students to the rudiments of game theory within political science. Provides all students with the ability to solve simple games. Readings draw from basic texts on game theoretic modeling and applied articles in American Politics, International Relations, and Comparative Politics. Students taking the graduate version evaluate applied theory articles in the major journals.
I. S. Kim
17.811 Game Theory and Political Theory
Subject meets with 17.810
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4-0-8 units. HASS-S
Introduces students to the rudiments of game theory within political science. Provides students with the ability to solve simple games. Readings draw from basic texts on game theoretic modeling and applied articles in American politics, international relations, and comparative politics. Students taking the graduate version evaluate applied theory articles in the major journals.
I. S. Kim

17.830 Empirical Methods in Political Economy
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Reviews recent quantitative empirical studies on important, substantive questions in political economy. Designed to increase students' understanding of the core research designs and measurement strategies employed in the empirical analysis of political institutions and political behavior. Topics include the political and economic consequences of direct democracy, reservations for political minorities, corruption, political effects of the media, and politics in authoritarian regimes.
D. Hidalgo

17.831 Data and Politics
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Explores the intersection between politics and data. Introduces principles and practice of data-driven methods used to understand electoral and other types of political behavior. Students use real world datasets to explore topics such as election polling and prediction, the determinants of voter turnout, how campaigns target voters, and how public opinion changes over time.
D. Hidalgo

17.835 Machine Learning and Data Science in Politics
Prereq: 6.0001 or permission of instructor
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
4-0-8 units. HASS-S
Introduces students to politics by analyzing political science data sets with machine learning methodologies. Covers a variety of data science tools, including supervised and unsupervised learning methods, visualization techniques, text analysis, and network analysis. Emphasizes how the research methodologies can be used for studying political science. Topics include lobbying, international trade, political networks, and estimating ideologies of political leaders.
I. S. Kim

17.830 Empirical Methods in Political Economy
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Introduces principles of empirical and theoretical analysis in political science. Exposes students to major research questions and different ways of examining them. Limited to Course 17 PhD students.
R. Nielsen

17.850 Political Science Scope and Methods
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Introduces students to politics by analyzing political science data sets with machine learning methodologies. Covers a variety of data science tools, including supervised and unsupervised learning methods, visualization techniques, text analysis, and network analysis. Emphasizes how the research methodologies can be used for studying political science. Topics include lobbying, international trade, political networks, and estimating ideologies of political leaders.
I. S. Kim

17.878 Qualitative Methods and Fieldwork
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Prepares students to conduct independent qualitative research, focusing on practical skills acquisition. Topics include methodological controversies, debates about transparency, human subjects protocols and research ethics, interviewing techniques, ethnography, focus groups, comparative historical case studies/archival research, and write-up of qualitative information collected from the field.
C. Lawson

General Subjects

17.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Research opportunities in Political Science in theoretical and applied research. For further information, contact the Departmental Coordinator.
Staff
17.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Research opportunities in political science in theoretical and applied research. For further information, contact the departmental coordinator.

**Staff**

17.901 Political Science Internship and Research
Prereq: None
U (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Independent research enabling students to do work in an agency, state, or local government, or other public organization. The academic component involves close contact between the student and a faculty advisor and written work. Work may be done during the summer.

_T. Weiner_

17.902 Political Science Internship and Research
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For students participating in off-campus internships relevant to the field of political science. Before registering, students must submit a 1-2 page application statement which describes the internship, the nature of the work, the time commitment (hours per week and number of weeks) and the connection to the field of political science. Students must also submit a formal offer letter from a host employer/organization which provides details of the internship. Subject to departmental approval. Consult departmental undergraduate office.

**Staff**

17.903 Community Service: Experience and Reflection
Prereq: None
U (Fall)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.

Seminar involves students in the community that exists beyond the labs and classrooms of the MIT campus. Through a combination of community service and academic study, students learn about political, economic, and social issues that confront residents in Boston and Cambridge. Students volunteer in a community service agency or private organization devoted to community needs and development. Students also responsible for directed readings, short writing assignments, and six seminar sessions. Subject can only be repeated for credit if area of community service is different.

_T. Weiner_

17.905-17.911 Reading Seminar in Social Science
Prereq: None
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.

Reading and discussion of special topics in the fields of social science. Open to advanced undergraduates by arrangement with individual staff members. 17.909 is taught P/D/F.

**Staff**

17.922 Martin Luther King, Jr. Design Seminar
Prereq: None
U (IAP)
Not offered regularly; consult department
3-0-3 units

Facilitates design and construction of installations and other community projects in conjunction with and beyond MIT’s celebration of Dr. King. Students discuss the ideas and goals of Dr. King and other human rights leaders in the US and the world. The first half of the class develops in-depth understanding of the history of US racial issues as well as past and present domestic and international political struggles. Addresses issues of justice, equality and racism through videos, readings and writings, and class discussions. In the second half, students work as a group complete the installation and projects which serve as models for connecting academics with real life problems and struggle.

_T. Weiner_
17.925 Fundamentals of Science and Technology Public Policy Making: Science and Technology Policy Boot Camp
Prereq: None
U (IAP)
Units arranged
Examines the public policy behind, and the government's role in, the science and technology-based innovation system. Focuses on the US, but also discusses international examples. Prepares students planning careers in and around science and technology with the basic background for involvement in science policy making. Students may register for 3-6 units.
W. Bonvillian

17.959 Preparation for General Exams
Prereq: Permission of instructor
G (Fall, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Selected readings for Political Science doctoral students in preparation for qualifying exams.
Staff

17.954-17.958, 17.960 Reading Seminar in Social Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.
Reading and discussion of special topics in the fields of social science. Open to advanced graduate students by arrangement with individual staff members. 17.954 and 17.959 are taught P/D/F.
Staff

17.962 Second Year Paper Workshop
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Workshop for research and writing of major research paper as part of pre-dissertation requirements. Restricted to doctoral students.
D. Singer

17.THG Graduate Political Science Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research and writing of thesis; to be arranged by the student with supervising committee.
Staff

17.THT Thesis Research Design Seminar
Prereq: 17.803 or permission of instructor
U (Fall)
3-0-9 units
Students writing a thesis in Political Science develop their research topics, review relevant research and scholarship, frame their research questions and arguments, choose an appropriate methodology for analysis, and draft the introductory and methodology sections of their theses.
D. Singer

17.THU Undergraduate Political Science Thesis
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of an SB thesis. To be arranged by the student under approved supervision.
Staff

17.S912 Special Undergraduate Subject in Political Science
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Reading and discussion of topics in the field of social science not covered in the regular curriculum.
Staff

17.S914 Special Undergraduate Subject in Political Science
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Reading and discussion of topics in the field of social science not covered in the regular curriculum.
Staff

17.S916 Special Undergraduate Subject in Political Science
Prereq: None
U (Spring)
Units arranged [P/D/F]
Can be repeated for credit.
Reading and discussion of topics in the field of social science not covered in the regular curriculum.
Staff
17.S917 Special Undergraduate Subject in Political Science
Prereq: None
U (Spring)
Units arranged
Can be repeated for credit.
Reading and discussion of topics in the field of social science not covered in the regular curriculum.
Staff

17.S918 Special Undergraduate Subject in Political Science
Prereq: None
U (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Reading and discussion of topics in the field of social science not covered in the regular curriculum.
Staff

17.S919 Special Undergraduate Subject in Political Science
Prereq: None
U (Spring)
Units arranged
Can be repeated for credit.
Reading and discussion of topics in the field of social science not covered in the regular curriculum.
Staff

17.S950 Special Graduate Subject in Political Science
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.
Open to qualified graduate students who would like to pursue special subjects or projects. Please consult graduate administration prior to registration.
Staff

17.S951 Special Graduate Subject in Political Science
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.
Open to qualified graduate students who would like to pursue special subjects or projects. Please consult graduate administration prior to registration.
Staff

17.S952 Special Graduate Subject in Political Science
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.
Open to qualified graduate students who would like to pursue special subjects or projects. Please consult graduate administration prior to registration.
Staff

17.S953 Special Graduate Subject in Political Science
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.
Open to qualified graduate students who would like to pursue special subjects or projects. Please consult graduate administration prior to registration.
Staff
Undergraduate Subjects

Tier I Subjects

STS.001 Technology in American History
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

A survey of America’s transition from a rural, agrarian, and artisan society to one of the world’s leading industrial powers. Treats the emergence of industrial capitalism: the rise of the factory system; new forms of power, transport, and communication; the advent of the large industrial corporation; the social relations of production; and the hallmarks of science-based industry. Views technology as part of the larger culture and reveals innovation as a process consisting of a range of possibilities that are chosen or rejected according to the social criteria of the time.

M. R. Smith

STS.002 Finance and Society
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S; CI-H

Examines finance as a social technology intended to improve economic opportunity by moving capital to where it is most needed. Surveys the history of modern finance, from medieval Italy to the Great Depression, while addressing credit, finance and state (and imperial) power, global financial interconnection, and financial crises. Explores modern finance (since about 1950) from a variety of historical and social-scientific perspectives, covering quant finance, financialization, the crisis of 2007-2008, and finance in the digital age. Enrollment limited.

W. Deringer

STS.003 Ancient Greeks to Modern Geeks: A History of Science
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H

Covers the development of major fields in the physical and life sciences, from 18th-century Europe through 20th-century America. Examines ideas, institutions, and the social settings of the sciences, with emphasis on how cultural contexts influence scientific concepts and practices.

W. Deringer, D. I. Kaiser

STS.004 Intersections: Science, Technology, and the World
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Exposes students to multidisciplinary studies in Science, Technology, and Society (STS), using four case studies to illustrate a broad range of approaches to basic principles of STS studies. Case studies vary from year to year, but always include a current MIT event. Other topics are drawn from legal and political conflicts, and arts and communication media. Includes guest presenters, discussion groups, field activities, visual media, and a practicum style of learning. Enrollment limited.

D. Fitzgerald

STS.005[J] Data and Society
Same subject as 11.155[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Introduces students to the social, political, and ethical aspects of data science work. Designed to create reflective practitioners who are able to think critically about how collecting, aggregating, and analyzing data are social processes and processes that affect people.

E. Medina, S. Williams

STS.006[J] Bioethics
Same subject as 24.06[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H; CI-H

See description under subject 24.06[J].

A. Chaudhuri, Q. White

STS.007 Technology in History
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H

Covers theories of the interactions between historical and technological change; relations between the histories of science and of technology; purported turning points such as the Neolithic, Industrial, and Information Revolutions; case studies from a wide range of times and places; and connections across time and space. Lectures supplemented by student presentations. Frequent writing, rewriting, and small group work. Enrollment limited.

R. H. Williams
STS.008 Technology and Experience
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S; CI-H

Introduces the “inner history” of technology: how it affects intimate aspects of human experience from sociological, psychological and anthropological perspectives. Topics vary, but may include how the internet transforms our experience of time, space, privacy, and social engagement; how entertainment media affects attention, creativity, aesthetics and emotion; how innovations in wearable and textile technologies reshape notions of history and identity; how pharmaceuticals reshape identity, mood, pain, and pleasure. Includes in-class discussion of readings, short written and multimedia assignments, final project. Enrollment limited.

Staff

STS.009 Evolution and Society
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H; CI-H

Provides a broad conceptual and historical introduction to scientific theories of evolution and their place in the wider culture. Embraces historical, scientific and anthropological/cultural perspectives grounded in relevant developments in the biological sciences since 1800 that are largely responsible for the development of the modern theory of evolution by natural selection. Students read key texts, analyze key debates (e.g. Darwinian debates in the 19th century, and the creation controversies in the 20th century) and give class presentations.

J. Durant, R. Scheffler

STS.011 Engineering Life: Biotechnology and Society
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Provides instruction in the history of humanity's efforts to control and shape life through biotechnology, from agriculture to gene editing. Examines the technologies, individuals and socio-economic systems that are associated with such efforts, as well as the impact that these efforts have on society and science as a whole. Explores these issues with particular attention to the development of the modern biotechnology industry in the Greater Boston area. Includes a field trip.

R. W. Scheffler

STS.012 Science in Action: Technologies and Controversies in Everyday Life
Prereq: None
U (Spring)
3-0-9 units. HASS-S

Explores a range of controversies about the role of technology, the nature of scientific research and the place of politics in science: debates about digital piracy and privacy, the role of activism in science, the increasingly unclear boundaries between human and non-human, the role of MRIs as courtroom evidence, the potential influence of gender on scientific research, etc. Provides exposure to science in a dynamic relation with social life and cultural ideas. Materials draw from humanities and social science research, ethnographic fieldwork, films and science podcasts, as well as from experimental multimedia.

D. Banerjee

Tier II Subjects

STS.021[J] Science Activism: Gender, Race, and Power (New)
Same subject as WGS.160[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-E

See description under subject WGS.160[J].

E. Bertschinger

STS.022[J] Gender, Race, and Environmental Justice
Same subject as 21G.057[J], WGS.275[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

See description under subject 21G.057[J]. Limited to 18.

B. Stoetzer

STS.023[J] Science, Gender and Social Inequality in the Developing World
Same subject as WGS.226[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

See description under subject WGS.226[J].

A. Sur
**STS.025[J] Making the Modern World: The Industrial Revolution in Global Perspective**
Same subject as 21H.285[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Global survey of the great transformation in history known as the "Industrial Revolution." Topics include origins of mechanized production, the factory system, steam propulsion, electrification, mass communications, mass production and automation. Emphasis on the transfer of technology and its many adaptations around the world. Countries treated include Great Britain, France, Germany, the US, Sweden, Russia, Japan, China, and India. Includes brief reflection papers and a final paper.

*M. R. Smith*

**STS.026 History of Manufacturing in America**
Subject meets with STS.425
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Introductory survey of fundamental innovations and transitions in American manufacturing from the colonial period to the mid-twentieth century. Primary emphasis on textiles and metalworking, with particular attention to the role of the machine tool industry in the American manufacturing economy. Students taking graduate version are expected to explore the material in greater depth.

*M. R. Smith*

**STS.027[J] The Civil War and the Emergence of Modern America: 1861-1890**
Same subject as 21H.205[J]
Subject meets with STS.427
Prereq: Permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Using the American Civil War as a baseline, considers what it means to become "modern" by exploring the war's material and manpower needs, associated key technologies, and how both influenced the United States' entrance into the age of "Big Business." Readings include material on steam transportation, telegraphic communications, arms production, naval innovation, food processing, medicine, public health, management methods, and the mass production of everything from underwear to uniforms – all essential ingredients of modernity. Students taking graduate version complete additional assignments.

*M. R. Smith*

**STS.028 Seven Wonders of the Engineering World**
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Uses case studies to take a broad-ranging look at seven major engineering achievements in world history. Examines the nature of engineering as a source of knowledge production/application, how it reflects the cultural settings in which it emerges, and how it changes as it enters different cultural and economic settings. Includes weekly reflection papers. Achievements covered vary from term to term. Limited to 20.

*M. R. Smith*

**STS.030 Forensic History: Problem Solving into the Past (New)**
Prereq: None
U (Fall)
3-0-9 units. HASS-S

Explores new pathways to use the latest science and technologies to understand the past. Working like detectives, students draw on research methods from such fields as climate science, geology, molecular biology, proteomics, DNA testing, carbon dating and big data analysis to invent their own forensic historical research techniques. They also study new narrative forms to accompany novel research techniques. Instruction and practice in oral and written communication provided. Enrollment limited.

*K. Brown*

**STS.032 Energy, Environment, and Society**
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Uses a problem-solving, multi-disciplinary, and multicultural approach that takes energy beyond the complex circuits, grids, and kilojoules to the realm of everyday life, with ordinary people as practitioners and producers of energy knowledge, infrastructures, and technologies. The three main objectives are to immerse students in the historical, cultural, multi-cultural, and entrepreneurial aspects of energy across the world to make them better energy engineers; to introduce them to research and analytical methods; and to deploy these methods and their various skills to solve/design a solution, in groups, to a specific energy problem chosen by the students. Each cohort tackles a different energy problem. Provides instruction on how to be active shapers of the world and to bring students' various disciplinary skills and cultural diversity into dialogue as conceptual tools for problem-solving. Enrollment limited.

*C. Mavhunga*
STS.033[J] People and the Planet: Environmental Histories and Engineering  
Same subject as 11.004[J]  
Subject meets with 11.204[J], IDS.524[J]  
Prereq: None  
U (Spring)  
3-3-6 units. HASS-E  
See description under subject 11.004[J].  
A. Glasmeier, J. Knox-Hayes, A. Slocum, R. Scheffler, J. Trancik

STS.034 Science Communication: A Practical Guide  
Prereq: None  
Acad Year 2019-2020: U (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units. HASS-H; CI-H  
Develops students' abilities to communicate science effectively in a variety of real-world contexts. Covers strategies for dealing with complex areas like theoretical physics, genomics and neuroscience, and addresses challenges in communicating about topics such as climate change and evolution. Projects focus on speaking and writing, being an expert witness, preparing briefings for policymakers, writing blogs, giving live interviews for broadcast, and influencing public dialogue through opinion-editorials. Enrollment limited.  
B. Venkataraman

STS.035 Exhibiting Science  
Prereq: One CI-H/CI-HW subject and permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
2-2-8 units. HASS-A  
Project-based seminar covers key topics in museum communication, including science learning in informal settings, the role of artifacts and interactives, and exhibit evaluation. Students work on a term-long project, organized around the design, fabrication, and installation of an original multimedia exhibit about current scientific research at MIT. Culminates with the project's installation in the MIT Museum's Mark Epstein Innovation Gallery. Limited to 20; preference to students who have taken STS.034.  
J. Durant

STS.042[J] Einstein, Oppenheimer, Feynman: Physics in the 20th Century  
Same subject as 8.225[J]  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Fall)  
3-0-9 units. HASS-H  
Explores the changing roles of physics and physicists during the 20th century. Topics range from relativity theory and quantum mechanics to high-energy physics and cosmology. Examines the development of modern physics within shifting institutional, cultural, and political contexts, such as physics in Imperial Britain, Nazi Germany, US efforts during World War II, and physicists' roles during the Cold War. Enrollment limited.  
D. I. Kaiser

STS.043 Technology and Self: Science, Technology, and Memoir  
Subject meets with STS.443  
Prereq: None  
Acad Year 2019-2020: U (Spring)  
Acad Year 2020-2021: Not offered  
2-0-7 units. HASS-S  
Focuses on the memoir as a window onto the relationship of the scientist, engineer, and technologist to his or her work. Studies the subjective side of technology and the social and psychological dimensions of technological change. Students write about specific objects and their role in their lives - memoir fragments. Readings concern child development theory and the role of technology in development. Explores the connection between material culture, identity, cognitive and emotional development. Students taking graduate version complete additional assignments. Limited to 15; no listeners.  
S. Turkle

STS.044 Technology and Self: Things and Thinking  
Subject meets with STS.444  
Prereq: None  
Acad Year 2019-2020: U (Spring)  
Acad Year 2020-2021: Not offered  
2-0-7 units. HASS-S  
Explores emotional and intellectual impact of objects. The growing literature on cognition and "things" cuts across anthropology, history, social theory, literature, sociology, and psychology and is of great relevance to science students. Examines the range of theories, from Mary Douglas in anthropology to D. W. Winnicott in psychoanalytic thinking, that underlies "thing" or "object" analysis. Students taking graduate version complete additional assignments. Limited to 15; no listeners.  
S. Turkle
STS.046[J] The Science of Race, Sex, and Gender
Same subject as 21A.103[J], WGS.225[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
See description under subject WGS.225[J].
A. Sur

STS.047 Quantifying People: A History of Social Science
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Historical examination of the quest to understand human society scientifically. Focuses on quantification, including its central role in the historical development of social science and its importance in the 21st-century data age. Covers the political arithmetic of the 17th century to the present. Emphasizes intensive reading of primary sources, which represent past attempts to count, calculate, measure, and model many dimensions of human social life (population, wealth, health, happiness, intelligence, crime, deviance, race).
Limited to 25.
W. Deringer

STS.048 African Americans in Science, Technology, and Medicine
Prereq: None
U (Spring)
3-0-9 units. HASS-H
A survey of the contributions of African Americans to science, technology, and medicine from colonial times to the present. Explores the impact of concepts, trends, and developments in science, technology, and medicine on the lives of African Americans. Examples include the eugenics movement, the Tuskegee Syphilis Experiment, the debate surrounding racial inheritance, and IQ testing.
K. Manning

STS.049 The Long War Against Cancer
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H; CI-H
Examines anticancer efforts as a critical area for the formation of contemporary biomedical explanations for health and disease. Begins with the premise that the most significant implications of these efforts extend far beyond the success or failure of individual cancer therapies. Considers developments in the epidemiology, therapy, and politics of cancer. Uses the history of cancer to connect the history of biology and medicine to larger social and cultural developments, including those in bioethics, race, gender, activism, markets, and governance.
R. W. Scheffler

STS.050 The History of MIT
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Examines the history of MIT, from its founding to the present, through the lens of the history of science and technology. Topics include William Barton Rogers; the modern research university and educational philosophy; campus, intellectual, and organizational development; changing laboratories and practices; MIT’s relationship with Boston, the federal government, and industry; and notable activities and achievements of students, alumni, faculty, and staff. Includes guest lecturers, on-campus field trips, and interactive exercises. Enrollment limited.
D. Douglas

STS.052 Living with Risk: Threats, Accidents, and Disasters in a Technological Age
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
Uses a set of case studies to develop an analytical framework for understanding complex scientific and technical systems and their occasional failures. Addresses topics such as nuclear power and weapons, marine shipping, cybersecurity, and rising sea levels.
D. Fitzgerald
STS.058 Space Exploration and Interplanetary Habitation
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-E

Engages with historical, contemporary and emerging practices in sciences, design, architecture, arts, and technology to examine how the study of the histories of colonialism, capitalism, racism, and sexism offers critical means and methods for (re)envisioning outer space exploration, life under extreme conditions, and planetary habitation. Instruction offers tools of analysis issued from Science and Technology Studies (STS) and Feminist Sciences Studies to assess the social, political and anthropological impact of outer space science and technology on Earth-based societies.

M-P. Boucher

STS.060[J] The Anthropology of Biology
Same subject as 21A.303[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

See description under subject 21A.303[J].

S. Helmreich

STS.062[J] Drugs, Politics, and Culture
Same subject as 21A.305[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

See description under subject 21A.305[J]. Limited to 25.

A. Moran-Thomas

STS.064[J] DV Lab: Documenting Science through Video and New Media
Same subject as 21A.550[J]
Subject meets with 21A.559
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-3-6 units. HASS-A; CI-H

See description under subject 21A.550[J]. Limited to 12.

C. Walley, C. Boebel

STS.065[J] The Anthropology of Sound
Same subject as 21A.505[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

See description under subject 21A.505[J].

