Nondiscrimination Policy

The Massachusetts Institute of Technology is committed to the principle of equal opportunity in education and employment. The Institute does not discriminate against individuals on the basis of race, color, sex, sexual orientation, gender identity, religion, disability, age, genetic information, veteran status, ancestry, or national or ethnic origin in the administration of its educational policies, admissions policies, employment policies, scholarship and loan programs, and other Institute administered programs and activities, but may favor US citizens or residents in admissions and financial aid.*

The Vice President for Human Resources is designated as the Institute’s Equal Opportunity Officer and Title IX Coordinator. Inquiries concerning the Institute’s policies, compliance with applicable laws, statutes, and regulations (such as Title VI, Title IX, and Section 504), and complaints may be directed to the Vice President for Human Resources, Room E19-215, 617-253-6512, or to the Coordinator of Staff Diversity Initiatives/Affirmative Action, Room E19-215, 617-253-1594. In the absence of the Vice President for Human Resources or the Coordinator of Staff Diversity Initiatives/Affirmative Action, inquiries or complaints may be directed to the Executive Vice President, Room 3-211, 617-253-3928, or to the Director of Labor and Employee Relations, Room E19-235N, 617-253-4264, respectively. Inquiries about the laws and about compliance may also be directed to the Assistant Secretary for Civil Rights, US Department of Education.

*The ROTC programs at MIT are operated under Department of Defense (DOD) policies and regulations, and do not comply fully with MIT’s policy of nondiscrimination with regard to sexual orientation. MIT continues to advocate for a change in DOD policies and regulations concerning sexual orientation, and will replace scholarships of students who lose ROTC financial aid because of these DOD policies and regulations.
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<td><strong>Computational and Systems Biology</strong></td>
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Architecture/Course 4  
Planning/Course 11  
School of Engineering
Aerospace Engineering/Course 16-1  
Aerospace Engineering with Information Technology/Course 16-2  
Archaeology and Materials/Course 3-C  
Biological Engineering/Course 20  
Chemical-Biological Engineering/Course 10-B  
Chemical Engineering/Course 10  
Civil and Environmental Engineering/Course 1-A  
Civil Engineering/Course 1-C  
Computer Science and Engineering/Course 6-3  
Computer Science and Molecular Biology/Course 6-7  
Electrical Engineering and Computer Science/Course 6-2  
Electrical Engineering and Computer Science/Course 6-P  
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Engineering as Recommended by the Department of Aeronautics and Astronautics/Course 16-ENG  
Engineering as Recommended by the Department of Chemical Engineering/Course 10-ENG  
Environmental Engineering Science/Course 1-E  
Mechanical and Ocean Engineering/Course 2-OE  
Mechanical Engineering/Course 2  
Mechanical Engineering/Course 2-A  
Nuclear Science and Engineering/Course 22  
School of Humanities, Arts, and Social Sciences
Anthropology/Course 21A  
Comparative Media Studies/Course CMS  
Economics/Course 14  
Foreign Languages and Literatures/Course 21F  
History/Course 21H  
Humanities/Course 21  
Humanities and Engineering/Course 21E  
Humanities and Science/Course 21S  
Linguistics and Philosophy/Course 24-2  
Literature/Course 21L  
Music/Course 21M  
Philosophy/Course 24-1  
Political Science/Course 17  
Science, Technology, and Society/Double Major/Course STS  
Writing/Course 21W  
MIT Sloan School of Management
Management Science/Course 15  
School of Science
Biology/Course 7  
Brain and Cognitive Sciences/Course 9  
Chemistry/Course 5  
Computer Science and Molecular Biology/Course 6-7  
Earth, Atmospheric, and Planetary Sciences/Course 12  
Mathematics/Course 18  
Mathematics with Computer Science/Course 18-C  
Physics/Course 8  