S. Helmreich

STS.071[J] Cross-Cultural Investigations: Technology and Development
Same subject as EC.702[J], 21A.801[J]
Subject meets with EC.792[J], 21A.839[J], STS.481[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

See description under subject 21A.801[J].

C. Walley

STS.074[J] Art, Craft, Science
Same subject as 21A.501[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Credit cannot also be received for 21A.509[J], STS.474[J]

See description under subject 21A.501[J].

H. Paxson

STS.075[J] Technology and Culture
Same subject as 21A.500[J]
Prereq: None
U (Fall, Spring)
2-0-7 units. HASS-S

See description under subject 21A.500[J]. Limited to 40.

S. Helmreich
**STS.080[J] Youth Political Participation**
Same subject as 11.151[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H

Surveys youth political participation in the US since the early 1800s. Investigates trends in youth political activism during specific historical periods, as well as what difference youth media production and technology use (e.g., radio, music, automobiles, ready-made clothing) made in determining the course of events. Explores what is truly new about “new media” and reviews lessons from history for present-day activists based on patterns of past failure and success. Some mandatory field trips may occur during class time. Limited to 40.

**J. S. Light**

**STS.081[J] Innovation Systems for Science, Technology, Energy, Manufacturing, and Health**
Same subject as 17.395[J]
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
2-0-7 units. HASS-S

Examines science and technology innovation systems, including case studies on energy, computing, advanced manufacturing, and health sectors. Emphasizes public policy and the federal government’s role in that system. Focuses on the US but uses international examples. Reviews foundations of economic growth theory, innovation systems theory, and the basic approaches to science and technology policy. Explores the organization and role of energy and medical science R&D agencies, as well as gaps in those innovation systems. Also addresses the science and technology talent base as a factor in growth, and educational approaches to better support it. Class meets for nine weeks; in the remaining weeks, students work on a final paper due at the end of the term. Limited to 25.

**W. B. Bonvillian**

**STS.083 Computers and Social Change (New)**
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H

Provides instruction on how people have historically connected computers to ideas on social, economic, and political change and how these ideas have changed over time. Based on a series of case studies from different parts of the world. Explores topics such as how computers have intertwined with ideas on work, freedom, governance, and access to knowledge. Limited to 25.

**E. Medina**

**STS.084[J] Social Problems of Nuclear Energy**
Same subject as 22.04[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S

See description under subject 22.04[J]. Limited to 18.

**R. S. Kemp**

**STS.085[J] Foundations of Information Policy**
Same subject as 6.805[J]
Subject meets with STS.487
Prereq: Permission of instructor
U (Fall)
3-0-9 units. HASS-S

See description under subject 6.805[J]. Enrollment limited.

**H. Abelson, M. Fischer, D. Weitzner**

**STS.086[J] Cultures of Computing**
Same subject as 21A.504[J], WGS.276[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-S

See description under subject 21A.504[J].

**Staff**
ST5.087 Biography in Science  
Prereq: None  
Acad Year 2019-2020: U (Fall)  
Acad Year 2020-2021: Not offered  
3-0-9 units. HASS-H  

An examination of biography as a literary genre to be employed in the history of science. The use of biography in different historical periods to illuminate aspects of the development of science. A critical analysis of autobiography, archival sources, and the oral tradition as materials in the construction of biographies of scientists. Published biographies of scientists constitute the major reading, but attention is given to unpublished biographical sources as well. Comparison is drawn between biography as a literary form in the history of science and in other disciplines.  

K. Manning

ST5.088 Africa for Engineers  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: U (Spring)  
3-0-9 units. HASS-H  

Covers historical, cultural, and ethical dimensions of engineering in Africa. Focuses on construction of big projects like cities, hydroelectricity dams, roads, railway lines, ports and harbors, transport and communication, mines, industrial processing plant, and plantations. Explores the contributions of big capital, engineers, politicians, and ordinary people. Emphasizes how local culture, politics, labor, and knowledge affect engineering. Also focuses on environmental and cultural impact assessment. Prepares students who wish to work or study in Africa and the Global South. Enrollment limited.  

C. Mavhunga

ST5.095, ST5.096 Independent Study in Science, Technology, and Society  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  

For students who wish to pursue special studies or projects with a member of the Program in Science, Technology, and Society. ST5.095 is letter-graded; ST5.096 is P/D/F.

Staff

Special Subjects

ST5.S20, ST5.S21 Special Subject: Science, Technology and Society  
Prereq: None  
U (Fall, IAP, Spring)  
Not offered regularly; consult department  
Units arranged  
Can be repeated for credit.  

Addresses subject matter in Science, Technology and Society that is not offered in the regular curriculum.  

Staff

Research

ST5.095, ST5.096 Independent Study in Science, Technology, and Society  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit.  

For students who wish to pursue special studies or projects with a member of the Program in Science, Technology, and Society. ST5.095 is letter-graded; ST5.096 is P/D/F.  

Staff

ST5.UR Undergraduate Research  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.  

Undergraduate research opportunities in the STS Program.  

Staff

ST5.URG Undergraduate Research  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.  

Undergraduate research opportunities in the STS Program.  

Staff
STS.THT Undergraduate Thesis Tutorial
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit.
Definition and early-stage work on thesis project leading to STS.THU. Taken during first term of student’s two-term commitment to thesis project. Student works closely with STS faculty tutor. Required of all candidates for an STS degree.
Staff

STS.THU Undergraduate Thesis
Prereq: STS.THT
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Completion of work of the senior major thesis under the supervision of a faculty tutor. Includes gathering materials, preparing draft chapters, giving an oral presentation of thesis progress to faculty evaluators early in the term, and writing and revising the final text. Students meet at the end of the term with faculty evaluators to discuss the successes and limitations of the project. Required of all candidates for an STS degree.
Staff

Graduate Subjects

Required Introductory Subjects

STS.250[J] Social Theory and Analysis
Same subject as 21A.859[J]
Prereq: None
G (Fall)
3-0-9 units
See description under subject 21A.859[J].
M. Fischer

STS.260 Introduction to Science, Technology, and Society
Prereq: None
G (Spring)
3-0-9 units
Intensive reading and analysis of major works in historical and social studies of science and technology. Introduction to current methodological approaches, centered around two primary questions: how have science and technology evolved as human activities, and what roles do they play in society? Preparation for graduate work in the field of science and technology studies and introduction to research resources and professional standards.
D. I. Kaiser

Advanced Seminars

STS.310 History of Science
Prereq:Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Intensive reading and analysis of key works in the history and historiography of science. Introduces students to basic interpretive issues, bibliographic sources, and professional standards. Topics change from year to year.
R. W. Scheffler

STS.320[J] Environmental Conflict
Same subject as 21A.429[J]
Prereq:Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Explores the complex interrelationships among humans and natural environments, focusing on non-western parts of the world in addition to Europe and the United States. Use of environmental conflict to draw attention to competing understandings and uses of "nature" as well as the local, national and transnational power relationships in which environmental interactions are embedded. In addition to utilizing a range of theoretical perspectives, subject draws upon a series of ethnographic case studies of environmental conflicts in various parts of the world.
C. Walley

STS.330[J] History and Anthropology of Medicine and Biology
Same subject as 21A.319[J]
Prereq:Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
See description under subject 21A.319[J].
S. Helmreich
**STS.340 Introduction to the History of Technology**  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  

Introduction to the consideration of technology as the outcome of particular technical, historical, cultural, and political efforts, especially in the United States during the 19th and 20th centuries. Topics include industrialization of production and consumption, development of engineering professions, the emergence of management and its role in shaping technological forms, the technological construction of gender roles, and the relationship between humans and machines.  

*M. R. Smith, D. Mindell*

**STS.360[J] Ethnography**  
Same subject as 21A.829[J]  
Prereq: None. *Coreq: 21A.859[J]; permission of instructor*  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  

Practicum-style course in anthropological methods of ethnographic fieldwork and writing. Depending on student experience in ethnographic reading and practice, subject combines reading ethnographies in anthropological and science studies with formulating and pursuing ethnographic work in local labs, companies, or other sites. Preference to HASTS, CMS, HTC and Sloan graduate students.  

*M. Fischer*

**STS.412 Quantiﬁcation**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units  

Surveys research on quantification, the practice of using numerical data and calculation to analyze, order, and control. Begins by examining historical accounts of the rise of quantitative methods and values since c. 1600. Goes on to explore the dynamics and consequences of quantification across a range of modern domains, including science, politics, governance, health, education, crime, law, economic development, finance, and environmental regulation. Readings drawn from STS, history, anthropology, sociology, and philosophy.  

*W. Deringer*

**STS.414[J] Risk, Fortune, and Futurity**  
Same subject as 21H.984[J]  
Prereq: None  
G (Spring)  
Not offered regularly; consult department  
3-0-9 units  

See description under subject 21H.984[J]. Open to undergraduates with permission of instructor; consult department for details.  

*W. Deringer, C. Horan*

**STS.417 STS Seminar on the Global South**  
Prereq: None  
Acad Year 2019-2020: G (Spring)  
Acad Year 2020-2021: Not offered  
3-0-9 units  

Covers Africa and its diaspora, Latin America and the Caribbean, the Middle East, Southeast Asia and Asia, and Oceania. Seeks to explore meanings of science and technology from traditions, experiences, and literatures of these regions; to understand encounters and outcomes of endogenous and inbound ideas, artifacts, and practice; and to engage European and North American science, technology, and society (STS) in dialogue with these literatures. Provides a global view of STS in an increasingly interconnected world. Focuses on peoples of the Global South as innovative intellectual agents, not just victims of technology or its appropriators.  

*D. Banerjee*

**STS.418 Science and Technology in South Asia: Perspectives from History and Anthropology**  
Prereq: None  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Fall)  
3-0-9 units  

Surveys transformations of science and technology in colonial and postcolonial South Asia, 19th-21st centuries. Explores colonial science paradigms, the colony as an experimental space, the scientifically planned postcolonial state, alternative science movements, genetic experimentations for food sovereignty, and most recently, the region’s role as a node in a global regimes of biotech and IT. Discussions address the scholarly and practical constructions of western, global, non-western and indigenous science, and the analytic limits and salience of such categories. Readings include works in history, anthropology and literature.  

*D. Banerjee*
**STS.419 Global Science: Ethnography, Literature, and Film**
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

Going beyond issues of brain drain and brain circulation, explores how contemporary science and technology innovations look from, and are being created in, parts of the world other than the US and Europe. Uses films, novels, and artworks to think across disciplinary boundaries and the impact of science and technology on social worlds (as well as the social worlds of scientists and engineers). Open to upperclassmen with permission of instructor.
*M. Fischer*

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**STS.425 History of Manufacturing in America**
Subject meets with STS.026
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Introductory survey of fundamental innovations and transitions in American manufacturing from the colonial period to the mid-twentieth century. Primary emphasis on textiles and metalworking, with particular attention to the role of the machine tool industry in the American manufacturing economy. Students taking graduate version are expected to explore the material in greater depth.
*M. R. Smith*

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**STS.427 The Civil War and the Emergence of Modern America: 1861-1890**
Subject meets with 21H.205[J], STS.027[J]
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

Using the American Civil War as a baseline, considers what it means to become "modern" by exploring the war's material and manpower needs, associated key technologies, and how both influenced the United States' entrance into the age of "Big Business." Readings include material on steam transportation, telegraphic communications, arms production, naval innovation, food processing, medicine, public health, management methods, and the mass production of everything from underwear to uniforms – all essential ingredients of modernity. Students taking graduate version complete additional assignments.
*M. R. Smith*

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**STS.429 Food and Power**
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Anthropological and historical analysis of food production, processing, and consumption in the US and globally. Emphasizes the social and technical practices of raising crops and livestock; efforts to preserve as well as create new foods; the industrialization and de-industrialization of food; the relation between food supply and safety and the state; the role of ethnicity and gender in consumption patterns; and the historical and cultural act of eating. STS.250[J] recommended.
*D. Fitzgerald*

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**STS.436 Cold War Science**
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units

Examines the history and legacy of the Cold War on science and the environment in the US and the world. Explores scientists' new political roles after World War II, ranging from elite policy makers in the nuclear age to victims of domestic anti-Communism. Also examines the changing institutions in which various scientific fields were conducted during the postwar decades, investigating possible epistemic effects on forms of knowledge. Subject closes by considering the places of science in the US during the post-Cold War era.
*K. Brown, D. I. Kaiser*

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**STS.441 Technology and Self: Technology and Conversation**
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-0-10 units

Explores the relationship between technology and conversation, with an emphasis on conversation in our digital age when so many say they would rather text than talk. Topics center on the psychology of online life, such as the way in which we both share and withhold information about the self. Discussion about the ways new kinds of online conversation are playing out in education, the workplace, and in families and what the changes in conversation mean for collaboration, innovation, and leadership. Readings include works in history, literature, anthropology, psychology, and linguistics. Open to undergraduates by permission of instructor. Limited to 15; no listeners.
*S. Turkle*
STS.443 Technology and Self: Science, Technology, and Memoir
Subject meets with STS.043
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
2-0-7 units
Focuses on the memoir as a window onto the relationship of the scientist, engineer, and technologist to his or her work. Studies the subjective side of technology and the social and psychological dimensions of technological change. Students write about specific objects and their role in their lives - memoir fragments. Readings concern child development theory and the role of technology in development. Explores the connection between material culture, identity, cognitive and emotional development. Students taking graduate version complete additional assignments. Limited to 15; no listeners.
S. Turkle

STS.444 Technology and Self: Things and Thinking
Subject meets with STS.044
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
2-0-7 units
Explores emotional and intellectual impact of objects. The growing literature on cognition and “things” cuts across anthropology, history, social theory, literature, sociology, and psychology and is of great relevance to science students. Examines the range of theories, from Mary Douglas in anthropology to D.W. Winnicott in psychoanalytic thinking, that underlies “thing” or “object” analysis. Students taking graduate version complete additional assignments. Limited to 15; no listeners.
S. Turkle

STS.450 The Global History of Medicine and Public Health
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Surveys recent and canonical scholarship on the history of medicine and public health as a global set of events starting in the 15th century. Examines themes including race, gender, class, imperialism, warfare, religion, governance, indigenous knowledge, disciplinarily, the body, and citizenship. Emphasizes the development of methods and historiographic approaches for studying these themes.
R. W. Scheffler

STS.454 Museums, Science and Technology
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Examines science, technology and museums. Includes regular readings and discussions about the evolution of museums of science and technology from (roughly) 1800 to the present. Students undertake special projects linked to the MIT Museum’s re-location to a new building under construction in Kendall Square. Students act as informal consultants to the MIT Museum, offering proposals for innovative elements that will be seriously considered for inclusion in the new Museum.
J. Durant

STS.460 Histories of Information, Communication, and Computing Technologies
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Introduction to the historical study of information, communication, and computing technologies with a focus on the United States. Pairs analysis of a multidisciplinary reading list with in-depth discussions of research methods and writing for academic publications. Later weeks of the course adapt to student interests and are determined by students in consultation with the instructor. Limited to 15.
J. S. Light

STS.461 History and Social Study of Computing (New)
Prereq: None
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Examines the history and social study of computers. Introduces students to the core and canonical literature in this area while also providing the opportunity to read and discuss more recent works from multiple disciplines.
E. Medina
STS.462 Social and Political Implications of Technology
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Historical and contemporary studies are used to explore the interaction of technology with social and political values. Emphasis on how technological devices, structures, and systems influence the organization of society and the behavior of its members. Examples drawn from the technologies of war, transportation, communication, production, and reproduction.
M. R. Smith

STS.463[J] Technocracy
Same subject as 11.461[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Survey of the history of efforts to apply scientific methods and technological tools to solve social and political problems, with a focus on the United States since 1850. Topics include: city planning, natural resource management, public education, economic development, quantification and modeling in the social and policy sciences, technology transfer, and political economies of expertise.
J. S. Light

STS.467[J] The History of Aviation
Same subject as 16.707[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

Reading course in the history of aviation, focusing on science and technology and cultural and political context. Themes include: the science of aeronautics, pilots and piloting, control systems and electronics, engineering epistemology, infrastructure, industry, government and politics, evolution of aeronautics research, culture and experience, automation and autonomy, role of MIT, literature and film. Case studies of specific systems and engineering projects. Emphasis is on book-length texts, close reading, historical methods of analyzing technological change. Study of social and political dimensions of engineering projects, examination of aviation institutions. Students prepare weekly response papers to readings, make extended presentations to class twice per semester, and submit a final research paper.
D. Mindell

Same subject as 16.440[J]
Prereq: 16.400, 16.453[J], or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

See description under subject 16.440[J].
D. A. Mindell

STS.471[J] Engineering Apollo: The Moon Project as a Complex System
Same subject as 16.895[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
4-0-8 units

Detailed technical and historical exploration of the Apollo project to fly humans to the moon and return them safely to Earth as an example of a complex engineering system. Emphasizes how the systems worked, the technical and social processes that produced them, mission operations, and historical significance. Guest lectures by MIT-affiliated engineers who contributed to and participated in the Apollo missions. Students work in teams on a final project analyzing an aspect of the historical project to articulate and synthesize ideas in engineering systems.
D. Mindell

STS.474[J] Art, Craft, Science
Same subject as 21A.509[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Credit cannot also be received for 21A.501[J], STS.074[J]

See description under subject 21A.509[J].
H. Paxson
Same subject as 21W.820[J]
Prereq: 21H.991
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Examination of different "voices" used to consider issues of scientific, technological, and social concern. Students write frequently and choose among a variety of non-fiction forms: historical writing, social analysis, political criticism, and policy reports. Instruction in expressing ideas clearly and in organizing a thesis-length work. Reading and writing on three case studies drawn from the history of science; the cultural study of technology and science; and policy issues.

K. Manning

STS.481[J] Cross-Cultural Investigations: Technology and Development
Same subject as EC.792[J], 21A.839[J]
Subject meets with EC.702[J], 21A.801[J], STS.071[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
3-0-9 units

See description under subject 21A.839[J].

C. Walley

STS.482[J] Science, Technology, and Public Policy
Same subject as 17.310[J], IDS.412[J]
Prereq: Permission of instructor
G (Spring)
4-0-8 units
Credit cannot also be received for 17.309[J], IDS.055[J], STS.082[J]

See description under subject 17.310[J].

K. Oye, N. Selin

STS.487 Foundations of Information Policy
Subject meets with 6.805[J], STS.085[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Studies the growth of computer and communications technology and the new legal and ethical challenges that reflect tensions between individual rights and societal needs. Topics include computer crime; intellectual property restrictions on software; encryption, privacy, and national security; academic freedom and free speech. Students meet and question technologists, activists, law enforcement agents, journalists, and legal experts. Instruction and practice in oral and written communication provided. Students taking graduate version complete additional assignments. Enrollment limited.

H. Abelson, M. Fischer, D. Weitzner

Special Subjects

STS.591 Special Subject: Science, Technology and Society
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.

Addresses a special topic in Science, Technology and Society which is not offered in the regular curriculum.

Staff

STS.592 Special Subject: Science, Technology and Society
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
Units arranged
Can be repeated for credit.

Addresses subject matter in Science, Technology and Society that is not offered in the regular curriculum.

Staff

Research and Teaching

STS.800 Teaching Science, Technology and Society
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For qualified graduate students serving as either a teaching assistant or instructor for subjects in Science, Technology and Society (STS). Enrollment limited by availability of suitable teaching assignments.

Staff
STS.850 Practical Experience in HASTS Fields (New)
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

For HASTS students participating in curriculum-related off-campus professional internship experiences. Before registering for this subject, students must have an offer letter from a company or organization and must receive written prior approval from their advisor. Upon completion of the experience, students must submit a substantive final report, approved by their advisor. Subject to departmental approval. Consult departmental graduate office. Permission of advisor.

Staff

STS.901-STS.904 Independent Study in Science, Technology, and Society
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.

For students who wish to pursue special studies or projects at an advanced level with a faculty member of the Program in Science, Technology, and Society.

Staff

STS.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of graduate research leading to the writing of a PhD thesis, to be arranged by the student with an appropriate MIT faculty member, who is the thesis supervisor.

Staff
Interphase EDGE: Pre-First-Year Summer Component

SP.100 Interphase
Prereq: Commitment to register as a first-year student in the Fall
U (Summer)
Units arranged [P/D/F]

Interphase is a seven-week program designed to enhance the academic success of students entering MIT. The program has a dual focus: it gives students an introduction to the MIT experience by exposing them to the rigors of a full subject load while simultaneously preparing them for academic success beyond MIT. The program includes calculus; chemistry; physical education; physics; writing, oral presentation and teamwork skills; and supporting academic activities, including small-group learning. Students can earn transcript credit for subjects taken in the program, sometimes resulting in advanced placement in corresponding subjects taken in the Fall. Activities include day trips to area cultural, recreational, and business sites. Students participate in a range of personal and educational development seminars and activities designed to ensure their smooth transition to college life.

S. Kalloo

Seminar XL

SP.110 Program XL: You Can Be a Success at MIT
Prereq: First-year undergraduate standing
U (Fall, Spring)
Units arranged [P/D/F]

Academic enrichment program for first-year students, XL utilizes the innovative and effective small-group learning concept to enhance academic performance in calculus and science. Students meet in study groups of five to six participants with facilitators trained in effective classroom techniques and concept focus. Study groups help students to reinforce concepts learned in the regular curriculum, and help them gain mastery of concepts and problems that are often more challenging than those dealt with during lecture. Emphasizes the full participation of each student with the facilitator acting as guide. The regularity of weekly meetings enhances the students’ understanding of MIT’s academic expectations. After the initial meetings, students are encouraged to take more responsibility and to lead the group in problem-solving sessions. Each study group meets for a minimum of three hours each week. The meeting time is set by the XL facilitator based on students’ schedules.

A. Perry

Institute-wide Discovery Subjects

SP.245 The Sum of All Courses (New)
Prereq: None
U (Fall)
2-0-0 units

Provides an overview of the wide variety of majors and joint majors as well as minors and concentrations at MIT. At each lecture, faculty from two to three departments describe their fields. One-hour seminars and panels are given on informative and engaging topics such as, “The Rationale Behind the MIT Curriculum,” “The Purpose of an Education,” “Integrating by Parts and Other Life Hacks,” “Etiquette and Why it is Important,” “So, Darwin, Shakespeare, and Newton Walk into a Bar,” “How to Avoid Burnout,” “What is your Implicit Bias?,” “How to be a Good Human,” “Social Impact, Unintended Consequences, and Moral Hazards,” and include panel discussions with MIT Administration and MIT’s Distinguished Professors. Subject can count toward the 9-unit discovery-focused credit limit for first year students. Limited to 1132; preference to first-year students.

C. Carter
SP.246 The Future: Global Challenges and Questions (STS.100)
Prereq: None
U (Fall)
2-0-1 units
Explores global challenges through the perspective of an array of majors / disciplines at MIT. Generative and creative questioning activities and reflective discussions introduce the intellectual breadth at the Institute and provide students with tools to develop their ability to question the world and their place in it. Aims to inspire and guide students to consider how they will shape and become a part of the future they want. Subject can count toward the 9-unit discovery-focused credit limit for first year students.
J. E. Fernandez, D. Darmofal, W. Deringer, R. Rigobon

SP.247 Exploring Majors at the Intersection of Engineering, Life Sciences & Medicine (New)
Prereq: None
U (Spring)
Units arranged [P/D/F]
Interactive introduction to the several majors at MIT that offer curricula bridging engineering and life sciences, through presentations by faculty, current students, and alumni. Representatives of these departments (Courses 1, 2, 3, 5, 6, 6-7, 7, 9, 10, and 20, as well as the BME minor) cover aptitudes of typical students, culture, class offerings and roadmaps, and unique opportunities. Provides first-year students practical advice about how to select, prepare for and thrive in each major. Subject can count toward the 9-unit discovery-focused credit limit for first year students.
S. A. Clarke, M. Jonas

SP.250 Transforming Good Intentions into Good Outcomes (New)
Prereq: None
U (Fall)
2-0-1 units
Explores hard choices, ethical dilemmas, and the risk of failure in the humanitarian, tech, climate change, and health sectors. Students examine case studies based on challenges faced by MIT alums, faculty, staff, students or community practitioners, and engage in simulations and facilitated discussions. Exposes students to ethical frameworks and standards for social engagement and intervention. Considers the choices faced, stakeholders involved, possible impact, and relevant MIT resources. Students produce a set of guiding questions to ask of themselves and others as they embark on social change work. Subject can count toward the 9-unit discovery-focused credit limit for first-year students. Limited to 20; preference to first-year students.
S. Bouchard, A. Hynd

SP.251 How to Change the World: Experiences from Social Entrepreneurs (New)
Prereq: None
U (Fall)
2-0-1 units
Every week, students meet a new role model who demonstrates what it means to change the world through social entrepreneurship. Students meet individual entrepreneurs, get immersed in the ecosystem that supports them, and visit MIT labs and startups in the Cambridge innovation community. Each session covers an aspect of social entrepreneurship, from identifying opportunities for change to market fit to planning for scale. Through these speakers and field trips, students gain a greater understanding of how technology-based, impactful solutions can address global challenges. Students learn to identify and address social and environmental problems and understand the relevance of this work for their time at MIT. They will see how to bring their ideas to fruition and extend their ties with the Solve community. Subject can count toward the 9-unit discovery-focused credit limit for first-year students.
K. Zolot

SP.252 Careers in Medicine (New)
Prereq: None
U (Fall)
2-0-1 units
Through this course, students will explore careers in medicine and health care. It will also explore potential majors for students looking to go into these different careers, which include physicians, physician-scientists, research scientists, biomedical engineers, bioinformatics analysts, computational biologists, health data scientists, health system managers, and health economists. Majors could include biological engineering, biology, chemical engineering, mechanical engineering, computer science, and more. Allows students to explore how they can have an impact in the field of medicine in a variety of different ways. Exposes students to career paths that are patient-facing (clinical) as well as career paths that are behind the scenes. Includes field trips to nearby labs and companies. Subject can count toward the 9-unit discovery-focused credit limit for first-year students. Limited to 25; preference to first-year students.
A. Carlsen-Bryan, A. Rosser
TERRASCOPE

SP.35UR Undergraduate Research in Terrascope
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Undergraduate research opportunities in Terrascope.  Staff

SP.360 Terrascope Radio
Prereq: None
U (Spring)
3-3-6 units. HASS-A; CI-H

An exploration of radio as a medium of expression and communication, particularly the communication of complex scientific or technical information to general audiences. Examines the ingredients of effective radio programming, drawing extensively on examples from both commercial and public radio. Student teams produce, assemble, narrate, record and broadcast/webcast radio programs on topics related to the complex environmental issue that is the focus of the year’s Terrascope subjects. Includes multiple individual writing assignments that explore the constraints and opportunities in radio as a medium. Limited to 15 first-year students.  A. W. Epstein

SP.361 Majors and Careers Through a Terrascope Lens
Prereq: None
U (IAP)
1-0-1 units
Can be repeated for credit.

MIT alumni pursuing sustainability-oriented careers describe ways in which their major and career choices have provided them with the lenses through which they see the problems they work to solve. Students participate in guided reflection, focused on making the discussion relevant to their own personal situations and affinities. Students strengthen their ability to think deeply about their goals, for MIT and for the world beyond, and come into direct contact with alumni who can continue to mentor them through this process. Open to all undergraduates, regardless of Terrascope affiliation.  D. McGee, A. W. Epstein

FIRST-YEAR/ALUMNI SUMMER INTERNSHIP PROGRAM

SP.800 First-Year/Alumni Summer Internship Program
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-0 units

Prepares first-year students for summer internship or research experiences. Enables students to explore their professional interests and careers early, providing an edge in the increasingly competitive internship search process. Includes sessions on self-assessment and career exploration, professional etiquette, internship search skills, interviewing, communications, networking, and dynamics in the workplace. Attendance at the sessions is mandatory.  C. Capozzola

SP.801 First-Year/Alumni Summer Internship Program II
Prereq: SP.800
U (Fall, Summer)
Not offered regularly; consult department
Units arranged

Students who have completed the subject requirements for SP.800 and work in an approved internship or research experience are eligible for SP.801, the second component of the First-year/Alumni Summer Internship Program. Students continue their career development and prepare for their sophomore internship search through this course.  C. Capozzola

SP.3550 Special Subject: Terrascope
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Covers areas of study not included in the regular Terrascope curriculum. Preference to students in Terrascope.  Staff
SCM.250 Analytical Methods for Supply Chain Management
Prereq: None
G (Fall; partial term)
3-0-3 units
Covers the primary methods of analysis required for supply chain management planning. The class solves various practical problems using simulation, linear programming, integer programming, regression, and other techniques. The work is primarily team based with a final exam. Restricted to SCM students.
J. Velazquez Martinez

SCM.251 Supply Chain Financial Analysis
Prereq: None. Coreq: SCM.260[J]; or permission of instructor
G (Fall; partial term)
3-0-6 units
Explores the linkages between supply chain management and corporate finance. Emphasizes how the supply chain creates value for both the shareholders of the company and for the stakeholders affected by the company's operations. Sessions combine lectures and data-rich cases from the manufacturer, distributor, and retailer perspective. Topics include accounting fundamentals, financial analysis, activity-based costing, working capital management, cash flow projections, capital budgeting, and sustainability.
J. Goentzel, J. Rice

SCM.253 Case Studies in Supply Chain Financial Analysis
Prereq: Permission of instructor
G (Spring; second half of term)
2-0-1 units
Students explore and discuss case studies that focus on financial analysis in real supply chains. Cases provide the opportunity for students to apply the theory and quantitative methods that they have studied in addressing actual supply chain challenges. These include decision making around sourcing, capital investments, inventory strategy, and new product introduction. Students present and defend their solutions to their peers.
J. Goentzel, J. Rice

SCM.254 Applied Programming and Data Analysis in Python
Prereq: SCM.264, SCM.500, or permission of instructor
G (IAP)
2-0-1 units
Introduces Python programming and data analysis applications for supply chain management. Students develop skills to program and analyze data to solve supply chain and logistics problems. Topics include data structures, Python structures and functions, Pandas, and other analysis tools. Restricted to SCM students.
S. Caballero

SCM.256 Data Science and Machine Learning for Supply Chain Management (New)
Prereq: SCM.254 or permission of instructor
G (Spring)
3-0-9 units
Introduces data science and machine learning topics in both theory and application. Data science topics include database and API connections, data preparation and manipulation, and data structures. Machine learning topics include model fitting, tuning and prediction, end-to-end problem solving, feature engineering and feature selection, overfitting, generalization, classification, regression, neural networks, dimensionality reduction and clustering. Covers software packages for statistical analysis, data visualization and machine learning. Introduces best practices related to source control, system architecture, cloud computing frameworks and modules, security, emerging financial technologies and software process. Applies teaching examples to logistics, transportation, and supply chain problems. Enrollment limited.
C. Cassa, T. Hall

SCM.258 Written Communication Topics for Supply Chain Management
Prereq: None
G (Fall, IAP)
1-0-0 units
Credit cannot also be received for SCM.259
Reviews the structure of and expectations for the master's capstone project and thesis. Discusses the concepts of genre and audience and their importance in writing the capstone/thesis. Explores techniques for developing and organizing ideas (such as freewriting, mapping, outlining) and for writing fluid, concise prose. Students also write a blog entry for the SCM student blog. Restricted to SCM students.
P. Siska
SCM.259 Written Communications for Supply Chain Management
Prereq: None
G (Fall)
1-0-2 units
Credit cannot also be received for SCM.258
Provides an overview of the expectations for the master’s capstone project and thesis. Students write and receive feedback on drafts of selected capstone/thesis chapters. Discusses the concepts of genre and audience and their importance in writing the capstone/thesis. Explores techniques for developing and organizing ideas (such as freewriting, outlining, synthesis matrix) and for writing fluid, concise prose. Covers how to find and work with source materials. Students also write a blog entry for the SCM student blog. Restricted to SCM students.
P. Siska

SCM.260[J] Logistics Systems
Same subject as 1.260[J], 15.770[J], IDS.730[J]
Subject meets with SCM.271
Prereq: Permission of instructor
G (Fall)
3-0-9 units
Provides an introduction to supply chain management from both analytical and practical perspectives. Taking a unified approach, students develop a framework for making intelligent decisions within the supply chain. Covers key logistics functions, such as demand planning, procurement, inventory theory and control, transportation planning and execution, reverse logistics, and flexible contracting. Explores concepts such as postponement, portfolio management, and dual sourcing. Emphasizes skills necessary to recognize and manage risk, analyze various tradeoffs, and model logistics systems. SCM.271 meets with SCM.260[J] but requires fewer assignments and lectures.
Y. Sheffi, C. Caplice

SCM.261[J] Case Studies in Logistics and Supply Chain Management
Same subject as 1.261[J], 15.771[J]
Prereq: Permission of instructor
G (Spring)
3-0-6 units
A combination of lectures and cases covering the strategic, management, and operating issues in contemporary logistics and integrated supply chain management. Includes: logistics strategy; supply chain restructuring and change management; and distribution, customer service, and inventory policy.
J. Byrnes

SCM.262 Leading Global Teams
Prereq: SCM.260[J] or permission of instructor
G (IAP)
2-0-1 units
Reinforces supply chain concepts and develops management and teamwork skills. Focuses on practical, rather than theoretical tools, methodologies, and approaches that students will use throughout their supply chain career. Includes guest lectures, a case competition, and several large-scale, team-based simulation learning games. Restricted to SCM students.
J. Velazquez Martinez

SCM.263 Advanced Writing Workshop for SCM
Prereq: None
G (Spring)
1-0-2 units
Focuses on helping students write and present their ideas in cogent, persuasive arguments and other analytical frameworks. Designed to improve students’ ability to communicate research information. Covers the basics of working with sources, including summarizing and paraphrasing, and synthesizing source materials. Workshops along with small team coaching sessions help students apply these lessons in the writing of their capstone project or thesis project. Restricted to SCM students.
P. Siska

SCM.264 Databases and Data Analysis for Supply Chain Management
Subject meets with SCM.274
Prereq: None
G (Fall; second half of term)
3-0-3 units
Introduces databases, data analysis, and machine learning topics. Covers data modeling, relational databases, SQL queries, data mining, non-relational databases, and data warehouses. Introduces data analysis tools for visualization, regression, supervised and unsupervised techniques including principal component analysis and clustering. Term project includes implementation of data model, database, visualization and data analysis. SCM.274 meets with SCM.264 but requires fewer assignments and lectures.
C. Cassa
SUPPLY CHAIN MANAGEMENT (SCM)

**SCM.265[J] Global Supply Chain Management**
Same subject as 1.265[J], 2.965[J], 15.765[J]
Prereq: 15.761, 15.778, SCM.260[J], SCM.261[J], or permission of instructor
G (Spring)
Not offered regularly; consult department
2-0-4 units

Focuses on the planning, processes, and activities of supply chain management for companies involved in international commerce. Students examine the end-to-end processes and operational challenges in managing global supply chains, such as the basics of global trade, international transportation, duty, taxes, trade finance and hedging, currency issues, outsourcing, cultural differences, risks and security, and green supply chains issues. Highly interactive format features student-led discussions, staged debates, and a mock trial. Includes assignments on case studies and sourcing analysis, as well as projects and a final exam.

**SCM.266 Freight Transportation**
Prereq: SCM.260[J]
G (Spring; second half of term)
2-0-4 units

Provides an in-depth introduction to the fundamental concepts and techniques related to the design, procurement, and management of freight transportation. Examines freight transportation as a bridging function for a firm, considering the physical flow of raw materials and finished goods as well as connections to suppliers and customers. Also covers how freight transportation insulates a firm’s core operations from external disruptions and variability of supply and demand.

C. Caplice, Y. Sheffi

**SCM.267 Global Supply Chain Management Topics**
Prereq: None. Coreq: SCM.265[J]
G (Spring)
Not offered regularly; consult department
2-0-1 units

Discusses the basic theories of international trade, cultural differences in global supply chains, sustainability, risks, and security. Highly interactive format features student-led discussions, staged debates, and a mock trial. Assignments include case studies and student presentations. Meets with SCM.265[J].

Staff

**SCM.271 Logistics Systems Topics (New)**
Subject meets with 1.260[J], 15.770[J], IDS.730[J], SCM.260[J]
Prereq: Permission of instructor
G (Fall)
1-0-2 units

Provides an introduction to supply chain management from both analytical and practical perspectives. Taking a unified approach, students develop a framework for making intelligent decisions within the supply chain. Covers key logistics functions, such as demand planning, procurement, inventory theory and control, transportation planning and execution, reverse logistics, and flexible contracting. Explores concepts such as postponement, portfolio management, and dual sourcing. Emphasizes skills necessary to recognize and manage risk, analyze various tradeoffs, and model logistics systems. SCM.271 meets with SCM.260[J] but requires fewer assignments and lectures.

Y. Sheffi, C. Caplice

**SCM.272 Supply Chain Specialty Workshop**
Prereq: None
G (IAP)
2-0-1 units

Introduces topics of maritime logistics, segmentation and revenue management, sourcing and purchasing fundamentals, service parts logistics, retailing operations, green supply chain management, and supply chain innovation in a series of hands-on workshops. Restricted to SCM students.

J. Velazquez Martinez

**SCM.274 Databases and Data Analysis Topics for Supply Chain Management (New)**
Subject meets with SCM.264
Prereq: Permission of instructor
G (Fall; second half of term)
1-0-2 units

Introduces databases, data analysis, and machine learning topics. Covers data modeling, relational databases, SQL queries, data mining, non-relational databases, and data warehouses. Introduces data analysis tools for visualization, regression, supervised and unsupervised techniques including principal component analysis and clustering. Term project includes implementation of data model, database, visualization and data analysis. SCM.274 meets with SCM.264 but requires fewer assignments and lectures.

C. Cassa, T. Hall
SCM.280 Supply Chain Communications Workshop
Prereq: None
G (Fall, IAP; partial term)
1-0-0 units

Introduces topics of communication and methods to improve communication skills. Provides students with tools needed to become clear speakers and effective leaders. Includes assessment of communication styles, tactics for effective negotiation, interview strategies, and presenting one's self. Restricted to SCM students.

J. Velazquez Martinez, M. Jesus Saenz

SCM.281 Supply Chain Public Speaking Workshop
Prereq: None
G (Spring; partial term)
1-0-0 units

Further develop and refine public speaking skills through engaging interactive workshops. Techniques learned will help students become dynamic and authentic speakers. Includes impromptu speaking preparation, facilitating meetings, selling to the board room, and crafting presentations, always in relation to concepts and fundamentals of supply chain management. Restricted to SCM students.

J. Velazquez Martinez

SCM.282 Supply Chain Leadership Workshop
Prereq: None
G (IAP)
2-0-1 units

Designed to enhance your ability to manage and lead in challenging times through a series of self assessment instruments, case studies, and workshops. The objectives are to increase awareness of your strengths and weaknesses as a leader, provide a battery of instruments and surveys to help one understand the way one operates in an organizational setting, and offer strategies and tips on how to leverage one’s strengths and work on areas in need of development. Restricted to SCM students.

J. Velazquez Martinez

SCM.283 Humanitarian Logistics
Subject meets with SCM.284
Prereq: None
G (Spring; first half of term)
2-0-4 units

Explores how logistics management principles apply in dynamic, resource-constrained contexts, ranging from humanitarian crisis response to international development. Class sessions combine interactive presentations, practical exercises, case discussions, and guest speakers from humanitarian organizations. Provides an introduction to supply chain concepts and the humanitarian context to accommodate students from various backgrounds.

J. Goentzel

SCM.284 Humanitarian Logistics with Project
Subject meets with SCM.283
Prereq: None
G (Spring)
3-0-9 units

Explores how logistics management principles apply in dynamic, resource-constrained contexts, ranging from humanitarian crisis response to international development. Combines interactive presentations, practical exercises, case discussions, and guest speakers from humanitarian organizations. Provides an introduction to supply chain concepts and the humanitarian context to accommodate students from various backgrounds. Team projects utilize data and information from the UN, NGOs, government agencies, and the private sector. Meets with SCM.283 first half of term.

J. Goentzel

SCM.290 Sustainable Supply Chain Management
Prereq: None
G (Spring; first half of term)
2-0-4 units

Introduces operational aspects of sustainable supply chains. Focuses on analyzing the implications of environmental considerations in logistics decisions. Topics include carbon footprint, sustainable logistics, closed-loop supply chains, reverse logistics, and sustainable supply chain strategy. Includes a team project that evaluates the sustainable supply chain strategy of an industry or a publicly-traded company.

J. Velazquez
SCM.291 Procurement Fundamentals
Prereq: None
G (Spring; first half of term)
2-0-4 units
Introduces strategic procurement fundamentals to enhance both competitive advantage and resilience to supply chains. Covers frameworks and tools that managers use to elevate purchasing from an operational function to a strategic one. Includes both classic resilience- and cost-based portfolios, as well as modern perspectives, which consider sustainability and power. Combines theoretical and applied perspectives and is designed for students with or without previous procurement experience. Assessment based on case analysis and a final project.
D. Correll

SCM.293[J] Urban Last-Mile Logistics
Same subject as 1.263[J], 11.263[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units
Explores specific challenges of urban last-mile B2C and B2B distribution in both industrialized and emerging economies. Develops an in-depth understanding of the perspectives, roles, and decisions of all relevant stakeholder groups, from consumers, to private sector decision makers, to public policy makers. Discussion of the most relevant traditional and the most promising innovating operating models for urban last-mile distribution. Introduces applications of the essential quantitative methods for the strategic design and tactical planning of urban last-mile distribution systems, including optimization and simulation. Covers basic facility location problems, network design problems, single- and multi-echelon vehicle routing problems, as well as associated approximation techniques.
M. Winkenbach

SCM.295 Supply Chain Study Trek
Prereq: None
G (Spring; partial term)
3-0-0 units
Focuses on real world application of logistics and supply chain. Includes travel to on-site locations, company visits, facility operation tours, and partner presentations. Requires prior approval, detailed proposal, and final report. Restricted to SCM students.
J. Velazquez, M. Jesus Saenz

SCM.301 Independent Study: Supply Chain Management
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for research in Supply Chain Management and Logistics on an individual or group basis. Registration subject to prior arrangement and supervision by staff.
Staff

SCM.302 Independent Study: Supply Chain Management
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for research in Supply Chain Management and Logistics on an individual or group basis. Registration subject to prior arrangement and supervision by staff.
Staff

SCM.500 Studies in Supply Chain Management
Prereq: Permission of department
G (IAP)
0-0-42 units
Y. Sheffi, CTL Staff
SCM.800 Capstone Project in Supply Chain Management
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Provides an opportunity for students to synthesize their coursework and professional experience in supply chain management. Students conduct research on a real-world problem of interest to supply chain practitioners. Projects may include site visits, in-person interviews and quantitative analysis of data provided by a sponsoring company, agency, or NGO. Students present their research results in both a report and to an audience of sponsors and supply chain executives. Restricted to SCM students.
J. Velazquez, M. Jesus Saenz

SCM.S90 Special Subject: Supply Chain Management
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
Opportunity for study of topics in Supply Chain Management not otherwise included in the curriculum.
Staff

SCM.S91 Special Subject: Supply Chain Management
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for study of topics in Supply Chain Management not otherwise included in the curriculum.
Staff

SCM.S92 Special Subject: Supply Chain Management
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for study of topics in Supply Chain Management not otherwise included in the curriculum.
Consult Staff

SCM.S94 Special Subject: Supply Chain Management
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for study of topics in Supply Chain Management not otherwise included in the curriculum.
Staff

SCM.THG Graduate Thesis
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Program of research leading to the writing of a master's thesis on a relevant supply chain management topic. Arranged by the student with a member of the Center for Transportation and Logistics (CTL) research staff.
J. Velazquez, M. Jesus Saenz
URBAN STUDIES AND PLANNING (COURSE 11)

Introductory Subjects

11.001[J] Introduction to Urban Design and Development
Same subject as 4.250[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Examines the evolving structure of cities and the way that cities, suburbs, and metropolitan areas can be designed and developed. Surveys the ideas of a wide range of people who have addressed urban problems. Stresses the connection between values and design. Demonstrates how physical, social, political and economic forces interact to shape and reshape cities over time.
L. Vale

11.002[J] Making Public Policy
Same subject as 17.30[J]
Prereq: None
U (Fall)
4-0-8 units. HASS-S; CI-H

Examines how the struggle among competing advocates shapes the outputs of government. Considers how conditions become problems for government to solve, why some political arguments are more persuasive than others, why some policy tools are preferred over others, and whether policies achieve their goals. Investigates the interactions among elected officials, think tanks, interest groups, the media, and the public in controversies over global warming, urban sprawl, Social Security, health care, education, and other issues.
Staff

11.003[J] Methods of Policy Analysis
Same subject as 17.303[J]
Prereq: 11.002[J]; Coreq: 14.01
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S

Provides students with an introduction to public policy analysis. Examines various approaches to policy analysis by considering the concepts, tools, and methods used in economics, political science, and other disciplines. Students apply and critique these approaches through case studies of current public policy problems.
Staff

11.004[J] People and the Planet: Environmental Histories and Engineering
Same subject as STS.033[J]
Subject meets with 11.204[J], IDS.524[J]
Prereq: None
U (Spring)
3-3-6 units. HASS-E