DEGREE CHARTS
**ACADEMIC CALENDAR 2011–2012**

**SEPTEMBER**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Mon</td>
<td>Labor Day—Holiday</td>
</tr>
<tr>
<td>6</td>
<td>Tue</td>
<td>Registration Day—Fall Term</td>
</tr>
<tr>
<td>7</td>
<td>Wed</td>
<td>Number of class days (Wed, Sep 7, through Wed, Dec 14): 13 Mon, 13 Tue, 14 Wed, 13 Thu, 12 Fri = 65 days</td>
</tr>
<tr>
<td>9</td>
<td>Fri</td>
<td>Deadline to change a Spring Term Exploratory subject to Listener status</td>
</tr>
<tr>
<td>12</td>
<td>Mon</td>
<td>First day of classes</td>
</tr>
<tr>
<td>13</td>
<td>Tue</td>
<td>Degree Application deadline for February SB and Advanced Degrees. $50 Late Fee ($85 after December 16).</td>
</tr>
<tr>
<td>15</td>
<td>Thu</td>
<td>Registration deadline. Signed Registration forms for all students due in Student Services Center. $50 Late Fee.</td>
</tr>
<tr>
<td>16</td>
<td>Fri</td>
<td>Deadline for second-term juniors to submit the HASS Concentration Proposal form. $50 Late Fee.</td>
</tr>
<tr>
<td>21</td>
<td>Wed</td>
<td>First quarter Physical Education classes begin</td>
</tr>
<tr>
<td>23</td>
<td>Fri</td>
<td>Minor Completion date. Deadline for submission of Minor Completion form for final-term seniors. $50 Late Fee.</td>
</tr>
</tbody>
</table>

**OCTOBER**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Fri</td>
<td>ADD date. Last day to add subjects to Registration</td>
</tr>
<tr>
<td>10–11</td>
<td>Mon–Tue</td>
<td>Last day for juniors/seniors to change an elective to or from P/D/F grading</td>
</tr>
<tr>
<td>14–16</td>
<td>Fri–Sun</td>
<td>Last day for graduate students to change a subject to or from P/D/F grading</td>
</tr>
<tr>
<td>31</td>
<td>Mon</td>
<td>Last day to change a subject from Listener to Credit</td>
</tr>
<tr>
<td>11</td>
<td>Fri</td>
<td>Last day for sophomores to change a subject to or from Exploratory</td>
</tr>
<tr>
<td>23</td>
<td>Wed</td>
<td>Late fee ($100) and petition required for students completing registration after this date</td>
</tr>
<tr>
<td>24–25</td>
<td>Thu–Fri</td>
<td>Last day to drop half-term subjects offered in second half of term</td>
</tr>
</tbody>
</table>

**NOVEMBER**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Fri</td>
<td>Veterans Day—Holiday</td>
</tr>
<tr>
<td>23</td>
<td>Wed</td>
<td>DROP date. Last day to cancel subjects from Registration</td>
</tr>
<tr>
<td>24–25</td>
<td>Thu–Fri</td>
<td>Last day to petition for December Advanced Standing Exam (given during Final Exam Period)</td>
</tr>
</tbody>
</table>

Thanksgiving Vacation
**2011–2012**

### DECEMBER

<table>
<thead>
<tr>
<th>1</th>
<th>Thu</th>
<th><strong>ONLINE PREREGISTRATION</strong> for Spring Term and IAP begins</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Fri</td>
<td><strong>SUBJECTS WITH FINAL EXAM</strong>—No test may be given and no assignment, term paper, or oral presentation shall fall due after this date.</td>
</tr>
<tr>
<td>11</td>
<td>Wed</td>
<td><strong>SUBJECTS WITH NO FINAL EXAM</strong>—No test may be given and at most one assignment may fall due after this date and before the end of the last scheduled class period in the subject.</td>
</tr>
<tr>
<td>16</td>
<td>Fri</td>
<td><strong>LAST DAY OF CLASSES</strong></td>
</tr>
<tr>
<td>16–22</td>
<td>Mon–Fri</td>
<td>Last day to drop half-term subjects offered in the second half of term</td>
</tr>
<tr>
<td>20–1/4</td>
<td>Tue–Wed</td>
<td><strong>GRADE DEADLINE.</strong> Grades must be submitted according to due date indicated</td>
</tr>
<tr>
<td>29</td>
<td>Thu</td>
<td><strong>SPRING PREREGISTRATION DEADLINE.</strong> Continuing students must initiate online preregistration by 5 pm on this date. $50 Late Fee ($85 after January 19).</td>
</tr>
</tbody>
</table>