Explores historical and cultural aspects of complex environmental problems and engineering approaches to sustainable solutions. Introduces quantitative analyses and methodological tools to understand environmental issues that have human and natural components. Demonstrates concepts through a series of historical and cultural analyses of environmental challenges and their engineering responses. Builds writing, quantitative modeling, and analytical skills in assessing environmental systems problems and developing engineering solutions. Through environmental data gathering and analysis, students engage with the challenges and possibilities of engineering in complex, interacting systems, and investigate plausible, symbiotic, systems-oriented solutions. Students taking graduate version complete additional analysis of reading assignments and a more in-depth and longer final paper.
A. Glasmeier, J. Knox-Hayes, A. Slocum, R. Scheffler, J. Trancik

11.005 Introduction to International Development
Prereq: None
U (Spring)
3-0-9 units. HASS-S

Introduces the political economy of international economic development planning, using an applied, quantitative approach. Considers why some countries are able to develop faster than others. Presents major theories and models of development and underdevelopment, providing tools to understand the mechanisms and processes behind economic growth and broader notions of progress. Offers an alternative view of development, focusing on the persistence of dichotomies in current theory and practice. Using specific cases, explores how different combinations of actors and institutions at various scales may promote or inhibit economic development. Students re-examine conventional knowledge and engage critically with the assumptions behind current thinking and policy.
Staff

2019–2020 MIT Subject Descriptions | 767
11.006 Poverty and Economic Security
Subject meets with 11.206
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Explores the evolution of poverty and economic security in the US within a global context. Examines the impacts of recent economic restructuring and globalization. Reviews current debates about the fate of the middle class, sources of increasing inequality, and approaches to advancing economic opportunity and security. Students taking graduate version complete additional assignments. A. Glasmeier

11.007 Urban and Environmental Technology Implementation Lab
Prereq: None
U (Spring)
2-2-8 units
Real-world clients and environmental problems form the basis of a project in which teams of students develop strategies for analysis and implementation of new sensor technology within cities. Working closely with a partner or client based on the MIT campus or in Cambridge, students assess the environmental problem, implement prototypes, and recommend promising solutions to the client for implementation. Equipment and working space provided. Limited to 12.
D. Hsu

11.011 The Art and Science of Negotiation
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-S
Introduction to negotiation theory and practice. Applications in government, business, and nonprofit settings are examined. Combines a “hands-on” personal skill-building orientation with a look at pertinent theory. Strategy, communications, ethics, and institutional influences are examined as they shape the ability of actors to analyze problems, negotiate agreements, and resolve disputes in social, organizational, and political circumstances characterized by interdependent interests.
B. Verdini

11.013[J] American Urban History
Same subject as 21H.217[J]
Prereq: None
U (Fall)
2-0-7 units. HASS-H; CI-H
Seminar on the history of institutions and institutional change in American cities from roughly 1850 to the present. Among the institutions to be looked at are political machines, police departments, courts, schools, prisons, public authorities, and universities. Focuses on readings and discussions.
R. M. Fogelson

11.014[J] History of the Built Environment in the US
Same subject as 21H.218[J]
Prereq: None
U (Fall)
2-0-7 units. HASS-H; CI-H
Seminar on the history of selected features of the physical environment of urban America. Among the features considered are parks, cemeteries, tenements, suburbs, zoos, skyscrapers, department stores, supermarkets, and amusement parks.
R. M. Fogelson

11.015[J] Riots, Strikes, and Conspiracies in American History
Same subject as 21H.226[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H; CI-H
See description under subject 21H.226[J].
R. M. Fogelson

11.016[J] The Once and Future City
Same subject as 4.211[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H
Examines the evolving structure of cities, the dynamic processes that shape them, and the significance of a city’s history for its future development. Develops the ability to read urban form as an interplay of natural processes and human purposes over time. Field assignments in Boston provide the opportunity to use, develop, and refine these concepts. Enrollment limited.
A. Spirn
11.021[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 1.801[J], 17.393[J], IDS.060[J]
Subject meets with 1.811[J], 11.630[J], 15.663[J], IDS.540[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Reviews and analyzes federal and state regulation of air and water pollution, hazardous waste, green-house gas emissions, and the production and use of toxic chemicals. Analyzes pollution as an economic problem and the failure of markets. Explores the role of science and economics in legal decisions. Emphasizes use of legal mechanisms and alternative approaches (such as economic incentives and voluntary approaches) to control pollution and encourage chemical accident and pollution prevention. Focuses on the major federal legislation, the underlying administrative system, and the common law in analyzing environmental policy, economic consequences, and the role of the courts. Discusses classical pollutants and toxic industrial chemicals, green-house gas emissions, community right-to-know, and environmental justice. Develops basic legal skills: how to read/understand cases, regulations, and statutes. Students taking graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart

11.022[J] Regulation of Chemicals, Radiation, and Biotechnology
Same subject as 1.802[J], IDS.061[J]
Subject meets with 1.812[J], 10.805[J], 11.631[J], IDS.436[J], IDS.541[J]
Prereq: IDS.060[J] or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units
Focuses on policy design and evaluation in the regulation of hazardous substances and processes. Includes risk assessment, industrial chemicals, pesticides, food contaminants, pharmaceuticals, radiation and radioactive wastes, product safety, workplace hazards, indoor air pollution, biotechnology, victims' compensation, and administrative law. Health and economic consequences of regulation, as well as its potential to spur technological change, are discussed for each regulatory regime. Students taking the graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart

11.025[J] D-Lab: Development
Same subject as EC.701[J]
Subject meets with 11.472[J], EC.781[J]
Prereq: None
U (Fall)
3-2-7 units. HASS-S
See description under subject EC.701[J]. Enrollment limited by lottery; must attend first class session.
S. L. Hsu, B. Sanyal

11.026[J] Downtown
Same subject as 21H.321[J]
Subject meets with 11.339
Prereq: None
U (Spring)
Not offered regularly; consult department
2-0-7 units. HASS-H
See description under subject 21H.321[J].
R. M. Fogelson

11.027 City to City: Comparing, Researching and Writing about Cities
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-S
Introduces client-oriented research and the use of urban planning tools. Students work directly with government and community agencies to find solutions to real world problems; interview planners and other field experts, and write and present findings to client and community audiences. Opportunity to travel for research. Limited to 14; preference to Course 11 majors.
C. Abbanat
Specialized Subjects

11.111[J] Leadership in Negotiation: Advanced Applications
   Same subject as 17.381[J]
   Prereq: 11.011 or permission of instructor
   U (Spring)
   4-0-8 units. HASS-S

   Building on the skills and strategies honed in 11.011, explores advanced negotiation through theory and practice. Emphasizes an experiential, personal skill-building approach, underpinned by foundational and cutting-edge research. Examines applications in management, public policy, social entrepreneurship, international diplomacy, and scientific discovery. Strengthens collaborative decision-making, communication, and leadership skills while enhancing students’ ability to proactively frame conflicts, analyze problems, engage stakeholders, create value, negotiate agreements, and resolve disputes. Limited to 36.

   B. Verdini

11.123 Big Plans and Mega-Urban Landscapes
   Prereq: None
   U (Spring)
   3-0-6 units. HASS-S

   Explores the physical, ecological, technological, political, economic and cultural implications of big plans and mega-urban landscapes in a global context. Uses local and international case studies to understand the process of making major changes to urban landscape and city fabric, and to regional landscape systems. Includes lectures by leading practitioners. Assignments consider planning and design strategies across multiple scales and time frames.

   Staff

11.124[J] Introduction to Education: Looking Forward and Looking Back on Education
   Same subject as CMS.586[J]
   Prereq: None
   U (Fall)
   3-6-3 units. HASS-S; CI-H

   See description under subject CMS.586[J]. Limited to 25.

   E. Klopfer

11.125[J] Introduction to Education: Understanding and Evaluating Education
   Same subject as CMS.587[J]
   Prereq: None
   U (Spring)
   3-6-3 units. HASS-S; CI-H

   See description under subject CMS.587[J]. Limited to 25.

   E. Klopfer

11.127[J] Design and Development of Games for Learning
   Same subject as CMS.590[J]
   Subject meets with 11.252[J], CMS.863[J]
   Prereq: None
   U (Spring)
   3-6-3 units. HASS-H

   Immerses students in the process of building and testing their own digital and board games in order to better understand how we learn from games. Explores the design and use of games in the classroom in addition to research and development issues associated with computer-based (desktop and handheld) and non-computer-based media. In developing their own games, students examine what and how people learn from them (including field testing of products), as well as how games can be implemented in educational settings. All levels of computer experience welcome. Students taking graduate version complete additional assignments.

   E. Klopfer

11.129[J] Educational Theory and Practice I
   Same subject as CMS.591[J]
   Prereq: None. Coreq: CMS.586[J]
   U (Fall)
   3-0-9 units. HASS-S

   See description under subject CMS.591[J]. Limited to 15; preference to juniors and seniors.

   G. Schwanbeck

11.130[J] Educational Theory and Practice II
   Same subject as CMS.592[J]
   Prereq: CMS.591[J]
   U (IAP)
   3-0-9 units

   See description under subject CMS.592[J].

   G. Schwanbeck

11.131[J] Educational Theory and Practice III
   Same subject as CMS.593[J]
   Prereq: CMS.592[J]
   U (Spring)
   3-0-9 units. HASS-S

   See description under subject CMS.593[J].

   G. Schwanbeck
11.133[J] Dilemmas in Biomedical Ethics: Playing God or Doing Good?
Same subject as 21A.302[J], WGS.271[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

An introduction to the cross-cultural study of biomedical ethics. Examines moral foundations of the science and practice of western biomedicine through case studies of abortion, contraception, cloning, organ transplantation and other issues. Evaluates challenges that new medical technologies pose to the practice and availability of medical services around the globe, and to cross-cultural ideas of kinship and personhood. Discusses critiques of the biomedical tradition from anthropological, feminist, legal, religious, and cross-cultural theorists.
E. C. James

11.134[J] Infections and Inequalities: Interdisciplinary Perspectives on Global Health
Same subject as 21A.331[J], HST.431[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

Examines case studies in infectious disease outbreaks to demonstrate how human health is a product of multiple determinants, such as biology, sociocultural and historical factors, politics, economic processes, and the environment. Analyzes how structural inequalities render certain populations vulnerable to illness and explores the moral and ethical dimensions of public health and clinical interventions to promote health. Limited to 25.
E. James, A. Chakraborty

11.135[J] Violence, Human Rights, and Justice
Same subject as WGS.270[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S

An examination of the problem of mass violence and oppression in the contemporary world, and of the concept of human rights as a defense against such abuse. Explores questions of cultural relativism, race, gender and ethnicity. Examines case studies from war crimes tribunals, truth commissions, anti-terrorist policies and other judicial attempts to redress state-sponsored wrongs. Considers whether the human rights framework effectively promotes the rule of law in modern societies. Students debate moral positions and address ideas of moral relativism.
E. C. James

11.136[J] Global Mental Health (New)
Same subject as 21A.308[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S

Provides skills to critically analyze issues of mental health in historical and cross-cultural contexts. Studies mental illness as a complex biopsychosocial experience embedded in particular political and economic frameworks. Examines the relationships among culture, gender, embodiment, and emotional distress; power inequalities and ideas of the “normal” and “abnormal;” and how such conceptions influence caregiving practices, whether in traditional or biomedical contexts. Evaluates how the disciplines of psychology, psychoanalysis, and psychiatry have developed in the West, and considers their influence on mental health interventions in global settings. Limited to 25.
E. James

11.137 Financing Economic Development
Subject meets with 11.437
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
4-0-8 units

Focuses on financing tools and program models to support local economic development. Provides an overview of private capital markets and financing sources to understand capital market imperfections that constrain economic development, business accounting, financial statement analysis, federal economic development programs, and public finance tools. Covers policies and program models, including revolving loan funds, guarantee programs, venture capital funds, bank holding companies, community development loan funds and credit unions, micro enterprise funds, and the Community Reinvestment Act. Students taking graduate version complete additional assignments. Limited to 25.
K. Seidman
11.139 The City in Film
Subject meets with 11.239
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
2-2-5 units. HASS-H; CI-H
Surveys important developments in urbanism from 1900 to the present, using film as a lens to explore and interpret aspects of the urban experience in the US and abroad. Topics include industrialization, demographics, diversity, the environment, and the relationship between the community and the individual. Films vary from year to year but always include a balance of classics from the history of film, an occasional experimental/avant-garde film, and a number of more recent, mainstream movies. Students taking undergraduate version complete writing assignments that focus on observation, analysis, and the essay, and give an oral presentation. Limited to 18.
E. Glenn

11.140 Urbanization and Development
Subject meets with 11.480
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
Examines developmental dynamics of rapidly urbanizing locales, with a special focus on the developing world. Case studies from India, China, Mexico, Brazil, and South Africa form the basis for discussion of social, spatial, political and economic changes in cities spurred by the decline of industry, the rise of services, and the proliferation of urban mega projects. Emphasizes the challenges of growing urban inequality, environmental risk, citizen displacement, insufficient housing, and the lack of effective institutions for metropolitan governance. Students taking graduate version complete additional assignments.

11.142 Geography of the Global Economy
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Analyzes implications of economic globalization for communities, regions, international businesses and economic development organizations. Uses spatial analysis techniques to model the role of energy resources in shaping international political economy. Investigates key drivers of human, physical, and social capital flows and their roles in modern human settlement systems. Surveys contemporary models of industrialization and places them in geographic context. Connects forces of change with their implications for the distribution of wealth and human well-being.
A. Glasmeier

11.143(J) Research Methods in Global Health and Development
Same subject as 21A.300(J)
Subject meets with 11.243(J), 21A.329(J)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-3-6 units. HASS-S
Provides training for students to critically analyze the relationship between “health” and “development.” Draws upon the theory and methods of medical anthropology, social medicine, public health, and development to track how culture, history, and political economy influence health and disease in global communities. Students work in teams to formulate research questions, and collect and analyze qualitative data in clinical and community settings in the greater Boston area, in order to design effective development interventions aimed at reducing health disparities in the US and abroad. Students taking graduate version complete additional assignments.
E. C. James
11.144 Project Appraisal in Developing Countries
Subject meets with 11.484
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units
Covers techniques of financial analysis of investment expenditures, as well as the economic and distributive appraisal of development projects. Critical analysis of these tools in the political economy of international development is discussed. Topics include appraisal's role in the project cycle, planning under conditions of uncertainty, constraints in data quality and the limits of rational analysis, and the coordination of an interdisciplinary appraisal team. Students taking graduate version complete additional assignments. Enrollment limited; preference to majors.
Y. Hong

11.145 International Housing Economics and Finance
Prereq: 14.01
U (Spring)
3-0-6 units
Credit cannot also be received for 11.355
Presents a theory of comparative differences in international housing outcomes. Introduces institutional differences in the ways housing expenditures are financed, and the economic determinants of housing outcomes, such as construction costs, land values, housing quality, and ownership rates. Analyzes the flow of funds to and from the different national housing finance sectors. Develops an understanding of the greater financial and macroeconomic implications of the mortgage credit sector, and how policies affect the ways housing asset fluctuations impact national economies. Considers the perspective of investors in international real estate markets and the risks and rewards involved. Draws on lessons from an international comparative approach, and applies them to economic and finance policies at the local, state/provincial, and federal levels within a country of choice. Meets with 11.355 when offered concurrently. Students taking graduate version complete additional assignments.
A. Saiz

11.147 Budgeting and Finance for the Public Sector
Subject meets with 11.487
Prereq: Permission of instructor
U (Spring)
3-0-9 units. HASS-S
Examines globally relevant challenges of adequately and effectively attending to public sector responsibilities for basic services with limited resources. Particular attention to the contexts of fiscal crises and rapid population growth, as well as shrinking, through an introduction to methods and processes of budgeting, accounting, and financial mobilization. Case studies and practice exercises explore revenue strategies, demonstrate fiscal analytical competencies, and familiarize students with pioneering examples of promising budget and accounting processes and innovative funding mobilization via taxation, capital markets, and other mechanisms (e.g., land-value capture). Students taking graduate version explore the subject in greater depth.
G. Carolini

11.148 Environmental Justice: Law and Policy
Subject meets with 11.368
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Introduces frameworks for analyzing and addressing inequalities in the distribution of environmental benefits and burdens. Explores the foundations and principles of the environmental justice movement from the perspectives of social science, public policy, and law. Applies environmental justice principles to contemporary issues in urban policy and planning. Students taking graduate version complete additional assignments.
Staff

11.150[J] Metropolis: A Comparative History of New York City
Same subject as 21H.220[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H
See description under subject 21H.220[J].
C. Wilder
11.151[J] Youth Political Participation
Same subject as STS.080[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
See description under subject STS.080[J]. Limited to 40.
J. S. Light

11.152[J] The Ghetto: From Venice to Harlem
Same subject as 21H.385[J]
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
See description under subject 21H.385[J].
C. Wilder

11.153[J] Shanghai and China's Modernization
Same subject as 21H.351[J]
Prereq: None
U (Fall)
Not offered regularly; consult department
2-0-10 units. HASS-H
See description under subject 21H.351[J].
Staff

11.154 Big Data, Visualization, and Society
Subject meets with 11.454
Prereq: None
U (Spring)
3-0-9 units
Studies data visualization as a way for architects, planners and policy experts to communicate with the public. Develops technical skills to work with big data to answer or expose urban issues, which include cleaning and aggregating data in python, D3, and other web-based visualization software, and accessing APIs to download data. Students work with a big data set in a particular urban area and use the data to answer a policy question. Students taking graduate version complete additional assignments.
S. Williams

11.155[J] Data and Society (New)
Same subject as STS.005[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
See description under subject STS.005[J].
E. Medina, S. Williams

11.156 Healthy Cities: Assessing Health Impacts of Policies and Plans
Subject meets with 11.356
Prereq: None
U (Spring)
3-0-9 units
Examines the built, psychosocial, economic, and natural environment factors that affect health behaviors and outcomes. Introduces tools designed to integrate public health considerations into policymaking and planning. Provides extensive practical training in the application of health impact assessment (HIA) methodology, which brings a health lens to policy, budgeting, and planning debates. Emphasizes health equity and healthy cities. Students taking graduate version complete additional assignments. Limited to 30.
M. Arcaya

11.158 Behavior and Policy: Connections in Transportation
Subject meets with 11.478
Prereq: None
U (Spring)
3-0-9 units
Examines the behavioral foundation for policy design using urban transportation examples. Introduces multiple frameworks for understanding behavior while contrasting the perspectives of classic economic theory with behavioral economics and social psychology. Suggests corresponding policy interventions and establishes a mapping across behavior, theory, and policy. Presents a spectrum of instruments for positively influencing behavior and improving welfare. Challenges students to critique, design, implement and interpret experiments that nudge travel behavior. Brings behavioral insights to creative design of transport policies that are efficient and equitable as well as simple, consistent, transparent, acceptable, and adaptive to behavioral changes. Students taking graduate version complete additional assignments.
J. Zhao
11.159 Entrepreneurial Negotiation
Subject meets with 11.259
Prereq: None
U (Fall, Spring; partial term)
1-3-2 units
Combines online weekly face-to-face negotiation exercises and in-person lectures designed to empower budding entrepreneurs with negotiation techniques to protect and increase the value of their ideas, deal with ego and build trust in relationships, and navigate entrepreneurial bargaining under constraints of economic uncertainty and complex technical considerations. Students must complete scheduled weekly assignments, including feedback memos to counterpart negotiators, and meet on campus with the instructor to discuss and reflect on their experiences with the course. Students taking graduate version complete additional assignments.

L. Susskind

11.162 Politics of Energy and the Environment
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
Focuses on the politics of making local, state, national and international decisions on energy and the environment. Topics include implementing energy efficiency measures, siting nuclear and alternative energy plants, promoting oil and gas development offshore and in wilderness, adapting to climate change, handling toxic waste, protecting endangered species, and conserving water. Case studies include Cape Wind, disputes over oil and gas exploration in the Arctic, the response to Hurricane Katrina, and efforts to craft and comply with the greenhouse gas emissions limits.

Staff

11.164[J] Human Rights at Home and Abroad
Same subject as 17.391[J]
Subject meets with 11.497
Prereq: Permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
2-0-10 units. HASS-S
Provides a rigorous and critical introduction to the history, foundation, structure, and operation of the human rights movement. Focuses on key ideas, actors, methods and sources, and critically evaluates the field. Addresses current debates in human rights, including the relationship with security, democracy, development and globalization, urbanization, equality (in housing and other economic and social rights; women's rights; ethnic, religious and racial discrimination; and policing/conflict), post-conflict rebuilding and transitional justice, and technology in human rights activism. No prior coursework needed, but work experience, or community service that demonstrates familiarity with global affairs or engagement with ethics and social justice issues, preferred. Students taking graduate version are expected to write a research paper.

B. Rajagopal

11.165 Urban Energy Systems and Policy
Subject meets with 1.286[J], 11.477[J]
Prereq: 14.01 or permission of instructor
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Examines efforts in developing and advanced nations and regions. Examines key issues in the current and future development of urban energy systems, such as technology, use, behavior, regulation, climate change, and lack of access or energy poverty. Case studies on a diverse sampling of cities explore how prospective technologies and policies can be implemented. Includes intensive group research projects, discussion, and debate. Students taking the graduate version complete additional assignments.

D. Hsu
11.166 Law, Social Movements, and Public Policy: Comparative and International Experience
Subject meets with 11.496
Prereq: Permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
Studies the interaction between law, courts, and social movements in shaping domestic and global public policy. Examines how groups mobilize to use law to affect change and why they succeed and fail. Case studies explore the interplay between law, social movements, and public policy in current issues, such as gender, race, labor, trade, climate change/environment, and LGBTQ rights. Introduces theories of public policy, social movements, law and society, and transnational studies. Students taking graduate version complete additional assignments. Limited to 15.
B. Rajagopal

Same subject as 14.47[J], 15.2191[J], 17.399[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Credit cannot also be received for 11.267[J], 15.219[J]
V. Karplus

11.169 Global Climate Policy and Sustainability
Subject meets with 11.269
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Examines climate politics both nationally and globally. Addresses economic growth, environmental preservation, and social equity through the lens of sustainability. Uses various country and regional cases to analyze how sociopolitical, economic and environmental values shape climate policy. Students develop recommendations for making climate policy more effective and sustainable. Students taking the graduate version complete additional assignments. Limited to 25.
J. Knox-Hayes

Laboratories
11.188 Urban Planning and Social Science Laboratory
Prereq: None
U (Fall, Spring)
3-3-6 units. Institute LAB
Credit cannot also be received for 11.205
An introduction to the research and empirical analysis of urban planning issues using geographic information systems. Extensive hands-on exercises provide experience with various techniques in spatial analysis and querying databases. Includes a small project on an urban planning problem involving the selection of appropriate methods, the use of primary and secondary data, computer-based modeling, and spatial analysis. Requires some computing experience.
J. Ferreira

Tutorials, Fieldwork, and Internships
11.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Undergraduate research opportunities in Urban Studies and Planning. For further information, consult the Departmental Coordinators.
J. Ferreira, Jr.