### JANUARY

<table>
<thead>
<tr>
<th>6</th>
<th>Fri</th>
<th><strong>IAP PREREGISTRATION DEADLINE.</strong> Deadline for all students to preregister for IAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Mon</td>
<td>Term Summaries of Fall Term grades available to departments</td>
</tr>
<tr>
<td>10</td>
<td>Tue</td>
<td>First day of January Independent Activities Period</td>
</tr>
<tr>
<td>12, 13</td>
<td>Thu, Fri</td>
<td><strong>DEADLINE FOR DOCTORAL STUDENTS</strong> to submit application, signed by department, to the Office of the Dean for Graduate Education, 3-138, for Spring Term Non-Resident status. $100 Late Fee. Not needed if Spring Term approved with Fall Term application.</td>
</tr>
<tr>
<td>13</td>
<td>Fri</td>
<td>IAP Physical Education classes begin</td>
</tr>
<tr>
<td>17</td>
<td>Mon</td>
<td>Graduate Academic Performance Grades Meeting</td>
</tr>
<tr>
<td>19</td>
<td>Thu</td>
<td>CAP Grades Meetings</td>
</tr>
<tr>
<td>20</td>
<td>Fri</td>
<td><strong>THESIS DUE</strong> for doctoral degrees</td>
</tr>
<tr>
<td>25, 26</td>
<td>Wed, Thu</td>
<td>Last day to petition for January Advanced Standing Exam</td>
</tr>
<tr>
<td>27</td>
<td>Thu</td>
<td>Martin Luther King, Jr. Day—Holiday</td>
</tr>
<tr>
<td>29</td>
<td>Fri</td>
<td><strong>5 PM FINAL DEADLINE FOR CONTINUING STUDENTS TO PREREGISTER ONLINE FOR SPRING.</strong> $85 Late Fee.</td>
</tr>
<tr>
<td>30</td>
<td>Sat</td>
<td><strong>THESIS DUE</strong> for degrees other than doctoral</td>
</tr>
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### FEBRUARY

<table>
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<tr>
<th>2</th>
<th>Thu</th>
<th>English Evaluation Test for international students, 9 am–12 pm</th>
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</thead>
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<tr>
<td>3</td>
<td>Fri</td>
<td>Last day of January Independent Activities Period</td>
</tr>
<tr>
<td>6</td>
<td>Mon</td>
<td><strong>REGISTRATION DAY—SPRING TERM</strong></td>
</tr>
<tr>
<td>7</td>
<td>Tue</td>
<td>Number of class days (Tue, Feb 7, through Thu, May 17): 12 Mon, 12 Tue, 14 Wed, 14 Thu, 13 Fri=65 days</td>
</tr>
<tr>
<td>8</td>
<td>Wed</td>
<td><strong>DEADLINE</strong> to change a Fall Term Exploratory subject to Listener status</td>
</tr>
<tr>
<td>10</td>
<td>Fri</td>
<td><strong>FIRST DAY OF CLASSES</strong></td>
</tr>
<tr>
<td>11</td>
<td>Sat</td>
<td><strong>GRADES DUE</strong> in Registrar’s Office, 5-119, for work completed in IAP, 12 pm</td>
</tr>
<tr>
<td>15</td>
<td>Mon</td>
<td><strong>REGISTRATION DEADLINE.</strong> Signed Registration forms for all students due in Student Services Center. $50 Late Fee.</td>
</tr>
<tr>
<td>17</td>
<td>Wed</td>
<td><strong>DEGREE APPLICATION DEADLINE</strong> for June SB and Advanced Degrees. $50 Late Fee ($85 Late Fee after April 6).</td>
</tr>
<tr>
<td>20</td>
<td>Fri</td>
<td><strong>DEADLINE FOR SECOND-TERM JUNIORS</strong> to submit the HASS Concentration Proposal form. $50 Late Fee.</td>
</tr>
<tr>
<td>25</td>
<td>Thu</td>
<td><strong>DEADLINE FOR FINAL-TERM SENIORS</strong> to submit the HASS Concentration Completion form. $50 Late Fee.</td>
</tr>
</tbody>
</table>
10 Fri Term Summaries of grades for IAP available to departments
   CAP February Degree Candidates Meeting
13 Mon Third quarter Physical Education classes begin
14 Tue Graduate Academic Performance Meeting
15 Wed Faculty Officers recommend degrees to Corporation
   Last day to sign up for family health insurance or waive individual coverage for spring, E23-308
20 Mon Presidents Day—Holiday
21 Tue Monday schedule of classes to be held
24 Fri Minor completion date. Deadline for submission of Minor Completion form for final-term seniors.
   $50 Late Fee.
   Add date. Last day to add subjects to Registration
   Last day for juniors/seniors to change an elective to or from P/D/F grading
   Last day for graduate students to change a subject to or from P/D/F grading
   Last day to change a subject from Listener to Credit
   Last day for sophomores to change a subject to or from Exploratory
   Late fee ($100) and petition required for students completing registration after this date
   Last day for February 2013 degree candidates to apply for a double major
   Last day to drop half-term subjects offered in first half of term
   Deadline for completing cross-registration. $50 Late Fee for petitions approved after this date.
26–30 Mon–Fri Spring Vacation
   Fourth quarter Physical Education classes begin
   Last day to submit or change Advanced Degree Thesis Title. $80 Late Fee.
   Patriots Day—Vacation
   Campus Preview Weekend
   Drop date. Last day to cancel subjects from Registration
   Last day to change a subject from Credit to Listener
   Last day to add time-arranged subject that started after beginning of the term
   Last day to petition for May Advanced Standing Exam (given during Final Exam Period)
   Last day to add half-term subjects offered in second half of term