11.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Undergraduate research opportunities in Urban Studies and Planning. For further information, consult the Departmental Coordinators.
E. Klopfer
Same subject as 4.THT[J]
Prereq: None
U (Fall)
3-0-9 units
Can be repeated for credit.

Designed for students writing a thesis in Urban Studies and Planning or Architecture. Develop research topics, review relevant research and scholarship, frame research questions and arguments, choose an appropriate methodology for analysis, and draft introductory and methodology sections.
C. Abbanat

11.THU Undergraduate Thesis
Prereq: 11.THT[J]
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research leading to the writing of an SB thesis. To be arranged by the student under approved supervision.
Staff

11.189-11.190 Urban Fieldwork
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Practical application of city and regional planning techniques to towns, cities, and regions, including problems of replanning, redevelopment, and renewal of existing communities. Includes internships, under staff supervision, in municipal and state agencies and departments.
Staff

11.191-11.192 Independent Study
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For undergraduates wishing to pursue further study in specialized areas of urban studies or city and regional planning not covered in regular subjects.
Staff

11.193-11.194 Supervised Readings
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Reading and discussion of topics in urban studies and planning.
Staff

11.195 Special Subject: Urban Studies and Planning
Prereq: None
U (Fall, IAP, Spring; first half of term)
Units arranged
Can be repeated for credit.

For undergraduates wishing to pursue further study or fieldwork in specialized areas of urban studies or city and regional planning not covered in regular subjects of instruction.
Staff

11.5196-11.5199 Special Subject: Urban Studies and Planning
Prereq: None
U (Spring)
Units arranged
Can be repeated for credit.

For undergraduates wishing to pursue further study or fieldwork in specialized areas of urban studies or city and regional planning not covered in regular subjects of instruction. 11.5198 is graded P/D/F.
Staff

Master's Core Subjects

11.201 Gateway: Urban Studies and Planning
Prereq: None
G (Fall)
4-1-7 units

Introduces the history, theory and praxis of urban and regional planning.
J. Jackson

11.202 Planning Economics
Prereq: 11.203
G (Spring; partial term)
2-0-2 units

Introduces applications of microeconomic theory to planning problems including urban form and structure, government’s role in urban settings and problems of housing finance.
A. Saiz
11.203 Microeconomics
Prereq: None
G (Spring; partial term)
3-0-5 units
Introduces basic economic analysis for planning students including the functioning of markets, the allocation of scarce resources among competing uses, profit maximizing behavior in different market structures. Course illustrates theory with contemporary economic issues.
A. Saiz

11.204[J] People and the Planet: Environmental Histories and Engineering
Same subject as IDS.524[J]
Subject meets with 11.004[J], STS.033[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-3-6 units
Explores historical and cultural aspects of complex environmental problems and engineering approaches to sustainable solutions. Introduces quantitative analyses and methodological tools to understand environmental issues that have human and natural components. Demonstrates concepts through a series of historical and cultural analyses of environmental challenges and their engineering responses. Builds writing, quantitative modeling, and analytical skills in assessing environmental systems problems and developing engineering solutions. Through environmental data gathering and analysis, students engage with the challenges and possibilities of engineering in complex, interacting systems, and investigate plausible, symbiotic, systems-oriented solutions. Students taking graduate version complete additional analysis of reading assignments and a more in-depth and longer final paper.
J. Knox-Hayes, A. Slocum, R. Scheffler, J. Trancik

11.205 Introduction to Spatial Analysis
Prereq: None
G (Fall, Spring; first half of term)
2-2-2 units
Credit cannot also be received for 11.188
Practical introduction to spatial analysis and geographic information systems (GIS). Examines how geography is represented digitally and how nonrandom distributions of phenomena as diverse as poverty and scenic resources can be better understood by examining their spatial characteristics. Limited enrollment; preference to first-year MCP students.
S. Williams, J. Ferreira

11.206 Poverty and Economic Security
Subject meets with 11.006
Prereq: None
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Explores the evolution of poverty and economic security in the US within a global context. Examines the impacts of recent economic restructuring and globalization. Reviews current debates about the fate of the middle class, sources of increasing inequality, and approaches to advancing economic opportunity and security. Students taking graduate version complete additional assignments.
A. Glasmeier

11.220 Quantitative Reasoning and Statistical Methods for Planning I
Prereq: Permission of instructor
G (Fall)
4-2-6 units
Develops logical, empirically based arguments using statistical techniques and analytic methods. Covers elementary statistics, probability, and other types of quantitative reasoning useful for description, estimation, comparison, and explanation. Emphasizes the use and limitations of analytical techniques in planning practice. Restricted to MCP students.
J. Zhao

Department-wide Subjects

11.228[J] Collectives: New Forms of Sharing (New)
Same subject as 4.229[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
See description under subject 4.229[J]. Limited to 12.
Consult R. Segal
11.233 Research Design for Policy Analysis and Planning  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
Develops skills in research design for policy analysis and planning. Emphasizes the logic of the research process and its constituent elements. Topics include philosophy of science, question formulation, hypothesis generation and theory construction, data collection techniques (e.g. experimental, survey, interview), ethical issues in research, and research proposal preparation. Limited to doctoral students in Course 11.  
G. Carolini

11.234 Making Sense: Qualitative Methods for Designers and Planners  
Prereq: None  
G (Spring)  
3-3-6 units  
Surveys uses of qualitative methods and social theory in urban design and planning research and practice. Topics include observing environments, physical traces, and environmental behavior; asking questions; focused interviews; standardized questionnaires; use of written archival materials; use of visual materials, including photographs, new media, and maps; case studies; and comparative methods. Emphasizes use of each of these skills to collect and make sense of qualitative data in community and institutional settings.  
E. C. James

11.236 Participatory Action Research (PAR) 1  
Prereq: None  
G (Fall; first half of term)  
2-0-4 units  
Introduces students to participatory action research (PAR), an approach to research and inquiry that enables communities to examine and address consequential societal problems. Explores theoretical and practical questions at the heart of partnerships between applied social scientists and community partners. Focus includes the history of PAR and action research; debates regarding PAR as a form of applied social science; and practical, political, and ethical questions in the practice of PAR. Guides students through an iterative process for developing their own personal theories of practice.  
D. Cunningham

11.237 Participatory Action Research (PAR) 2  
Prereq: 11.236 or permission of instructor  
G (Spring; partial term)  
3-0-3 units  
Focuses on co-designing and co-conducting research with community partners at various stages of the research process; examination of actual cases in which PAR-like methods have been used with greater or lesser success; and interaction with community members, organizations, and individuals who have been involved in PAR collaborations. Students produce a PAR research proposal, as well as content that can be added to the PAR website.  
D. Cunningham

11.238 Ethics of Intervention  
Same subject as 21A.409(J)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 units  
An historical and cross-cultural study of the logics and practices of intervention: the ways that individuals, institutions, and governments identify conditions of need or states of emergency within and across borders that require a response. Examines when a response is viewed as obligatory, when is it deemed unnecessary, and by whom; when the intercession is considered fulfilled; and the rationales or assumptions that are employed in assessing interventions. Theories of the state, globalization, and humanitarianism; power, policy, and institutions; gender, race, and ethnicity; and law, ethics, and morality are examined.  
E. C. James

11.239 The City in Film  
Subject meets with 11.139  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
2-2-5 units  
Surveys important developments in urbanism from 1900 to the present, using film as a lens to explore and interpret aspects of the urban experience in the US and abroad. Topics include industrialization, demographics, diversity, the environment, and the relationship between the community and the individual. Films vary from year to year but always include a balance of classics from the history of film, an occasional experimental/avant-garde film, and a number of more recent, mainstream movies. Students taking undergraduate version complete writing assignments that focus on observation, analysis, and the essay, and give an oral presentation.  
E. Glenn
Same subject as 21A.329[J]
Subject meets with 11.143[J], 21A.300[J]
Prereq: None
G (Fall)
Not offered regularly; consult department
3-3-6 units
Provides training for students to critically analyze the relationship between "health" and "development." Draws upon the theory and methods of medical anthropology, social medicine, public health, and development to track how culture, history, and political economy influence health and disease in global communities. Students work in teams to formulate research questions, and collect and analyze qualitative data in clinical and community settings in the greater Boston area, in order to design effective development interventions aimed at reducing health disparities in the US and abroad. Students taking graduate version complete additional assignments.
E. C. James

11.245[J] DesignX Entrepreneurship
Same subject as 4.245[J]
Prereq: Permission of instructor
G (IAP)
6-0-0 units
Students work in teams to create their own design and business narrative, technology and social strategies, and preliminary plan for moving their innovation forward. Lectures and workshops are interspersed with one-on-one critiques with instructors and outside mentors in specific areas of student interest. Students visit SA+P alumni firms to learn how principals have developed their own business, technology, design, and civic platforms. End-of-term presentation highlights important features of their venture. Limited to 30; preference to students in DesignX Program.
D. Frenchman and G. Rosenzweig

11.246[J] DesignX Accelerator
Same subject as 4.246[J]
Prereq: Permission of instructor
G (Spring)
2-4-6 units
Students work in entrepreneurial teams to advance innovative ideas, products, services, and firms oriented to design and the built environment. Lectures, demonstrations, and presentations are supplemented by workshop time, when teams interact individually with instructors and industry mentors, and by additional networking events and field trips. At the end of the term, teams pitch for support of their venture to outside investors, accelerators, companies, or cities. Limited to 30; preference to students in DesignX Program.
D. Frenchman, G. Rosenzweig

11.250 Transportation Research Design
Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 units
Can be repeated for credit.
Seminar dissects ten transportation studies from head to toe to illustrate how research ideas are initiated, framed, analyzed, evidenced, written, presented, criticized, revised, extended, and published, quoted and applied. Students design and execute their own transportation research. Limited to 20.
J. Zhao

11.252[J] Design and Development of Games for Learning
Same subject as CMS.863[J]
Subject meets with 11.127[J], CMS.590[J]
Prereq: None
G (Spring)
3-6-3 units
Immerses students in the process of building and testing their own digital and board games in order to better understand how we learn from games. Explores the design and use of games in the classroom in addition to research and development issues associated with computer-based (desktop and handheld) and non-computer-based media. In developing their own games, students examine what and how people learn from them (including field testing of products), as well as how games can be implemented in educational settings. All levels of computer experience welcome. Students taking graduate version complete additional assignments.
E. Klopfer

11.255 Negotiation and Dispute Resolution in the Public Sector
Prereq: None
G (Spring)
4-0-8 units
Investigates social conflict and distributional disputes in the public sector. While theoretical aspects of conflict and consensus building are considered, focus is on the practice of negotiation and dispute resolution. Comparisons between unassisted and assisted negotiation are reviewed along with the techniques of facilitation and mediation.
L. Susskind
11.259 Entrepreneurial Negotiation
Subject meets with 11.159
Prereq: None
G (Fall, Spring; partial term)
1-3-2 units

Combines online weekly face-to-face negotiation exercises and in-person lectures designed to empower budding entrepreneurs with negotiation techniques to protect and increase the value of their ideas, deal with ego and build trust in relationships, and navigate entrepreneurial bargaining under constraints of economic uncertainty and complex technical considerations. Students must complete scheduled weekly assignments, including feedback memos to counterpart negotiators, and meet on campus with the instructor to discuss and reflect on their experiences with the course. Students taking graduate version complete additional assignments.
L. Susskind

11.260 Sustainable Development and Institutions
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-9 units

Explores the theory and application of the principles of sustainable development as they relate to organizational change management, decision-making processes, goal setting methodology and solution development. Leverages the MIT campus as a living laboratory to gain unique insight into the change management and solution development process. Limited to 18.
J. Newman

11.263[J] Urban Last-Mile Logistics
Same subject as 1.263[J], SCM.293[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units

See description under subject SCM.293[J].
M. Winkenbach

Same subject as 15.219[J]
Prereq: None
G (Spring)
3-0-9 units

Credit cannot also be received for 11.167[J], 14.47[J], 15.2191[J], 17.399[J]

See description under subject 15.219[J].
V. Karplus

11.269 Global Climate Policy and Sustainability
Subject meets with 11.169
Prereq: None
G (Spring)
3-0-9 units

Examines climate politics both nationally and globally. Addresses economic growth, environmental preservation, and social equity through the lens of sustainability. Uses various country and regional cases to analyze how sociopolitical, economic and environmental values shape climate policy. Students develop recommendations for making climate policy more effective and sustainable. Students taking graduate version complete additional assignments. Limited to 25.
J. Knox-Hayes

Program Group Subjects

11.301[J] Introduction to Urban Design and Development
Same subject as 4.252[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Examines the physical and social structure of cities and ways they can be changed. Includes historical forces that have produced cities, models of urban form, contemporary theories of urban design, implementation strategies. Core lectures are supplemented by student projects analyzing the evolution of urban place, and factors of high quality urban design and development. Guest speakers present cases involving current projects illustrating the scope and methods of urban design practice.
D. Frenchman

11.302[J] Urban Design Politics
Same subject as 4.253[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Examines ways urban design contributes to distribution of political power and resources in cities. Investigates the nature of relations between built form and political purposes through close study of a wide variety of situations where public sector design commissions and planning processes have been clearly motivated by political pressures. Lectures and discussions focus on specific case studies of 20th-century government-sponsored designs carried out under diverse regimes in the US, Europe, and elsewhere.
L. Vale
11.303[J] Real Estate Development Studio
Same subject as 4.254[J]
Prereq: Permission of instructor
G (Spring)
6-0-12 units

Focuses on the synthesis of urban, mixed-use real estate projects, including the integration of physical design and programming with finance and marketing. Interdisciplinary student teams analyze how to maximize value across multiple dimensions in the process of preparing professional development proposals for sites in US cities and internationally. Reviews emerging real estate products and innovative developments to provide a foundation for studio work. Two major projects are interspersed with lectures and field trips. Integrates skills and knowledge in the MSRED program; also open to other students interested in real estate development by permission of the instructors.

D. Frenchman, K. Shen

11.304[J] Site and Environmental Systems Planning
Same subject as 4.255[J]
Prereq: Permission of instructor
G (Spring)
6-0-9 units

Introduces a range of practical approaches involved in evaluating and planning sites within the context of natural and cultural systems. Develops the knowledge and skills to analyze and plan a site for development through exercises and an urban design project. Topics include land inventory, urban form, spatial organization of uses, parcelization, design of roadways, grading, utility systems, off-site impacts, and landscape architecture.

M. A. Ocampo

11.305 Doing Good by Doing Well: Planning and Development Case Studies that Promote both the Public Good and Real Estate Value (New)
Prereq: None
G (Fall)
2-0-1 units

Seminar studies how the messy and complex forces of politics, planning and the real estate market have collectively shaped Boston’s urban fabric and skyline in the last two decades. Using some of the city’s most important real estate development proposals as case studies, students dissect and analyze Boston’s negotiated development review and permitting process to understand what it takes beyond a great development concept and a sound financial pro forma to earn community and political support. Throughout the term, students identify strategies for success and pitfalls for failure within this intricate approval process, as well as how these lessons can be generalized and applied to other cities and real estate markets.

K. Shen

11.307[J] China Urban Design Studio
Same subject as 4.173[J]
Prereq: Permission of instructor
G (Spring)
0-21-0 units

Design studio that includes architects and city planners working in teams on a contemporary development project of importance in China, particularly in transitional, deindustrializing cities. Students analyze conditions, explore alternatives, and synthesize architecture, city design, and implementation plans. Lectures and brief study tours expose students to history and contemporary issues of urbanism in China. Offered each spring at MIT in parallel with urban design studio at Tsinghua University, Beijing, involving students and faculty from both schools. Field visit to China will occur in January prior to studio. Limited to 10.

B. Ryan

11.308[J] Ecological Urbanism Seminar
Same subject as 4.213[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

Examines the urban environment as a natural phenomenon, human habitat, medium of expression, and forum for action. Subject has two related, major themes: how ideas of nature influence the way cities are perceived, designed, built, and managed; and how natural processes and urban form interact and the consequences of these for human health safety and welfare. Enrollment limited.

A. Spirn

11.309[J] Sensing Place: Photography as Inquiry
Same subject as 4.215[J]
Prereq: None
G (Fall)
3-0-9 units

Explores photography as a disciplined way of seeing, of investigating urban landscapes and expressing ideas. Readings, observations, and photographs form the basis of discussions on light, detail, place, poetics, narrative, and how photography can inform design and planning. Enrollment limited.

A. Spirn
11.312 Engaging Community: Models and Methods for Strengthening Democracy
Prereq: None
G (Spring)
3-0-9 units
Students examine design principles, and review and practice strategies, techniques, and methods for creating public engagement practices that are necessary for building inclusive civic infrastructure in cities, with the premise that demographic complexity presents fundamental design challenges for planners and other professions that have a responsibility to engage the public.
C. McDowell

11.313 Advanced Research Workshop in Landscape and Urbanism
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
In-depth research workshop on pressing environmental design issue of our time, includes discussion and practices of various Landscape-based disciplines used to generate design-based solutions and landscape infrastructural responses to physical urban entropy and decline. Specific focus is adjusted each year.
A. Berger

Same subject as 4.214[J]
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-3-6 units
Can be repeated for credit.
See description under subject 4.214[J]. Limited to 15.
J. Wescoat

11.315[J] Disaster Resilient Design
Same subject as 4.217[J]
Subject meets with 4.218
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-6 units
J. Wescoat

11.318 Senseable Cities
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Studies how ubiquitous and real-time information technology can help us to understand and improve cities and regions. Explores the impact of integrating real-time information technology into the built environment. Introduces theoretical foundations of ubiquitous computing. Provides technical tools for tactile development of small-scale projects. Limited to 24.
C. Ratti

11.320 Digital City Design Workshop
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Students develop proposals, at the city and neighborhood scales, that integrate urban design, planning, and digital technology. Aims to create more efficient, responsive, and livable urban places and systems that combine physical form with digital media, sensing, communications, and data analysis. Students conduct field research, build project briefs, and deliver designs or prototypes, while supported by lectures, case studies, and involvement from experts and representatives of subject cities. Limited to 12.
C. Ratti

11.321 Data Science and Machine Learning Principles for Real Estate (New)
Prereq: None
G (Spring; second half of term)
2-0-4 units
Introduces students to data sources and science techniques for understanding real estate. Covers the foundations of data analytics. Includes a survey of machine learning methods and its applications to real estate development and financial analysis.
A. Chegut

11.322 Innovative Products, Spaces, and Technology (New)
Prereq: None
G (Spring; second half of term)
2-0-4 units
Focuses on the economic foundations of innovation, trace innovation to the primary and secondary commercial real estate markets, and survey products, spaces and technologies in the commercial real estate development pipeline of today and beyond. Candidly discusses the challenges faced by innovators in the real estate innovation domain.
A. Chegut
11.323 International Real Estate Transactions (New)
Prereq: None
G (Spring; second half of term)
3-0-3 units
Builds upon students' previous real estate coursework in finance, capital markets, ventures, and development and applies the key concepts studied therein to international real estate transactions that involve varied geographies (and investors). Addresses a range of issues related to a variety of unique transactional dynamics. Focuses on discussion-based learning from a multidisciplinary standpoint.

M. Srivastava

11.328[J] Urban Design Skills: Observing, Interpreting, and Representing the City
Same subject as 4.240[J]
Prereq: None
G (Fall)
4-2-9 units
Introduces methods of recording, evaluating, and representing the urban environment. Through visual observation, field analysis, measurements, interviews, and other means, students draw on their senses and develop their ability to deduce, conclude, question, and test conclusions about how the environment is used and valued. Using representational tools such as drawing, photographing, computer modeling and desktop publishing, students communicate what they observe along with their impressions and design ideas. Intended as a foundation for future studio work in urban design. Includes design-based projects.

E. Ben-Joseph

Same subject as 4.241[J]
Prereq: 11.001[J], 11.301[J], or permission of instructor
G (Spring)
Units arranged
See description under subject 4.241[J].
L. Jacobi, R. Segal

11.332[J] Urban Design Studio
Same subject as 4.163[J]
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
See description under subject 4.163[J].

Consult R. Segal

11.333[J] Urban Design Seminar: Perspectives on Contemporary Practice
Same subject as 4.244[J]
Prereq: None
G (Spring)
2-0-7 units
Examines innovations in urban design practice occurring through the work of leading practitioners in the fields of architecture, landscape architecture, and urban planning. Features lectures by major national and global practitioners in urban design. Projects and topics vary based on term and speakers but may cover architectural urbanism, landscape and ecology, arts and culture, urban design regulation and planning agencies, and citywide and regional design. Focuses on analysis and synthesis of themes discussed in presentations and discussions.

Staff

11.334[J] Advanced Seminar in Landscape and Urbanism
Same subject as 4.264[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Explores theories, practices, and emerging trends in the fields of landscape architecture and urbanism, such as systemic design, landscape urbanism, engineered nature, drosscapes, urban biodiversity, urban mobility, megaregions, and urban agriculture. Lectures, readings, and guest speakers present a wide array of multi-disciplinary topics, including current works from P-REX lab. Students conduct independent and group research that is future-oriented.

A. Berger

11.337[J] Urban Design Ideals and Action
Same subject as 4.247[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-0-7 units
Examines the relationship between urban design ideals, urban design action, and the built environment through readings, discussions, presentations, and papers. Analyzes the diverse design ideals that influence cities and settlements, and investigates how urban designers use them to shape urban form. Provides a critical understanding of the diverse formal methods used to intervene creatively in both developed and developing contexts, especially pluralistic and informal built environments.