Online preregistration for Fall Term and Summer Session begins
   Thesis due for doctoral degrees
   Subjects with final exam—No test may be given and no assignment, term paper, or oral presentation shall fall due after this date.
   Subjects with no final exam—No test may be given and at most one assignment may fall due after this date and before the end of the last scheduled class period in the subject.
   Thesis due for degrees other than doctoral
   Last day of classes
   Last day to drop half-term subjects offered in the second half of term
2012

<table>
<thead>
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<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>21–25</td>
<td>Mon–Fri <strong>FINAL EXAM PERIOD</strong></td>
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<tr>
<td>22–29</td>
<td>Tue–Tue <strong>GRADE DEADLINE. Grades must be submitted according to due date indicated</strong></td>
</tr>
<tr>
<td>25</td>
<td>Fri <strong>LAST DAY TO GO OFF THE JUNE DEGREE LIST</strong></td>
</tr>
<tr>
<td>28</td>
<td>Mon <strong>MEMORIAL DAY—HOLIDAY</strong></td>
</tr>
<tr>
<td>31</td>
<td>Thu <strong>LAST DAY TO GO OFF THE JUNE DEGREE LIST</strong></td>
</tr>
<tr>
<td>22–29</td>
<td>Tue–Tue <strong>TERM SUMMARIES OF SPRING TERM GRADES DELIVERED TO DEPARTMENTS</strong></td>
</tr>
<tr>
<td>25</td>
<td>Fri <strong>DEPARTMENT GRADES MEETINGS</strong></td>
</tr>
<tr>
<td>28</td>
<td>Mon <strong>FALL PREREGRISTRATION DEADLINE. Continuing students must initiate online preregistration by this date. $50 Late Fee ($85 after August 19).</strong></td>
</tr>
<tr>
<td>30</td>
<td>Sun <strong>SUMMER SESSION PREREGRISTRATION DEADLINE. Deadline for all students to preregister online for Summer Session. $50 Late Fee.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Mon <strong>CAP JUNE DEGREE CANDIDATES MEETING</strong></td>
</tr>
<tr>
<td>5</td>
<td>Tue <strong>CAP GRADUES MEETING</strong></td>
</tr>
<tr>
<td>7</td>
<td>Thu <strong>GRADUATE ACADEMIC PERFORMANCE MEETING</strong></td>
</tr>
<tr>
<td>8</td>
<td>Fri <strong>FACULTY OFFICERS RECOMMEND DEGREES TO CORPORATION</strong></td>
</tr>
<tr>
<td>11</td>
<td>Mon <strong>CAP GRADUES MEETING</strong></td>
</tr>
<tr>
<td>13, 14</td>
<td>Wed, Thu <strong>DOCTORAL HOODING CEREMONY</strong></td>
</tr>
<tr>
<td>15</td>
<td>Fri <strong>FIRST DAY OF CLASSES FOR REGULAR SUMMER SESSION (ENDS TUE, AUGUST 21)</strong></td>
</tr>
<tr>
<td>15</td>
<td>Fri <strong>DEGREE APPLICATION DEADLINE</strong> for September SB and Advanced Degrees. $50 Late Fee ($85 after July 13).**</td>
</tr>
<tr>
<td>31</td>
<td>Thu <strong>REGISTRATION DEADLINE. Signed Registration forms for all students due in Student Services Center. $50 Late Fee.</strong></td>
</tr>
</tbody>
</table>

The Academic Calendar is available at [http://web.mit.edu/registrar/calendar/](http://web.mit.edu/registrar/calendar/).

Projected key dates for future academic years are available at [http://web.mit.edu/registrar/calendar/projected.html](http://web.mit.edu/registrar/calendar/projected.html).
SUBJECT KEY

This book lists MIT classes, or subjects, grouped by course number.

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.

These subject descriptions are accurate at the time of publication, but are subject to change. For current listings, consult the online Student Information System at http://student.mit.edu/catalog/index.cgi. The online information is updated as changes occur.

How to Read Subject Descriptions

A subject description consists of four parts: subject name, subject information, subject content, and instructor(s).

Subject Name

The subject name consists of its number and title.

J at the end of a subject number indicates that the subject is offered jointly by more than one department. Its subject numbers in the other departments are indicated in the subject information section.

(New) following the subject number and title indicates a subject that is new to the catalogue.

Subject Information

The subject information section may include the following:

If a subject has been renumbered, its former number appears in parentheses.

If a subject is jointly offered or is a school-wide elective (SWE), the phrase Same subject as followed by the subject’s other number(s) appears in parentheses.

Meets with appears if the subject is taught together with one or more subjects at a different level, or if part of the subject is taught in conjunction with another subject. Subjects that meet together generally have different coursework requirements.

Prerequisites are listed in this section or are indicated below in the subject content section. Students who have not completed the stated prerequisites must obtain the instructor’s permission to register. Numbers in italics indicate corequisites that must be taken simultaneously with the subject described. Prerequisites are listed before corequisites.

The use of “and” denotes that all of the subjects in a series are required, for example:

Prereq: 6.021J, 6.034, 6.046, and 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

A semicolon is used to separate individual prerequisites from one of a series of prerequisites, or to separate several series of prerequisites, for example:

Prereq: 6.046J; 6.041 or 6.042J

Implicit prerequisites are not listed. For example, it is not necessary to list 6.02 as a prerequisite if 6.03 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. Below are the current subjects that fulfill each requirement:

- Biology (GIR): 7.012, 7.013, 7.014
- Calculus I (GIR): 18.01, 18.01A, 18.014
- Calculus II (GIR): 18.02, 18.02A, 18.022, 18.023, 18.024
- Chemistry (GIR): 3.091, 5.111, 5.112
- Physics I (GIR): 8.01, 8.01L, 8.011, 8.012
- Physics II: (GIR): 8.02, 8.021, 8.022

Acad Year may indicate “2011–2012: Not offered” or “2012–2013: Not offered.” There is no comment if the subject is offered in both academic years.

Subject level and term follow. U is an undergraduate subject, and G is a subject offered primarily to graduate students. IAP is MIT’s Independent Activities Period.

Credit units, which indicate a subject’s time distribution, are represented by three numbers separated by dashes. First is the number of units assigned for recitation and lecture; second, the number of units for laboratory, design, or fieldwork; and third, the number of units for preparation. Add the units together to obtain the total credit for a subject.

One unit represents approximately 14 hours of work. Units arranged indicates that units are specially arranged with the instructor.

Subjects fulfilling 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, or HASS (Humanities, Arts, and Social Sciences) are so designated to the right of the credit units.

For students entering as freshmen in Fall 2010 or later, subjects that fulfill the HASS Requirement are designated HASS-H (Humanities), HASS-A (Arts), HASS-S (Social Sciences), or HASS-E (Elective).

For students who entered prior to Fall 2010, subjects that fulfill the HASS Requirement are displayed in parentheses [e.g., (HASS-D 3)].