B. Ryan
11.338 Urban Design Studio
Prereq: 11.328[J]
G (Spring)
0-12-9 units
Examines the rehabilitation and re-imagination of a city. Analyzes the city at three scales: citywide, neighborhood, and individual dwellings. Aims to shape innovative design solutions, enhance social amenity, and improve economic equity through strategic and creative geographical, urban design, and architectural thinking. Intended for students with backgrounds in architecture, community development, and physical planning. Limited to 12 via application and lottery.
B. Ryan

11.339 Downtown
Subject meets with 11.026[J], 21H.321[J]
Prereq: None
G (Spring)
Not offered regularly; consult department
2-0-7 units
Seminar on downtown in US cities from the late 19th century to the late 20th. Emphasis on downtown as an idea, place, and cluster of interests, on the changing character of downtown, and on recent efforts to rebuild it. Topics considered include subways, skyscrapers, highways, urban renewal, and retail centers. Focus on readings, discussions, and individual research projects. Students taking graduate version complete additional assignments.
F. M. Fogelson

11.344[J] Innovative Project Delivery in the Public and Private Sectors
Same subject as 1.472[J]
Prereq: Permission of instructor
G (Spring; first half of term)
2-0-4 units
Develops a strong strategic understanding of how best to deliver various types of projects in the built environment. Examines the compatibility of various project delivery methods, consisting of organizations, contracts, and award methods, with certain types of projects and owners. Six methods examined: traditional general contracting; construction management; multiple primes; design-build; turnkey; and build-operate-transfer. Includes lectures, case studies, guest speakers, and a team project to analyze a case example.
C. M. Gordon

11.345[J] Entrepreneurship in Construction and Real Estate Development
Same subject as 1.462[J]
Prereq: Permission of instructor
G (Fall; first half of term)
2-0-4 units
Develops skills necessary to incubate concepts into new products and services in the built environment, and to evolve those ideas into viable startup ventures. Addresses the progression of an idea, from inception to opportunity to sustainable business. Students develop a business model and a plan to launch their own business. Guest lecturers share their entrepreneurial paths and relevant qualitative and quantitative experience. Explores the role of entrepreneurs in developing/emerging markets, with a focus on solving social development challenges and innovating new development strategies/products, all within the built and human environment. Provides an ideal platform to prepare for the DesignX program.
J. F. Kennedy

11.351 Real Estate Ventures I: Negotiating Development-Phase Agreements
Prereq: None
G (Fall)
3-0-9 units
Focuses on key business and legal issues within the principal agreements used to control, entitle, capitalize, and construct a mixed-use real estate development. Through the lens of the real estate developer and its counter-parties, students identify, discuss, and negotiate the most important business issues in right of entry, purchase and sale, development, and joint-venture agreements, as well as a construction contract and construction loan agreement. Students work closely with attorneys who specialize in the construction of such agreements and with students from area law schools and Columbia University and New York University. Enrollment limited; preference to MSRED students. No listeners.
W. T. McGrath
11.352 Real Estate Ventures II: Negotiating Leases, Financings, and Restructurings  
Prereq: None  
G (Spring)  
3-0-9 units  
Focuses on key business and legal issues within the principal agreements used to lease, finance, and restructure a real estate venture. Through the lens of the real estate developer and its counter-parties, students identify, discuss and negotiate the most important business issues in office and retail leases, and permanent loan, mezzanine loan, inter-creditor, standstill/forbearance, and loan modification (workout) agreements. Students work closely with attorneys who specialize in the construction of such agreements and with students from area law schools and New York University and Columbia University. Single-asset real estate bankruptcy and the federal income tax consequences of debt restructuring are also addressed. Enrollment limited; preference to MSRED students; no listeners.  
W. T. McGrath

11.353[J] Securitization of Mortgages and Other Assets  
Same subject as 15.429[J]  
Prereq: 11.431[J], 15.401, or permission of instructor  
G (Spring)  
3-0-6 units  
See description under subject 15.429[J].  
W. Torous

11.354 Real Estate Products Development  
Prereq: None  
G (Fall)  
3-0-9 units  
Introduces core components of developing commercial real estate. Explores the process of developing, from initial site selection to site and design planning, entitlements, deal financing, and construction. Includes faculty and industry leader lectures, field trips, and group work on a real-time development case study.  
J. Cooke

11.355 International Housing Economics and Finance  
Prereq: 11.202, 11.203, 14.01, or permission of instructor  
G (Spring)  
3-0-6 units  
Credit cannot also be received for 11.145  
Presents a theory of comparative differences in international housing outcomes. Introduces institutional differences in ways housing expenditures are financed, and economic determinants of housing outcomes (construction costs, land values, housing quality, ownership rates). Analyzes flow of funds to and from the different national housing finance sectors. Develops an understanding of the greater financial and macroeconomic implications of mortgage credit sector, and how policies affect ways housing asset fluctuations impact national economies. Considers perspective of investors in international real estate markets and risks and rewards involved. Draws on lessons from international comparative approach, applies them to economic and finance policies at the local, state/provincial, and federal levels within country of choice. Meets with 11.145 when offered concurrently. Students taking graduate version complete additional assignments.  
A. Saiz

11.356 Healthy Cities: Assessing Health Impacts of Policies and Plans  
Subject meets with 11.156  
Prereq: None  
G (Spring)  
3-0-9 units  
Examines the built, psychosocial, economic, and natural environment factors that affect health behaviors and outcomes. Introduces tools designed to integrate public health considerations into policymaking and planning. Provides extensive practical training in the application of health impact assessment (HIA) methodology, which brings a health lens to policy, budgeting, and planning debates. Emphasizes health equity and healthy cities. Students taking graduate version complete additional assignments. Limited to 30.  
M. Arcaya
11.360 Community Growth and Land Use Planning
Prereq: Permission of instructor
G (Fall)

3-0-9 units

Practicum workshop on strategies of planning and control for growth and land use, chiefly at the municipal level. Growth and its local consequences; land use planning approaches; implementation tools including innovative zoning and regulatory techniques, physical design, and natural systems integration. Semester-long projects arranged with student teams serving municipal clients. Preference to MCP second year students.

T. S. Szold

11.367 The Law and Politics of Land Use
Prereq: Permission of instructor
G (Spring)

3-0-9 units

Analysis of local and state power to regulate land use and development. Particular emphasis on the evolution of planning and zoning regulations, and the perceived narrowing of the relationship between public improvements requirements and development impact. The ability of regulatory bodies to impose environmental performance standards and limit development activity is explored in relation to recent Supreme Court and State SJC decisions. Development decisions rendered by public agencies are reviewed, critiqued, and discussed.

T. S. Szold

11.368 Environmental Justice: Law and Policy
Subject meets with 11.148
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered

3-0-9 units

Introduces frameworks for analyzing and addressing inequalities in the distribution of environmental benefits and burdens. Explores the foundations and principles of the environmental justice movement from the perspectives of social science, public policy, and law. Applies environmental justice principles to contemporary issues in urban policy and planning.

Staff

11.371[J] Sustainable Energy
Same subject as 1.818[J], 2.65[J], 10.391[J], 22.811[J]
Subject meets with 2.650[J], 10.291[J], 22.081[J]
Prereq: Permission of instructor
G (Fall)

3-1-8 units

See description under subject 22.811[J].

M. W. Golay

11.373[J] Science, Politics, and Environmental Policy
Same subject as 12.885[J]
Subject meets with 12.385
Prereq: Permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered

3-0-6 units

See description under subject 12.885[J].

S. Solomon, J. Knox-Hayes

11.376 Urban Sustainability in Action
Prereq: Permission of instructor
G (Spring)

Not offered regularly; consult department

3-0-9 units

Considers the theory and practice of urban sustainability. Introduces concepts of environmental sustainability, systems dynamics, ecological footprints, and environmental indicators. Investigates cutting-edge practices of cities in the US and around the world. Drawing on those examples, students work in and around the City of Boston on local sustainability initiatives.

Staff

11.377 Food Systems and the Environment
Prereq: Permission of instructor
G (Fall)

Not offered regularly; consult department

3-0-9 units

Explores the evolution of food production in the US and globally. Considers the science, economics, and politics behind the transition from pre-industrial to an industrial food system. Debates the costs and benefits of genetically modified food, organic agriculture, and local/regional food production. Focuses on the environmental sustainability and human-health consequences of different approaches, for both the developed and developing world.

Staff
11.378[J] Water Planning, Policy, and Design
Same subject as 4.625[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
Units arranged
Can be repeated for credit.
See description under subject 4.625[J]. Limited to 15.
J. Wescoat

11.380 Urban Climate Adaptation
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Examines the challenges cities face and strategies to prepare for the impacts of climate change. Particular attention to the needs of vulnerable populations and resource-constrained cities, global and national adaptation policies and funding mechanisms, and ways in which local government and community-based activities can promote climate-readiness.
Staff

11.381 Infrastructure Systems in Theory and Practice
Prereq: (14.01 and (11.202 or 11.203)) or permission of instructor
G (Spring)
3-0-9 units
Examines theories of infrastructure from science and technology studies, history, economics, and anthropology in order to understand the prospects for change for many new and existing infrastructure systems. Examines how these theories are then implemented within systems in the modern city, including but not limited to, energy, water, transportation, and telecommunications infrastructure. Seminar is conducted with intensive group research projects, in-class discussions and debates.
D. Hsu

11.382 Water Diplomacy: The Science, Policy, and Politics of Managing Shared Resources
Prereq: Permission of instructor
G (Spring)
3-0-9 units
Examines the history and dynamics of international environmental treaty-making, or what is called environmental diplomacy. Emphasizes climate change and other atmospheric, marine resource, global waste management and sustainability-related treaties and the problems of implementing them. Reviews the legal, economic, and political dynamics of managing shared resources, involving civil society on a global basis, and enforcing transboundary agreements. Focuses especially on principles from international relations, international law, environmental management, and negotiation theory as they relate to common-pool resource management.
L. Susskind

Same subject as 15.662[J]
Prereq: None
G (Spring)
3-3-3 units
See description under subject 15.662[J].
T. Kochan, B. Dyer

11.387 Environmental Finance and Political Economy
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units
Examines the sociopolitical, cultural and economic dimensions of the financialization of environmental goods and services. Provides an introduction to key financial terms, practices, and institutions; analyzes the logics and origins of environmental finance, as well as the operation and implications of particular systems such as carbon-trading, REDD and ecosystem service pricing and swapping. Limited to 15.
J. Knox-Hayes
**11.401 Introduction to Housing, Community and Economic Development**  
Prereq: None  
G (Fall)  
3-0-9 units

Provides a critical introduction to the shape and determinants of political, social, and economic inequality in America. Explores the role of the city in visions of justice. Analyzes the historical, political, and institutional contexts of housing and community development policy in the U.S., including federalism, municipal fragmentation, and decentralized public financing. Reviews major themes in U.S. housing policy, such as private housing finance, public housing policy, state and local housing affordability mechanisms. Reviews major themes in community economic development, including drivers of economic inequality, small business policy, employment policy, and cooperative economics. 

*J. Steil*

**11.402 Urban Politics: Race and Political Change**  
Prereq: None  
G (Fall)  
Not offered regularly; consult department  
3-0-9 units

Examines the place of US cities in political theory and practice. Particular attention given to contemporary issues of racial polarization, demographic change, poverty, sprawl, and globalization. Specific cities are a focus for discussion. 

*J. P. Thompson*

**11.403 Urban China Research Seminar**  
Prereq: Permission of instructor  
G (Fall)  
2-0-7 units  
Can be repeated for credit.

Examines the behavioral foundations and key policy issues of urban development, real estate markets, and sustainability in China. Discusses urban agglomeration economies, place-based investment, and urban vibrancy; economic geography of innovation and entrepreneurship; real estate dynamics and housing policies; land use and transportation; and urban quality of life and green cities, focusing on China but with some international comparisons. 

*S. Zheng*

**11.404 Housing Policy and Planning in the US and Abroad**  
Prereq: None  
G (Spring)  
Not offered regularly; consult department  
3-0-9 units

Explores the policy tools and planning techniques used to formulate and implement housing strategies at local, state and federal levels. Topics include America's housing finance system and the causes of instability in mortgage markets; economic and social inequity in access to affordable housing; approaches to meeting community housing needs through local and state planning programs; programs for addressing homelessness; and emerging ideas about sustainable development and green building related to housing development and renovation. Introduces comparative policy approaches from other countries. 

*Staff*

**11.405 Political Economy & Society**  
Prereq: Permission of instructor  
G (Fall)  
Not offered regularly; consult department  
3-0-6 units

Focuses on the connection (or not) between mind (theory) and matter (lived experience). Examines basic tenets of classical and recent political economic theories and their explication in ideas of market economies, centrally planned economies, social market economies, and co-creative economies. Assesses theories according to their relation to the lived experiences of people in communities and workplaces. 

*J. P. Thompson*

**11.407 Economic Development Tools and Techniques**  
Prereq: Permission of instructor  
Acad Year 2019-2020: Not offered  
Acad Year 2020-2021: G (Spring)  
3-0-9 units

Introduces a suite of tools representing the basic set of practices used in the development field. Presents a wealth creation framework that focuses on place, improving livelihoods, incentivizing collaboration, creating multiple forms of wealth, and promoting local ownership. Students work with web-based tools designed for use in a professional setting. Discussions are based on results from tools, their interpretation, and their meaning. Relevant to all students interested in the structure and function of local, state, national and international economic contexts. Students develop a series of memos as students they complete assignments. 

*A. Glasmeier*
11.409 The Institutions of Modern Capitalism: States and Markets
Prereq: None
G (Spring)
3-0-9 units
Investigates the relationship between states and markets in the evolution of modern capitalism. Critically assesses the rise of what Karl Polanyi and Albert Hirschman have referred to as "market society," a powerful conceptual framework that views the development of modern capitalism not as an outcome of deterministic economic and technological forces, but rather as the result of contingent social and political processes. Exposes students to a range of conceptual tools and analytic frameworks through which to understand the politics of economic governance and to consider the extent to which societal actors can challenge its limits and imagine alternative possibilities. Sub-themes vary from year to year and have focused on urban futures, markets and morality, and the global financial crisis. Limited to 25.
J. Jackson

11.427[J] Urban Labor Markets and Employment Policy
Same subject as 15.677[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
See description under subject 15.677[J].
P. Osterman

11.430[J] Leadership in Real Estate
Same subject as 15.941[J]
Prereq: None
G (Fall; first half of term)
3-0-3 units
See description under subject 15.941[J]. Limited to 15.
G. Schuck

11.431[J] Real Estate Finance and Investment
Same subject as 15.426[J]
Prereq: Permission of instructor
G (Fall)
4-0-8 units
Concepts and techniques for analyzing financial decisions in commercial property development and investment. Topics include property income streams, urban economics, discounted cash flow, equity valuation, leverage and income tax considerations, development projects, and joint ventures. Limited to graduate students.
D. Geltner

11.432[J] Real Estate Capital Markets
Same subject as 15.427[J]
Prereq: 11.431[J] and (15.402 or 15.414)
G (Spring; first half of term)
2-0-4 units
Introduces real estate capital markets for institutional investors. Topics include real estate investment trusts (REIT), commercial mortgage-backed securities (CMBS), and private equity. Concepts and techniques for investment analysis include portfolio theory and equilibrium asset pricing. Additional topics may include price indexing and derivatives. Focuses primarily on aggregates of many properties: portfolios, firms, markets, industries. Relates macro-level capital markets topics to micro-level bricks-and-mortar of real estate development projects in a direct and concrete manner.
D. Geltner

11.433[J] Real Estate Economics
Same subject as 15.021[J]
Prereq: 14.01, 15.010, or 15.011
G (Fall)
4-0-8 units
Develops understanding of the fundamental economic factors that shape the market for real property, as well as the influence of capital markets in asset pricing. Analyzes of housing as well as commercial real estate. Covers demographic analysis, regional growth, construction cycles, urban land markets, and location theory. Exercises and modeling techniques for measuring and predicting property demand, supply, vacancy, and prices.
W. C. Wheaton

11.434[J] Tools for Analysis: Design for Real Estate and Infrastructure Development
Same subject as 15.428[J], IDS.720[J]
Prereq: None
G (Spring; second half of term)
2-0-4 units
Introduction to analytical tools to support design and decision-making in real estate, infrastructure development, and investment. Particular focus on identifying and valuing sources of flexibility using "real options," Monte-Carlo simulation, and other techniques from the field of engineering systems. Integrates economic and engineering perspectives, and is suitable for students with various backgrounds. Provides useful preparation for thesis work in the area.
D. Geltner, R. de Neufville
11.435 Mixed-Income Housing Development
Prereq: None
G (Spring)
4-0-8 units
Provides an overview of affordable and mixed-income housing development for students who wish to understand the fundamental issues and requirements of urban scale housing development, and the process of planning, financing and developing such housing. Students gain practical experience assembling a mixed-income housing development proposal.
R. Roth

11.436 Housing Studio: Neighborhood Sustainability Plan
Prereq: 11.301[J], 11.401, or 11.601
G (Spring)
Not offered regularly; consult department
6-0-9 units
Explores ways to improve housing quality and affordability, increase energy savings, and promote transportation access as part of a neighborhood sustainability plan. Students work with a local client to define the terms of local sustainability for a specific Boston neighborhood, then design an appropriate framework for action for the target site focusing on existing and future housing needs, community services, transit connections, and energy policy.
Staff

11.437 Financing Economic Development
Subject meets with 11.137
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
4-0-8 units
Focuses on financing tools and program models to support local economic development. Provides an overview of private capital markets and financing sources to understand capital market imperfections that constrain economic development, business accounting, financial statement analysis, federal economic development programs, and public finance tools. Covers policies and program models, including revolving loan funds, guarantee programs, venture capital funds, bank holding companies, community development loan funds and credit unions, micro enterprise funds, and the Community Reinvestment Act. Students taking graduate version complete additional assignments. Limited to 25.
K. Seidman

11.438 Economic Development Planning
Prereq: 11.203, 11.220, and permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Focuses on the policy tools and planning techniques used to formulate and implement local economic development strategies. Includes an overview of economic development theory, discussion of major policy areas and practices employed to influence local economic development, a review of analytic tools to assess local economies and how to formulate strategy. Coursework includes formulation of a local economic development strategy for a client. Limited to 15.
K. Seidman

11.439 Revitalizing Urban Main Streets
Prereq: (11.301[J], 11.328[J], or 11.401) and permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
4-0-11 units
Workshop explores the integration of economic development and physical planning interventions to revitalize urban commercial districts. Covers: an overview of the causes of urban business district decline, revitalization challenges, and the strategies to address them; the planning tools used to understand and assess urban Main Streets from both physical design and economic development perspectives; and the policies, interventions, and investments used to foster urban commercial revitalization. Students apply the theories, tools and interventions discussed in class to preparing a formal neighborhood commercial revitalization plan for a client business district. Limited to 15.
K. Seidman, M. A. Ocampo

Same subject as 4.232[J]
Prereq: Permission of instructor
G (Spring)
3-0-6 units
See description under subject 4.232[J].
R. Goethert
11.450 Real Estate Development Building Systems
Prereq: None
G (Fall; first half of term)
2-0-1 units
Provides students with a concise overview of the range of building systems that are encountered in professional commercial real estate development practice in the USA. Focuses on the relationship between real estate product types, building systems, and the factors that real estate development professionals must consider when evaluating these products and systems for a specific development project. Surveys commercial building technology including Foundation, Structural, MEP/FP, Envelope, and Interiors systems and analyzes the factors that lead development professionals to select specific systems for specific product types. One or more field trips to active construction sites may be scheduled during non-class hours based on student availability.
Y. Tsipis

11.452 Planning against Evictions and Displacement
Prereq: None
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units
Combines state-of-the-art research on evictions and displacement globally (in the context of the global crisis of evictions, land grabbing, and gentrification) with the study of policy and practical responses to displacement, assisted by selected case studies. First half covers explanations about the mechanisms and drivers of displacement, while the second half introduces and evaluates policy and legal responses developed by many actors. Analyzes the use of UN and national standards on displacement as well as the use of tools such as the Eviction Impact Assessment Tool. Limited to 15 graduate students.
B. Rajagopal

11.454 Big Data, Visualization, and Society
Subject meets with 11.154
Prereq: None
G (Spring)
3-0-9 units
Studies data visualization as a way for architects, planners and policy experts to communicate with the public. Develops technical skills to work with big data to answer or expose urban issues, which include cleaning and aggregating data in python, D3, and other web-based visualization software, and accessing APIs to download data. Students work with a big data set in a particular urban area and use the data to answer a policy question. Students taking graduate version complete additional assignments.
S. Williams

11.455 Financial Decision Making in Real Estate and Other Markets
Prereq: None
G (Fall)
3-0-6 units
Provides a rigorous introduction to the fundamentals of modern finance including valuation, risk analysis and investment decisions. Where possible, applications and examples drawn from real estate and mortgage markets.
W. N. Torous

11.457 More than Data: Smart Cities, Big Data, Civic Technology and Policy
Prereq: None
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-6 units
Discussions of future directions in the 'smart cities' debate. Begins by framing the current smart city with past trends such as the efficient city movement of the 1930s and the Modernist city of the 1950s and 60s. Examines current trends in big data, civic apps, Code for America, the open data movement, DIY data collections devices, and their policy impacts.
S. Williams

11.458 Crowd Sourced City: Civic Tech Prototyping Class
Prereq: None
G (Spring)
3-0-9 units
Investigates the use of social medial and digital technologies for planning and advocacy by working with actual planning and advocacy organizations to develop, implement, and evaluate prototype digital tools. Students use the development of their digital tools as a way to investigate new media technologies that can be used for planning.
S. Williams
11.460 Development, Planning, and Implementation: The Dialectic of Theory and Practice
Prereq: None
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Advanced seminar analyzes the effectiveness of developmental and planning theories. Aims to create a new planning sensibility which theorizes from practice, and to create a new conceptualization of the developmental process from the point of view of practitioners who must transcend conventional thinking to implement projects and policies. Organized around twelve implementation puzzles which should be considered for rethinking developmental planning processes. Review of conventional theories of development, urbanization and planning set the stage for critical reviews of how such theories actually influence practice.

B. Sanyal

11.461[J] Technocracy
Same subject as STS.463[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

See description under subject STS.463[J].

J. S. Light

11.463[J] Structuring Low-Income Housing Projects in Developing Countries
Same subject as 4.236[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

See description under subject 4.236[J].

R. Goethert

11.466[J] Technology, Globalization, and Sustainable Development
Same subject as 1.813[J], 15.657[J], IDS.437[J]
Prereq: Permission of instructor
G (Fall)
3-0-9 units

See description under subject IDS.437[J].

N. Ashford

11.468[J] SIGUS Workshop
Same subject as 4.230[J]
Subject meets with 4.231
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit.

See description under subject 4.230[J].

R. Goethert

11.469 Urban Sociology in Theory and Practice
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units

Introduction to core writings in urban sociology. Explores the nature and changing character of the city and the urban experience, providing context for the development of urban studies research and planning skills. Topics include the changing nature of community, neighborhood effects, social capital and networks, social stratification, feminist theory and critical race theory, and the interaction of social structure and political power. Subject will take place in the Massachusetts Correctional Institution at Norfolk with half of the class from MIT and half of the class from MCI-Norfolk. Limited to 25.

J. Steil

11.470 The Politics of Development Policy
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units

Examines the political forces and conditions that affect urban, regional, and national development policymaking. Key protagonists include political parties, state actors, social movements, NGOs (domestic and global), business groups, and labor organizations, both formal and informal. Primary emphasis is the developing world, but seeks parallels across a variety of comparative and historical contexts.