HASS-D, followed by a number, identifies a subject in one of the five distribution categories; HASS-D Language Option indicates language subjects that may be substituted for one HASS-D subject; and HASS-E denotes a HASS Elective.

Subjects fulfilling the Communication Requirement are designated CI-H or CI-HW. (See degree charts for CI-M designations.)

[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).

H-LEVEL Grad Credit indicates a subject approved for higher graduate-level credit. In some cases, a message follows to indicate that the subject is H-level in certain departments.

Can be repeated for credit appears under the credit units if the subject can be taken more than once for academic credit.

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) as known at the time of publication, or the name of the department contact, appears in italics at the end of the subject description.

1.125J Web System Architecting: Building Web Services

(Same subject as ESD.341J)

Prereq: 1.124J, 6.001

G (Spring)

3.0-9 H-LEVEL Grad Credit

Software architecture and design of web systems in the context of a start-up company. Lectures and readings cover core database, XML, web server components and browser issues in a Web Service environment. Limited enrollment.

J. R. Williams
FUNDAMENTALS

1.00 Introduction to Computers and Engineering Problem Solving
(Subject meets with 1.001, 1.002)
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-1-6 REST

1.001 Introduction to Computers and Engineering Problem Solving
(Subject meets with 1.00, 1.002)
Prereq: Calculus I (GIR)
G (Fall, Spring)
5-1-3

1.002 Introduction to Computers and Engineering Problem Solving (New)
(Subject meets with 1.00, 1.001)
Prereq: Calculus I (GIR)
G (Fall, Spring)
5-1-6

1.011 Project Evaluation
Prereq: None
U (Spring)
3-1-5

Methodologies for evaluating civil engineering projects, which typically are large-scale and long-lived, involving many economic, financial, social and environmental factors. Emphasis on dealing with uncertainty. Presents basic techniques of engineering economics, including net present value analysis, life-cycle costing, benefit-cost analysis, and other approaches to project evaluation. Examples drawn from both contemporary and historical projects in various fields, including transportation systems, urban development, energy and environmental projects, water resource management, telecommunications systems, and other elements of the public and private projects and programs.

J. Sussman

1.013 Senior Civil and Environmental Engineering Design
Prereq: Permission of instructor
U (Spring)
2-4-6

Synthesizes prior design education through a semester long design project, concurrent smaller projects, lectures and related assignments. Students who have specialized in structural, geotechnical, engineering systems, and environmental areas form mixed teams to work on the projects. For the semester long project, which has to be planned and designed for a specific location, students demonstrate creativity in applying theories and methodologies from their design and analysis subjects while considering the project’s technical, environmental, and social feasibility. Parallel to this design project are smaller projects involving actual building. Lectures on a variety of civil and environmental engineering projects, engineering practice and ethics, as well as field trips, are also part of the subject. Instruction and practice in oral and written communication are an integral part, culminating in the completion of the design portfolio.

H. H. Einstein, P. Shanahan, L. O’Donnell

1.015J Design of Electromechanical Robotic Systems
(Same subject as 2.017J)
Prereq: 2.003; Coreq: 2.005 or 2.016; 2.671
U (Spring)
3.4-5 1/2 Institute LAB
See description under subject 2.017J.

F. S. Hover, J. J. Leonard

1.016 Design for Complex Environmental Issues: Building Solutions and Communicating Ideas
Prereq: 12.000
U (Spring)
3-1-5

Provides an opportunity to pursue issues related to the Earth System problem studied during the Fall term Terrascope subject, 12.000. Student teams conceptualize, design and prototype devices intended to address the Earth System problem; they also create museum exhibits that communicate the context and proposed solutions to the problem. Teams design a concept with researchers at MIT and professionals from local museums, and display their exhibits to the MIT community. The Terrascope field trip provides first-hand experience and shapes the final designs. Limited to Terrascope students.

C. Harvey, A. Epstein

1.018J Ecology I: The Earth System
(Subject same as 7.30J)
Prereq: None
U (Fall)
3-1-8 REST

Fundamentals of ecology, considering Earth as an integrated dynamic system. Coevolution of the biosphere, geosphere, atmosphere and oceans. Introduction to biological energy transfer and thermodynamics. The Earth’s energy budget. Photosynthesis and respiration. The hydrologic, carbon and nitrogen cycles. Flow of energy and materials through ecosystems, regulation of the distribution and abundance of organisms, structure and function of ecosystems. Metabolic diversity; productivity. Trophic dynamics; models of population growth, com-
petition, mutualism and predation. Instruction and practice in oral and written communication provided. 7.012–7.014 recommended.  
S. W. Chisholm, E. DeLong

1.020 Ecology II: Engineering for Sustainability
Prereg: Physics I (GIR); Coreq: 18.03 or permission of instructor
U (Spring)
3-2-7
Review of physical, chemical, ecological, and economic principles used to examine interactions between humans and the natural environment. Applications of mass balance concepts in ecology, chemical kinetics, and hydrology; energy balance concepts in building design, ecology, and climate change; economic and life cycle concepts in resource evaluation and engineering design. Numerical models are used to integrate concepts and to assess environmental impacts of human activities. Problem sets involve development of MATLAB models for particular engineering applications. Some experience with computer programming is helpful but not essential.  
D. McLaughlin

1.021 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject  
(Offered under: 3.021, 10.333, 22.00)
Prereg: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 REST
See description under subject 3.021.  
M. Buehler, J. Grossman

1.032 Geomaterials and Geomechanics
(Subject meets with 1.361, 1.366)
Prereg: 1.010, 1.011, 1.036
U (Fall)
3-0-9
Presentation and application of principles of soil mechanics. Considers topics: the origin and nature of soils; soil classification; the effective stress principle; hydraulic conductivity and seepage; stress-strain-strength behavior of cohesionless and cohesive soils and application to lateral earth stresses, bearing capacity and slope stability; consolidation theory and settlement analyses; laboratory and field methods for evaluation of soil properties in design practice. Same lectures as 1.361.  
L. C. Jen

1.035 Mechanics of Structures and Soils
Prereg: 1.050, 18.03
U (Fall)
5-3-10
E. Kausel, R. Juanes, J. T. Germaine

1.036 Structural and Geotechnical Engineering Design
Prereg: 1.035
U (Spring)
3-1-8
Basic philosophy of planning and design of structures. Loading conditions, design criteria and factors of safety. Application of principles of structural mechanics and soil mechanics in design. Structural system design concepts. Design of reinforced concrete structural elements using the ultimate strength design method. Load factor design of structural steel members and connections. Selection of soil parameters from laboratory and in situ tests. Stability and ground deformations in geotechnical design. Design with soil-structure interaction. Emphasis on problem-based learning through team design projects.  
O. Buyukozturk, L. C. Jen

1.040 Project Management
(Subject meets with 1.401J, ESD.018J)
Prereg: None
U (Spring)
3-0-9
Credit cannot also be received for ESD.052
Introduction to project management with emphasis on finance, evaluation, and organization. Topics include project financing; public-private partnership; cost-benefit analysis, resource and cost estimation; project organization; and project control and delivery. Case studies used to demonstrate relevant issues. Students taking graduate version complete additional assignments.  
F. Moavenzadeh

1.041) Transportation Systems Modeling
(Subject as 1.341J, ESD.018J)
Prereg: 1.00, 1.010
U (Spring)
3-1-8
Introduces basic concepts of transportation systems data collection, modeling, analysis and visualization techniques. Covers fundamental analytical and simulation-based methodologies. Topics include time-space diagrams, cumulative plots, queuing theory, traffic assignment, transportation paradoxes, and urban travel control. Provides students with an understanding of the current challenges and opportunities in different areas of transportation.  
C. Osorio, J. Williams

1.044J Fundamentals of Energy in Buildings
(Subject as 2.66J, 4.42J)
Prereg: Physics I (GIR), Calculus II (GIR)
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-2-7 REST
See description under subject 4.42J.  
L. R. Glickman

1.050 Engineering Mechanics I
Prereg: Physics I (GIR); Coreq: Calculus II (GIR)
U (Fall)
3-2-7 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, M. J. Buehler