Staff
11.472 D-Lab: Development
Same subject as EC.781
Subject meets with 11.025, EC.701
Prereq: None
G (Fall)
3-2-7 units
See description under subject EC.781. Enrollment limited by lottery; must attend first class session.
S. L. Hsu, A. B. Smith, B. Sanyal

11.474 D-Lab: Water, Sanitation and Hygiene
Subject meets with EC.715
Prereq: None
G (Fall)
3-0-9 units
Focuses on disseminating Water, Sanitation and Hygiene (WASH) or water/environment innovations in developing countries and underserved communities worldwide. Structured around field-based learning, case studies, lectures and videos in which teams propose an idea and are mentored through the process of bringing that innovation to fruition. Emphasizes core WASH and water/environment principles, culture-specific solutions, tools for start-ups, appropriate and sustainable technologies, behavior change, social marketing, building partnerships, and the theory and practice of innovation diffusion. Term project entails entering the IDEAS or other competition(s) while implementing a WASH innovation in a specific locale. Guest lectures on specific real-world WASH projects which have been disseminated by MIT faculty, students, alumni, and others. Students taking graduate version complete additional assignments. Limited to 30.
S. E. Murcott, S. L. Hsu

11.475 Navigating Power in Water and Sanitation Planning
Prereq: Open to undergraduates with permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units
Informs and prepares students to navigate the explicit and implicit power dynamics among stakeholders in decision-making processes that govern the planning and delivery of water and sanitation systems. Through investigations of organization, regulation, financing, physical delivery, and research designs, students examine the trajectory of decisions that shape and influence the accessibility, affordability, and adequacy of water and sanitation services, particularly in vulnerable neighborhoods in mostly urban and peri-urban areas. Emphasis is placed on the importance of moving beyond the limited dimensions of supply and demand studies and gaining fluency in the multiplicative political-economic and social factors driving choices in water and sanitation systems planning. In-depth, globally comparative readings inform the course, and expose basic services in water and sanitation as a misnomer.
G. Carolini

11.477 Urban Energy Systems and Policy
Same subject as 1.286
Subject meets with 11.165
Prereq: 11.203, 14.01, or permission of instructor
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units
Examines efforts in developing and advanced nations and regions. Examines key issues in the current and future development of urban energy systems, such as technology, use, behavior, regulation, climate change, and lack of access or energy poverty. Case studies on a diverse sampling of cities explore how prospective technologies and policies can be implemented. Includes intensive group research projects, discussion, and debate.
D. Hsu
**11.478 Behavior and Policy: Connections in Transportation**  
Subject meets with 11.158  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 units  
Examines the behavioral foundation for policy design using urban transportation examples. Introduces multiple frameworks for understanding behavior while contrasting the perspectives of classic economic theory with behavioral economics and social psychology. Suggests corresponding policy interventions and establishes a mapping across behavior, theory, and policy. Presents a spectrum of instruments for positively influencing behavior and improving welfare. Challenges students to critique, design, implement and interpret experiments that nudge travel behavior. Brings behavioral insights to creative design of transport policies that are efficient and equitable as well as simple, consistent, transparent, acceptable, and adaptive to behavioral changes. Students taking graduate version complete additional assignments.  
*J. Zhao*

**11.480 Urbanization and Development**  
Subject meets with 11.140  
Prereq: None  
G (Spring)  
Not offered regularly; consult department  
3-0-9 units  
Examines developmental dynamics of rapidly urbanizing locales, with a special focus on the developing world. Case studies from India, China, Mexico, Brazil, and South Africa form the basis for discussion of social, spatial, political and economic changes in cities spurred by the decline of industry, the rise of services, and the proliferation of urban mega projects. Emphasizes the challenges of growing urban inequality, environmental risk, citizen displacement, insufficient housing, and the lack of effective institutions for metropolitan governance. Students taking graduate version complete additional assignments.  
*Staff*

**11.481[J] Analyzing and Accounting for Regional Economic Change**  
Same subject as 1.284[J]  
Prereq: 14.03 and 14.04  
G (Spring)  
Not offered regularly; consult department  
3-0-9 units  
Surveys theories of regional growth, factor mobility, clustering, industrial restructuring, learning regions, and global supply chains from a political-economy perspective. Examines/critiques multipliers, linkages, and supply chains used to assess employment and environmental impacts, energy and infrastructure investments, and accounting issues related to the underground economy, work in the home, and environmental degradation. Assesses price indices, industrial location and employment measures, and shift-share analyses. Discussions of US and foreign applications.  
*Staff*

**11.482[J] Regional Socioeconomic Impact Analyses and Modeling**  
Same subject as 1.285[J]  
Prereq: 11.481[J] or permission of instructor  
G (Fall)  
Not offered regularly; consult department  
2-1-9 units  
Reviews regional economic theories and models and provides students with experience in using alternative economic impact assessment models on microcomputers. Problem sets are oriented around infrastructure, housing, energy, and environmental issues. Students work with a client generally in Boston and make a presentation to the client. Emphasis on written and oral presentation skills.  
*K. R. Polenske*

**11.483 Housing and Land Use in Rapidly Urbanizing Regions**  
Prereq: Permission of instructor  
G (Spring)  
Not offered regularly; consult department  
3-0-9 units  
Studies current urban controversies over affordable housing, land redevelopment, and public space, with special attention to property rights. Reviews how law, economics, sociology and planning theories frame these issues and interplays them with spatial approaches of urban design and geography. Explores cases that use property rights strategies to increase economic growth and social justice, providing insight for future design and policymaking. Topics include land trusts for affordable housing, mixed-use public space, and critical cartography.  
*Y. Hong*
11.484 Project Appraisal in Developing Countries
Subject meets with 11.144
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Covers techniques of financial analysis of investment expenditures, as well as the economic and distributive appraisal of development projects. Critical analysis of these tools in the political economy of international development is discussed. Topics include appraisal’s role in the project cycle, planning under conditions of uncertainty, constraints in data quality and the limits of rational analysis, and the coordination of an interdisciplinary appraisal team. Students taking graduate version complete additional assignments. Enrollment limited; preference to majors.
Y. Hong

11.485 Southern Urbanisms
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
2-0-10 units
Guides students in examining implicit and explicit values of diversity offered in "Southern" knowledge bases, theories, and practices of urban production. With a focus on Sub-Saharan Africa, considers why the South-centered location of the estimated global urban population boom obligates us to examine how cities work as they do, and why Western-informed urban theory and planning scholarship may be ill-suited to provide guidance on urban development there. Examines the "rise of the rest" and its implications for the making and remaking of expertise and norms in planning practice. Students engage with seminal texts from leading authors of Southern urbanism and critical themes, including the rise of Southern theory, African urbanism, Chinese international cooperation, Brazilian urban diplomacy, and the globally-driven commodification of urban real estate.
G. Carolini

11.487 Budgeting and Finance for the Public Sector
Subject meets with 11.147
Prereq: None
G (Spring)
3-0-9 units
Examines globally relevant challenges of adequately and effectively attending to public sector responsibilities for basic services with limited resources. Particular attention to the contexts of fiscal crises and rapid population growth, as well as shrinkage, through an introduction to methods and processes of budgeting, accounting, and financial mobilization. Case studies and practice exercises explore revenue strategies, demonstrate fiscal analytical competencies, and familiarize students with pioneering examples of promising budget and accounting processes and innovative funding mobilization via taxation, capital markets, and other mechanisms (e.g., land-value capture). Students taking graduate version explore the subject in greater depth.
G. Carolini

11.488 Urban Development in Conflict Cities: Planning Challenges and Policy Innovations
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 units
Economic, religious, gender and ethnic differences must be negotiated every day in the urban arena. When tensions and conflict escalate into violence, the urban space becomes the battlespace in which these tensions are negotiated. Examines urban development challenges in conflict cities through multiple disciplinary perspectives on urban conflict. Review of the literature about when violence and cities intersect. Focuses on policy innovations, and an examination of potential planning, design, and policy solutions.
Staff

11.490 Law and Development
Prereq: Permission of instructor
Acad Year 2019-2020: G (Spring)
Acad Year 2020-2021: Not offered
2-0-10 units
Examines the role of law in development and introduces economic and legal theories. Topics include formality/informality of property, contracts and bargaining in the shadow of the law, institutions for transparency and accountability, legitimation of law, sequencing of legal reform, and international economic law aspects. Studies the roles of property rights in economic development, the judiciary and the bureaucracy in development, and law in aid policy. Includes selected country case studies. Limited to 15.
B. Rajagopal
Same subject as 17.176[J]
Prereq: 11.701
G (Fall)
Not offered regularly; consult department
3-0-9 units

Examines the process of economic development to understand why some countries or regions within countries have increased their incomes and reduced their poverty faster than others. Economic development is treated as a process of learning, as countries weigh theories and role models as guides for policy formulation and institution building. Historical and empirical examination of three role models for development/underdevelopment, as formulated by the Third World’s new intelligentsia that emerged after decolonization: the OPEC development role model, the East Asian role model, and the Brazilian role model.

Staff

11.493 Property and Land Use Law for Planners
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Examines legal and institutional arrangements for the establishment, transfer, and control over property and land under American and selected comparative systems, including India and South Africa. Focuses on key issues of property and land use law regarding planning and economic development. Emphasizes just and efficient resource use; institutional, entitlement and social relational approaches to property; distributional and other social aspects; and the relationship between property, culture, and democracy.

B. Rajagopal

11.495 Governance and Law in Developing Countries
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
2-0-10 units

Examines the multiple dimensions of governance in international development with a focus on the role of legal norms and institutions in the balance between state and the market. Analyzes changes in the distribution of political and legal authority as a result of economic globalization. Topics include the regulation of firms; forms of state and non-state monitoring; varieties of capitalism, global governance and development; and good governance, including transparency and accountability mechanisms, the role of the judiciary and legal culture, and tools for measuring governance performance.

B. Rajagopal

11.496 Law, Social Movements, and Public Policy: Comparative and International Experience
Subject meets with 11.166
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units

Studies the interaction between law, courts, and social movements in shaping domestic and global public policy. Examines how groups mobilize to use law to affect change and why they succeed and fail. Case studies explore the interplay between law, social movements, and public policy in current issues, such as gender, race, labor, trade, climate change/environment, and LGBTQ rights. Introduces theories of public policy, social movements, law and society, and transnational studies. Students taking graduate version complete additional assignments. Limited to 15.

B. Rajagopal

11.497 Human Rights at Home and Abroad
Subject meets with 11.164[J], 17.391[J]
Prereq: None
Acad Year 2019-2020: G (Fall)
Acad Year 2020-2021: Not offered
2-0-10 units

Provides a rigorous and critical introduction to the history, foundation, structure, and operation of the human rights movement. Focuses on key ideas, actors, methods and sources, and critically evaluates the field. Addresses current debates in human rights, including the relationship with security, democracy, development and globalization, urbanization, equality (in housing and other economic and social rights; women's rights; ethnic, religious and racial discrimination; and policing/conflict), post-conflict rebuilding and transitional justice, and technology in human rights activism. Students taking graduate version expected to write a research paper.

B. Rajagopal

11.499 Master of Science in Real Estate Development Thesis Preparation
Prereq: None
G (Spring; first half of term)
2-0-1 units

Seminar provides students with a concise overview of the requirements for thesis writing and submission. Covers types of theses, COUHES requirements, formatting and submission requirements and stipulations. Culminates in submission of thesis proposal.

Staff
11.520 Workshop on Geographic Information Systems
Prereq: 11.205 or permission of instructor
G (Fall, Spring; second half of term)
2-2-2 units

An introduction to geographic information systems (GIS) as applied to urban and regional planning, community development, and local government. Emphasis on learning GIS technology and spatial analysis techniques through extensive hands-on exercises using real-world data sets such as the US census of population and housing. Includes a small project on an urban planning problem involving the selection of appropriate methods, the use of primary and secondary data, computer-based modeling, and spatial analysis. Enrollment limited; preference to MCP students.

S. Williams, J. Ferreira

11.521 Spatial Database Management and Advanced Geographic Information Systems
Prereq: 11.205 and Coreq: 11.220; or permission of instructor
G (Spring)
3-3-6 units
Credit cannot also be received for 11.523, 11.524

Extends the computing and geographic information systems (GIS) skills developed in 11.520 to include spatial data management in client/server environments and advanced GIS techniques. First half covers the content of 11.523, introducing database management concepts, SQL (Structured Query Language), and enterprise-class database management software. Second half explores advanced features and the customization features of GIS software that perform analyses for decision support that go beyond basic thematic mapping. Includes the half-term GIS project of 11.524 that studies a real-world planning issue.

J. Ferreira

11.522 Research Seminar on Urban Information Systems
Prereq: 11.521 or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-4-6 units
Can be repeated for credit.

Advanced research seminar enhances computer and analytic skills developed in other subjects in this sequence. Students present a structured discussion of journal articles representative of their current research interests involving urban information systems and complete a short research project. Suggested research projects include topics related to ongoing UIS Group research.

J. Ferreira

11.523 Fundamentals of Spatial Database Management
Prereq: Permission of instructor
G (Spring; first half of term)
2-2-2 units
Credit cannot also be received for 11.521, 11.524

The fundamentals of database management systems as applied to spatial analysis. Includes extensive hands-on exercises using real-world planning data. Introduces database management concepts, SQL (Structured Query Language), and enterprise-class database software. Same content as first half of 11.521.

J. Ferreira

11.524 Advanced Geographic Information System Project
Prereq: 11.523 or permission of instructor
G (Spring; second half of term)
Units arranged
Can be repeated for credit. Credit cannot also be received for 11.521, 11.523

Learning and utilizing advanced geographic information system techniques in studio/lab setting with real-world client problem and complex digital spatial data infrastructure. Projects typically use the client and infrastructure setting for 11.521. Credit cannot also be received for 11.521 in the same term.

J. Ferreira

11.526[J] Comparative Land Use and Transportation Planning
Same subject as 1.251[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Focuses on the integration of land use and transportation planning, drawing from cases in both industrialized and developing countries. Reviews underlying theories, analytical techniques, and the empirical evidence of the land use-transportation relationship at the metropolitan, intra-metropolitan, and micro-scales. Also covers the various ways of measuring urban structure, form, and the “built environment.” Develops students’ skills to assess relevant policies, interventions and impacts.

C. Zegras
11.527 Advanced Seminar in Transportation Finance
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
2-1-9 units

Focuses on the theory and practice of transportation system finance, examining the range of relevant topics including basic public finance, politics, institutional structures, externalities, pricing, and the role of advanced technologies. Primarily oriented around land-based, surface transportation, although in their research students are welcome to examine air and maritime modes according to their interests. Explores issues across a range of contexts, including North America, Europe, Latin America, and Asia.

C. Zegras

11.528 Transportation and Urban Development Workshop
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
Units arranged

Combines class- and field-based learning and applications and includes four basic parts: knowledge of the context (field study); global knowledge of urban development-transportation integration (e.g., in-depth case studies); application of the global knowledge to specific field site(s); generalization of application(s) to potential sites across the metropolitan area. Over the course the term, students have the opportunity to deepen their knowledge of the local context; develop an understanding of how urban development and transportation can be viably integrated, generally; design proposals for specific sites; develop the business and social and development cases for the sites; and craft a plan to better integrate urban development and transportation in the metropolitan area, involving local authorities, private investors, and citizens.

C. Zegras

11.533 Ecological Planning with GIS
Prereq: 11.205
G (Spring)
Not offered regularly; consult department
3-3-6 units

Provides a practical introduction to spatial environmental assessment and planning methods, from landscape to regional scales. Lectures and discussions focus on key concepts in landscape ecology as well as the data and methods needed to incorporate these concepts in environmental planning. Weekly lab exercises demonstrate how natural systems are represented in modern geographic information systems, how to synthesize information using overlay analysis and suitability modeling, and design methods that build on the resulting syntheses. Features raster GIS analysis methods.

Staff

11.543[J] Transportation Policy, the Environment, and Livable Communities
Same subject as 1.253[J]
Prereq: Permission of instructor
G (Spring)
3-0-9 units

Examines the economic and political conflict between transportation and the environment. Investigates the role of government regulation, green business and transportation policy as a facilitator of economic development and environmental sustainability. Analyzes a variety of international policy problems, including government-business relations, the role of interest groups, non-governmental organizations, and the public and media in the regulation of the automobile; sustainable development; global warming; politics of risk and siting of transport facilities; environmental justice; equity; as well as transportation and public health in the urban metropolis. Provides students with an opportunity to apply transportation and planning methods to develop policy alternatives in the context of environmental politics. Students taking graduate version complete additional assignments.

J. Coughlin

Same subject as 1.200[J]
Prereq: 1.010 and permission of instructor
G (Spring)
3-1-8 units

See description under subject 1.200[J].

C. Osorio
11.545[J] Transportation Systems Analysis: Demand and Economics
Same subject as 1.201[J]
Prereq: Permission of instructor
G (Spring)
3-1-8 units
See description under subject 1.201[J].
Staff

11.601 Introduction to Environmental Policy and Planning
Prereq: None
G (Fall)
3-0-9 units
Required introductory subject for graduate students pursuing environmental policy and planning as their specialization in the MCP Program. Also open to other graduate students interested in environmental policymaking and the practice of environmental planning. Taught comparatively, with numerous references to examples from around the world. Four major areas of focus: National Environmental Policymaking, Environmental Ethics, Environmental Forecasting and Analysis Techniques, and Strategies for Collaborative Decision-making.
L. Susskind

11.630[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
Same subject as 1.811[J], 15.663[J], IDS.540[J]
Subject meets with 1.801[J], 11.021[J], 17.393[J], IDS.060[J], IDS.436[J]
Prereq: IDS.540[J] or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Focuses on policy design and evaluation in the regulation of hazardous substances and processes. Includes risk assessment, industrial chemicals, pesticides, food contaminants, pharmaceuticals, radiation and radioactive wastes, product safety, workplace hazards, indoor air pollution, biotechnology, victims' compensation, and administrative law. Health and economic consequences of regulation, as well as its potential to spur technological change, are discussed for each regulator regime. Students taking the graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart

11.631[J] Regulation of Chemicals, Radiation, and Biotechnology
Same subject as 1.812[J], IDS.541[J]
Subject meets with 1.802[J], 10.805[J], 11.022[J], IDS.061[J], IDS.436[J]
Prereq: IDS.540[J] or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 units
Focuses on policy design and evaluation in the regulation of hazardous substances and processes. Includes risk assessment, industrial chemicals, pesticides, food contaminants, pharmaceuticals, radiation and radioactive wastes, product safety, workplace hazards, indoor air pollution, biotechnology, victims' compensation, and administrative law. Health and economic consequences of regulation, as well as its potential to spur technological change, are discussed for each regulator regime. Students taking the graduate version are expected to explore the subject in greater depth.
N. Ashford, C. Caldart

11.701 Introduction to International Development Planning
Prereq: None
G (Fall)
3-0-9 units
Studies interactions between planners and institutions at different scales, from local to global/transnational. Emphasizes historical and institutional approaches to development planning. Includes an overview of theories of development, actors, organizational arrangements, and implementation mechanisms. Covers current topics in development planning, such as migration, participatory planning, urban-rural linkages, corruption, legal institutions and post-conflict development. Analyzes various roles planners play in different institutional contexts. Restricted to first-year MCP and SPURS students.
B. Rajagopal
Tutorials, Research, and Fieldwork Subjects

11.800 Reading, Writing and Research
Prereq: 11.233; Coreq: 11.801
G (Spring)
3-0-6 units

Required subject intended solely for 1st-year DUSP PhD students. Develops capacity of doctoral students to become independent scholars by helping them to prepare their first-year papers and plan for their dissertation work. Focuses on the process by which theory, research questions, literature reviews, and new data are synthesized into new and original contributions to the literature. Seminar is conducted with intensive discussions, draft writing, peer review, revisions, and editing. Guest speakers from faculty and advanced students discuss strategies and potential pitfalls with doctoral-level research.
D. Hsu

11.801 Doctoral Research Paper
Prereq: None. Coreq: 11.800; permission of instructor
G (Spring)
3-0-6 units

Students develop a first-year research paper in consultation with their advisor.

Staff

11.901 Independent Study: Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Opportunity for independent study under regular supervision by a faculty member.

Staff

11.902 Independent Study: Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Opportunity for independent study under regular supervision by a faculty member.

Staff

11.903 Supervised Readings in Urban Studies
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Reading and discussion of topics in urban studies and planning.

Staff

11.904 Supervised Readings in Urban Studies
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit.

Reading and discussion of topics in urban studies and planning.

Staff

11.905 Research Seminar in Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.

Special research issues in urban planning.

Staff

11.906 Research Seminar in Urban Studies and Planning
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Special research issues in urban planning.

Staff

11.907 Urban Fieldwork
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Practical application of planning techniques to towns, cities, and regions, including problems of replanning, redevelopment, and renewal of existing communities. Includes internships, under staff supervision, in municipal and state agencies and departments.

Staff
11.908 Urban Fieldwork  
Prereq: None  
G (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit.

Practical application of planning techniques to towns, cities, and regions, including problems of replanning, redevelopment, and renewal of existing communities. Includes internships, under staff supervision, in municipal and state agencies and departments.  
Staff

11.909 Graduate Tutorial  
Prereq: None  
G (Fall)  
Units arranged [P/D/F]  
Can be repeated for credit.

Planned programs of instruction for a minimum of three students on a planning topic not covered in regular subjects of instruction. Registration subject to prior arrangement with appropriate faculty member.  
Staff

11.910 Doctoral Tutorial  
Prereq: None  
G (Fall)  
3-0-3 units  
Required subject exclusively for first-year DUSP PhD candidates, but with multiple colloquium sessions open to the full department community. Introduces students to a range of department faculty (and others) by offering opportunities to discuss applications of planning theory and planning history. Assists in clarifying the departments intellectual diversity. Encourages development of a personal intellectual voice and capacity to synthesize and respond to the arguments made by others.  
L. Vale, J. Zhao

11.912[J] Advanced Urbanism Colloquium (New)  
Same subject as 4.275[J]  
Prereq: Permission of instructor  
G (Fall, Spring)  
1-1-1 units  
Can be repeated for credit.

See description under subject 4.275[J]. Preference to doctoral students in the Advanced Urbanism concentration.  
Consult J. Wescoat

11.920 Planning in Practice  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.

Familiarizes students with the practice of planning, by requiring actual experience in professional internship placements. Requires students to both apply what they are learning in their classes in an actual professional setting and to reflect, using a variety of platforms, on the learning personal and professional - growing out of their internship experience. Through readings, practical experience and reflection, empirical observation, and contact with practitioners, students gain deeper general understanding of the practice of the profession.  
M. J. Daly

11.960 Independent Study: Real Estate  
Prereq: None  
G (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.

Opportunity for independent study under regular supervision by a faculty member.  
Staff

11.961 Independent Study: Real Estate  
Prereq: None  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit.

Opportunity for independent study under regular supervision by a faculty member.  
Staff

11.962 Fieldwork: Real Estate  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit.

Practical application of real estate techniques in the field.  
Staff
11.963 Independent Study: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.
Opportunity for independent study under regular supervision by a faculty member.
Staff

11.964 Independent Study: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.
Opportunity for independent study under regular supervision by a faculty member.
Staff

11.985 Summer Field Work
Prereq: None
G (Summer)
Units arranged [P/D/F]
Practical application of planning techniques over the summer with prior arrangement.
S. Wellford

11.5938 Special Subject: Urban Studies and Planning
Prereq: None
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit.
For graduate students wishing to pursue further study in advanced areas of urban studies and planning not covered in regular subjects of instruction.
Staff

11.5940-11.5944 Special Subject: Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit.
For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
M. Kothari

11.5948 Special Subject: Urban Studies and Planning
Prereq: Permission of instructor
G (Spring)
Units arranged
Can be repeated for credit.
For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

11.5945-11.5949 Special Subject: Urban Studies and Planning
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
Units arranged
Can be repeated for credit.
For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

11.5950-11.5957 Special Seminar: Urban Studies and Planning
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F]
Can be repeated for credit.
For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

S. Wellford
11.S958 Special Seminar: Urban Studies and Planning
Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F]
Can be repeated for credit.

For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

11.S965 Special Subject: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of real estate not covered in regular subjects of instruction.
Staff

11.S966 Special Subject: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of real estate not covered in regular subjects of instruction.
Staff

11.S967 Special Subject: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of real estate not covered in regular subjects of instruction.
Staff

11.S968 Special Seminar: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer; second half of term)
Units arranged [P/D/F]
Can be repeated for credit.

Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of real estate not covered in regular subjects of instruction.
Staff

11.S969 Special Seminar: Real Estate
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit.

Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of real estate not covered in regular subjects of instruction.
Staff

11.S970 Special Seminar: Real Estate
Prereq: Permission of instructor
G (Fall, Spring; second half of term)
Units arranged [P/D/F]
Can be repeated for credit.

Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of real estate not covered in regular subjects of instruction.
Staff

11.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Program of research and writing of thesis; to be arranged by the student with supervising committee.
Staff
WOMEN'S AND GENDER STUDIES (WGS)

Consult the program office, 14E-316, for information about other subjects that may qualify for WGS credit.

Undergraduate Subjects

WGS.101 Introduction to Women's and Gender Studies
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H; CI-H

Drawing on multiple disciplines - such as literature, history, economics, psychology, philosophy, political science, anthropology, media studies and the arts - to examine cultural assumptions about sex, gender, and sexuality. Integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the ways sex and gender interact with race, class, nationality, and other social identities. Students are introduced to recent scholarship on gender and its implications for traditional disciplines.
A. Walsh

WGS.109 Women and Global Activism in Media and Politics
Prereq: None
U (Spring)
3-0-9 units. HASS-H; CI-H

An interdisciplinary subject that examines questions of feminism, international women's issues, and globalization through the study of novels, films, critical essays, painting and music. Considers how women redefine the notions of community and nation, how development affects their lives, and how access to the internet and to the production industry impacts women's lives. Primary topics of interest include transformations of traditional values, social change, gender role distribution, identity formation, migration flows, globalization and development, popular culture, urban life, cyberculture, activism, and human rights. Limited to 25 when Writing Tutor is assigned to the class. Otherwise, limited to 18.
A. Sur

WGS.110[J] Sexual and Gender Identities
Same subject as 21H.108[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H

Provides an introduction to the history of gender, sex, and sexuality in the modern United States, from the end of the 19th century to the present. Surveys historical approaches to the field, emphasizing the changing nature of sexual and gender identities over time. Traces attempts to control, construct, and contain sexual and gender identities. Examines the efforts of those who worked to resist, reject, and reform institutionalized heterosexuality and mainstream configurations of gendered power.
K. Surkan

WGS.111[J] Gender and Media Studies
Same subject as CMS.619[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Examines representations of race, gender, and sexual identity in the media. Considers issues of authorship, spectatorship, and the ways in which various media (film, television, print journalism, advertising) enable, facilitate, and challenge these social constructions in society. Studies the impact of new media and digital media through analysis of gendered and racialized language and embodiment online in blogs and vlogs, avatars, and in the construction of cyberidentities. Provides introduction to feminist approaches to media studies by drawing from work in feminist film theory, cultural studies, gender and politics, and cyberfeminism.
K. Surkan

WGS.115 Gender and Technology
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H

Considers a wide range of issues related to the contemporary and historical use of technology, the development of new technologies, and the cultural representation of technology, including the role women have played in the development of technology and the effect of technological change on the roles of women and ideas of gender. Discusses the social implications of technology and its understanding and deployment in different cultural contexts. Investigates the relationships between technology and identity categories, such as gender, race, class, and sexuality. Examines how technology offers possibilities for new social relations and how to evaluate them.
Staff
WGS.118 Gender in the Visual Arts (New)
Prereq: None
U (Spring)
3-0-9 units. HASS-A
Survey course investigates issues central to theorizations of gender and technology in the visual arts and moving images in the 20th and 21st centuries. Through readings, screenings, and formal analyses of a broad range of visual media, students examine the primary visual, aural and narrative conventions by which social and political forces shape perceptions and experiences of gender, sexuality, and race while considering broader questions related to the contemporary artistic and media landscape. Culminates in a student collaborative multi-media exhibition or moving image festival.
J. Lee

WGS.123 The History of Women in Science and Engineering
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-H
Provides a basic overview of the history of women in science, technology, engineering, and mathematics (STEM). Students discuss specific contributions of women across a variety of disciplines to form a broad perspective on how these contributions played a larger role in the advancement of human knowledge and technological achievement. Also grapples with how both historic and modern biases within the STEM disciplines, as well as in representations of women and girls in media and popular culture, can affect outcomes in these areas.
M. Weinstock

WGS.125[J] Games and Culture
Same subject as 21W.768[J], CMS.616[J]
Subject meets with CMS.868
Prereq: None
U (Fall)
3-0-9 units. HASS-S
See description under subject CMS.616[J].
T. L. Taylor

WGS.140[J] Race and Identity in American Literature
Same subject as 21L.504[J]
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
Can be repeated for credit.
See description under subject 21L.504[J].
J. Terrones

WGS.141[J] International Women's Voices
Same subject as 21G.022[J], 21L.522[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
See description under subject 21L.522[J].
M. Resnick

WGS.142 Narrative and Identity: Writing and Film by Contemporary Women of Color
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Explores the diverse voices and experiences reflected in writing and film by and about women of color. Examines the roles that culture, community, and kinship play in the development of the writer's individual voice, and compares the similarities and differences of the writer experience across texts and genres. Discussion and assignments, including an independent research presentation, consider the social and political contexts that inform each work, with an emphasis on gender, race, and economic status. Includes works by a variety of novelists, poets, and filmmakers.
S. E. King

WGS.145[J] Globalization: The Good, the Bad and the In-Between
Same subject as 21L.020[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
See description under subject 21L.020[J]. Enrollment limited.
M. Resnick

WGS.151 Gender, Medicine, and Public Health
Prereq: None
U (Fall)
3-0-9 units. HASS-S
Draws on different disciplines, conceptual frameworks, and methodological approaches to examine gender in relation to health, including public health practice, epidemiologic research, health policy, and clinical application. Discusses a variety of health-related issues that illustrate global, international, domestic, and historical perspectives. Considers other social determinants of health as well, including social class and race. Limited to 25.
B. Charlton
WGS.154[J] Gender and Japanese Popular Culture
Same subject as 21A.143[J], 21G.039[J]
Subject meets with 21G.591
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
See description under subject 21G.039[J].  
I. Condry

WGS.160[J] Science Activism: Gender, Race, and Power (New)
Same subject as STS.021[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-E
Examines the role scientists have played as activists in social movements in the US following World War II. Themes include scientific responsibility and social justice, the motivation of individual scientists, strategies for organizing, the significance of race and gender, and scientists' impact within social movements. Case studies include atmospheric testing of nuclear weapons and the nuclear freeze campaign, climate science and environmental justice, the civil rights movement, Vietnam War protests, the March 4 movement at MIT, and concerns about genetic engineering, gender equality, intersectional feminism, and student activism at MIT.  
E. Bertschinger

WGS.161[J] Gender and the Law in US History
Same subject as 21H.320[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H
See description under subject 21H.320[J].  
C. Capozzola

WGS.172[J] For Love and Money: Rethinking the Family
Same subject as 21A.111[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-S
See description under subject 21A.111[J].  
H. Paxson

WGS.181 Queer Cinema and Visual Culture
Prereq: None
U (Fall)
3-0-9 units. HASS-H
Analyzes mainstream, popular films produced in the post-WWII 20th century US as cultural texts that shed light on ongoing historical struggles over gender identity and appropriate sexual behaviors. Traces the history of LGBTQ/queer film through the 20th and into the 21st century. Examines the effect of the Hollywood Production Code and censorship of sexual themes and content, and the subsequent subversion of queer cultural production in embedded codes and metaphors. Also considers the significance of these films as artifacts and examples of various aspects of queer theory.  
K. Surkan

WGS.190[J] Black Matters: Introduction to Black Studies
Same subject as 24.912[J], 21H.106[J], 21L.008[J], 21W.741[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-A, HASS-H; CI-H
See description under subject 24.912[J].  
M. Degraff

WGS.220[J] Women and Gender in the Middle East and North Africa
Same subject as 21H.263[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Provides an overview of key issues and themes in the study of women and gender relations in the Middle East and North Africa. Includes readings from a variety of disciplines, e.g., history, anthropology, sociology, literature, religious studies, and media studies. Addresses themes such as the relationship between the concepts of nation and gender; women's citizenship; Middle Eastern women's activism and the involvement of their Western "sisters" to this movement; gendered interpretations of the Qur'an and the example of the Prophet Muhammad; and the three H's of Orientalism (hijab, harem, and hamam).  
L. Eckmekcioglu
WGS.221 Women in the Developing World
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-S
Can be repeated for credit.
Study of women and gender in the developing world. Interdisciplinary approaches highlight relationships between gender and public policy, economics, art, education, health care, and scientific research. Topics vary by term.
A. Sur

WGS.222 Women and War
Same subject as 21H.381
Prereq: None
U (Fall)
3-0-9 units. HASS-S
See description under subject 21H.381.
L. Ekmekcioglu

WGS.224 Race, Gender and Social Inequality: Reproductive Health Care in the United States
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Explores the politics of reproductive health care delivery in the United States, with a particular focus on how clinical care is shaped by--and, in turn, shapes--social inequality along axes of race and gender. Considers a variety of reproductive health issues from multiple perspectives, drawing on readings from the fields of history, anthropology, sociology, medicine, epidemiology, and law. Develops skills to interrogate how each field conceptualizes and values reproductive health, both explicitly and implicitly. Introduces major conceptual issues foundational to understanding the politics of reproduction. Goes on to cover topics such as the human biofemale reproductive lifecycle and social movements explicitly organized around reproductive health. Limited to 40.
E. Janiak

WGS.225 The Science of Race, Sex, and Gender
Same subject as 21A.103, STS.046
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Examines the role of science and medicine in the origins and evolution of the concepts of race, sex, and gender from the 17th century to the present. Focus on how biological, anthropological, and medical concepts intersect with social, cultural, and political ideas about racial, sexual, and gender difference in the US and globally. Approach is historical and comparative across disciplines emphasizing the different modes of explanation and use of evidence in each field.
A. Sur

WGS.226 Science, Gender and Social Inequality in the Developing World
Same subject as STS.023
Prereq: None
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
Examines the influence of social and cultural determinants (colonialism, nationalism, class, and gender) on modern science and technology. Discusses the relationship of scientific progress to colonial expansions and nationalist aspirations. Explores the nature of scientific institutions within a social, cultural, and political context, and how science and technology have impacted developing societies.
A. Sur

WGS.228 Psychology of Sex and Gender
Prereq: None
U (Fall)
3-0-9 units. HASS-S
Examines evidence (and lack thereof) regarding when and how an individual’s thoughts, feelings, and actions are affected by sex and gender. Using a biopsychosocial model, reviews the following topics: gender identity development across the lifespan, implicit and explicit bias, achievement, stereotypes, physical and mental health, sexuality, interpersonal relationships, work, and violence. Limited to 20.
C. Kapungu
WGS.229 Race, Culture, and Gender in the US and Beyond: A Psychological Perspective
Prereq: None
U (Spring)
3-0-9 units. HASS-S
Examines the biopsychosocial factors which impact racial-ethnic identity, racial and cultural socialization, and experiences of prejudice, bias, discrimination, and racial microaggressions across gender identities. Reviews topics in multicultural psychology from the lens of challenging ethnocentric biases in the field. Critically evaluates the intersection of race with other social identities (e.g., gender, sexual identity, and socioeconomic status) and how it impacts human behavior. Using a case study approach, students integrate empirical evidence from international psychosocial research on oppression in order to provide more breadth in understanding the influence of race and gender upon human behavior. Develops multicultural competency skills essential for practice in clinical and non-clinical organizational settings. Limited to 25.
C. Kapungu

WGS.231[J] Writing about Race
Same subject as 21W.742[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-H; CI-H
See description under subject 21W.742[J]. Enrollment limited.
K. Ragusa

WGS.232[J] The Making of the Latin American City: Culture, Gender, and Citizenship (New)
Same subject as 21G.732[J]
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
See description under subject 21G.732[J].
P. Duong

WGS.233[J] New Culture of Gender: Queer France
Same subject as 21G.325[J]
Prereq: One intermediate subject in French
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H
Can be repeated for credit.
See description under subject 21G.325[J].
B. Perreau

WGS.234[J] The Invention of French Theory: A History of Transatlantic Intellectual Life since 1945
Same subject as 21G.068[J]
Prereq: None
Acad Year 2019-2020: U (Spring)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
See description under subject 21G.068[J].
B. Perreau

WGS.235[J] Classics of Chinese Literature in Translation
Same subject as 21G.044[J]
Subject meets with 21G.195
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-H
See description under subject 21G.044[J].
E. Teng

WGS.236[J] Introduction to East Asian Cultures: From Zen to K-Pop
Same subject as 21G.030[J]
Subject meets with 21G.193
Prereq: None
U (Fall)
3-0-9 units. HASS-H
See description under subject 21G.030[J].
E. Teng

WGS.238[J] Intersectional Feminist Memoir (New)
Same subject as 21W.738[J]
Prereq: None
U (Fall, Spring)
3-0-9 units. HASS-H
Explores the memoir genre through a feminist intersectional lens, looking at the ways in which feminist writers ground personal experience within a complex understanding of race, gender, sexuality, class, ethnicity, immigration status/nationality, and dis/ability. Gives particular attention to the relationships between the personal and the political; form and content; fact, truth, and imagination; self and community; trauma and healing; coming to voice and breaking silence. Readings include books by Audre Lorde, Janet Mock, Daisy Hernandez, Jessica Valenti, and Ariel Gore, and shorter pieces by Meena Alexander and Leah Lakshmi Piepzna-Samarasinha. Drawing on lessons taken from these works, students write a short memoir of their own.
K. Ragusa
WGS.240 Jane Austen
Same subject as 21L.473
Prereq: One subject in Literature
Acad Year 2019-2020: U (Fall)
Acad Year 2020-2021: Not offered
3-0-9 units. HASS-H
See description under subject 21L.473.
R. Perry

WGS.242 The Latina Experience in Literature, Film and Popular Culture
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H
Explores the rich diversity of Latina and Latino voices and experiences as reflected in various media. Studies cross-cultural expressions of solidarity and examines the Latina experience as it relates to both other women of color and Latino men. Considers how Latinas are represented by mainstream Hollywood and independent filmmakers, and explores the intersections of popular culture and feminism in productions such as music videos and Latina-centered television series. Limited to 30.
S. E. King

WGS.245 Identities and Intersections: Queer Literatures
Same subject as 21L.480
Prereq: None
U (Spring)
3-0-9 units. HASS-H
Focuses on LGBT literature from the mid-19 century to the present, with an emphasis on fiction and poetry. In particular, analyzes how LGBT identities and their literary representations have changed over time. Covers authors such as Walt Whitman, Oscar Wilde, Virginia Woolf, James Baldwin, Audre Lorde, Cherrie Moraga, Melvin Dixon, Leslie Feinberg, and Luis Negron.
J. Terrones

WGS.250 HIV/AIDS in American Culture
Prereq: None
U (Fall)
3-0-9 units. HASS-H
Examines cultural responses to HIV/AIDS in the US during the first fifteen years of the epidemic, prior to the advent of highly active antiretroviral therapy. Students consider how sexuality, race, gender, class, and geography shaped the experience of HIV/AIDS and the cultural production surrounding it, as well as the legacy of this cultural production as it pertains to the communities most at risk today. Materials include mainstream press coverage, film, theater, television, popular music, comic books, literature, and visual art.
J. Terrones

WGS.270 Violence, Human Rights, and Justice
Same subject as 11.135
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 units. HASS-S
See description under subject 11.135.
E. C. James

WGS.271 Dilemmas in Biomedical Ethics: Playing God or Doing Good?
Same subject as 11.133, 21A.302
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Fall)
3-0-9 units. HASS-S
See description under subject 11.133.
E. C. James

WGS.274 Images of Asian Women: Dragon Ladies and Lotus Blossoms
Same subject as 21A.141, 21G.048
Prereq: None
U (Spring)
3-0-9 units. HASS-S
See description under subject 21A.141.
M. Buyandelger
WGS.275[J] Gender, Race, and Environmental Justice
Same subject as 21G.057[J], STS.022[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: U (Spring)
3-0-9 units. HASS-H
See description under subject 21G.057[J]. Limited to 18.
B. Stoetzer

WGS.276[J] Cultures of Computing
Same subject as 21A.504[J], STS.086[J]
Prereq: None
U (Fall)
3-0-9 units. HASS-S
See description under subject 21A.504[J].
Staff

WGS.301[J] Feminist Thought
Same subject as 17.007[J], 24.237[J]
Subject meets with 17.006[J], 24.637[J]
Prereq: None
U (Spring)
3-0-9 units. HASS-H

Analyzes theories of gender and politics, especially ideologies of gender and their construction; definitions of public and private spheres; gender issues in citizenship, the development of the welfare state, experiences of war and revolution, class formation, and the politics of sexuality. Graduate students are expected to pursue the subject in greater depth through reading and individual research.
E. Wood

WGS.310[J] Gender
Same subject as 21H.983[J]
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Spring)
3-0-9 units

See description under subject 21H.983[J].
L. Ekmekcioglu, E. Wood

Same subject as 21G.344[J]
Prereq: One intermediate subject in French or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 units. HASS-H
See description under subject 21G.344[J]. Limited to 18.
B. Perreau

WGS.400 WGS Undergraduate Independent Study
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit.

Individual supervised work for undergraduate students who wish to study topics not covered in the regular Women's and Gender Studies curriculum. Before registering for this subject, students must plan a course of study with a member of the WGS faculty and secure the Director's approval. Normal maximum credit is 6 units, but exceptional 9-unit projects occasionally approved.
Staff

WGS.UR Undergraduate Research in Women's and Gender Studies
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit.

Undergraduate research opportunities in the Women's and Gender Studies Program.
Staff

WGS.URG Undergraduate Research in Women's and Gender Studies
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit.

Undergraduate research opportunities in the Women's and Gender Studies Program.
Staff
WGS.510 Special Subject in Women’s and Gender Studies
Prereq: None
U (Fall, Spring)
3-0-9 units
Can be repeated for credit.

Covers topics not included in regular curriculum; taught in seminar format. May be repeated for credit with permission of instructor.
M. Weinstock, KJ Brown

Graduate Subjects

WGS.600 Workshop for Dissertation Writers in Women’s and Gender Studies
Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall, Spring)
3-0-9 units

Addresses the main challenges faced by dissertation writers: isolation, writing schedules, and cogent arguments. Opportunity for members to exchange ideas and experiences, learn general principles of academic argument, and receive feedback. Open to graduate students in all phases of dissertation writing. Meets bi-weekly, spans Fall and Spring terms. Limited to 10.
Consult Graduate Consortium in Women’s Studies

WGS.605 WGS Graduate Independent Study
Prereq: Permission of instructor
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall, Spring)
Units arranged
Can be repeated for credit.

Individual supervised work for graduate students who wish to study topics not covered in the regular Women’s and Gender Studies offerings. Before registering for this subject, students must plan a course of study with a member of the Women’s and Gender Studies faculty and secure the Director’s approval. Normal maximum is 6 units; exceptional 9-unit projects occasionally approved.
Staff

WGS.610 Seminar in Feminist Issues
Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall)
3-0-9 units
Can be repeated for credit.

Syllabi vary depending on instructors. Limited to 10.
Information: Graduate Consortium in Women’s Studies

WGS.615 Feminist Inquiry: Strategies for Effective Scholarship
Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall)
3-0-9 units
Can be repeated for credit.

Investigates theories and practices of feminist inquiry across a range of disciplines. Feminist research involves rethinking disciplinary assumptions and methodologies, developing new understandings of what counts as knowledge, seeking alternative ways of understanding the origins of problems/issues, formulating new ways of asking questions and redefining the relationship between subjects and objects of study. Focus on methodology, i.e., the theory and analysis of how research should proceed. Special attention to epistemological issues--pre-suppositions about the nature of knowledge. What makes research distinctively feminist lies in the complex connections between epistemologies, methodologies and research methods. Explore how these connections are formed in the traditional disciplines and raise questions about why they are inadequate and/or problematic for feminist inquiry and what, specifically, are the feminist critiques of these intersections.
Information: Graduate Program in Women’s Studies

WGS.640 Studies in Women’s Life Narratives
Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall)
3-0-9 units
Can be repeated for credit.

Close examination of women’s life narratives. Topics vary from term to term. Limited to 10.
Information: Graduate Consortium in Women’s Studies

WGS.645 Issues of Representation: Feminist Theory
Prereq: Application to the Graduate Consortium in Women’s Studies
G (Spring)
3-0-9 units
Can be repeated for credit.

Syllabi vary depending on instructors.
Consult Graduate Program in Women’s Studies
WGS.680 The Economic History of Work and the Family
Prereq: None
Acad Year 2019-2020: Not offered
Acad Year 2020-2021: G (Fall)
3-0-9 units

Explores the changing map of the public and the private in pre-industrial and modern societies and examines how that map affected men’s and women’s production and consumption of goods and leisure. The reproductive strategies of women, either in conjunction with or in opposition to their families, is another major theme. Subject asks how an ideal of the "domestic" arose in the early modern west, and to what extent did it limit the economic position of women; and how has that idea been challenged, and with what success in the post-industrial period. Focuses on western Europe since the Middle Ages and on the United States, but also examines how these issues have played themselves out in non-Western cultures. Graduate students are expected to pursue the subject in greater depth through reading and individual research.

A. McCants

WGS.700 Interdisciplinary Area Studies in Feminist Theories
Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Spring)
3-0-9 units
Can be repeated for credit.

Syllabi vary depending on instructors.
Consult Graduate Consortium in Women’s Studies Program Manager