1.053J Dynamics and Control I
(Subject as 2.003J)
Prereg: Physics I (GIR), 18.03
U (Fall, Spring)
4-1-7 REST
See description under subject 2.003J.  
N. G. Hadjiconstantinou, J. K. Vandiver, N. C. Makris, N. M. Patrikalakis, T. Peacock
1.054 Mechanics and Design of Concrete Structures
(Subject meets with 1.541)
Prereq: 1.035
U (Fall)
3-0-9
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 containments. Students taking graduate version complete additional assignments.
O. Buyukozturk

1.055 Steel Bridge Competition
(Subject meets with 1.58)
Prereq: None
U (Fall, IAP, Spring)
0-4-0
Can be repeated for credit
Students participate in the ASCE/AISC Student Steel Bridge Competition, gaining practical experience in structural design, steel fabrication processes, construction planning, organization, and teamwork. Provides an opportunity to compete against, and network with, students from other colleges and universities from around the country.
J. J. Connor

1.056J Building Structural Systems I
(Same subject as 4.440J)
(Subject meets with 4.462)
Prereq: Calculus II (GIR); 4.401 or permission of instructor
U (Spring)
3-3-6 REST
See description under subject 4.440J.
J. Ochsendorf

1.058 Structural Dynamics and Vibrations
(Subject meets with 1.581J, 2.060J, 16.221J)
Prereq: Permission of instructor
U (Fall)
3-1-8
Single- and multiple-degree-of-freedom vibration problems, using matrix formulation and normal mode superposition methods. Time and frequency domain solution techniques including convolution and Fourier transforms. Applications to vibration isolation, damping treatment, and dynamic absorbers. Analysis of continuous systems by exact and approximate methods. Applications to buildings, ships, aircraft and offshore structures. Vibration measurement and analysis techniques. Students should possess basic knowledge in structural mechanics and in linear algebra. Students taking graduate version complete additional assignments.
E. Kausel

1.060 Engineering Mechanics II
Prereq: Permission of instructor or Coreq: 18.03
U (Spring)
3-2-7
R. Stocker, O. S. Madsen

1.061 Transport Processes in the Environment
(Subject meets with 1.61)
Prereq: 1.060; Coreq: 1.106, 1.070; or permission of instructor
U (Fall)
3-1-8
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.
H. M. Nepf

1.070J Introduction to Hydrology
(Same subject as 12.320J)
Prereq: 1.060; Coreq: 1.061, 1.106
U (Fall)
3-0-9
Introduction to the global water and energy cycles and the earth system including the atmosphere, oceans, land, and biosphere. Fundamentals of hydrologic science and its applications. Covers bases for the characterization of hydrologic processes such as precipitation, evaporation, transpiration by vegetation, infiltration, and storm runoff. Understanding and modeling of groundwater flow, hydraulics of wells, and subsurface transport of pollutants. Probabilistic analysis and risk estimation for hydrologic variables.
D. Entekhabi

1.071J Global Change Science
(Subject meets with 12.300J)
Prereq: 18.03; 5.60
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9
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

1.080 Environmental Chemistry
Prereq: Chemistry (GIR)
U (Spring)
4-0-8
Covers basic environmental chemistry with a focus on understanding the principles governing the function of both natural systems and systems perturbed or engineered by humans. Emphasizes the key processes that act on chemical species in the atmosphere, natural waters, soils and sediments, allowing for the prediction of chemical concentrations and fates. Topics include acid-base chemistry, metal complexation, mineral dissolution and precipitation, oxidation/reduction reactions, photolysis, phase partitioning including bioaccumulation, and radiochemistry. Concurrent enrollment in 1.083 and 1.107 recommended.
P. M. Gschwend, J. Kroll

1.081J Environmental Cancer Risks, Prevention, and Therapy
(Same subject as 20.104J, ESD.053J)
Prereq: Biology (GIR), Chemistry (GIR)
U (Spring)
3-0-9
See description under subject 20.104J.
W. Thilly, R. McCunney
CIVIL AND ENVIRONMENTAL ENGINEERING

1.083 Environmental Health Engineering and Biology
Prereq: Chemistry (GIR), Biology (GIR), 1.061
U (Spring)
3-0-9

Considers human health issues associated with environmental engineering for air, land, and water. Topics include the fundamental and applied aspects of biological and microbial processes in natural and engineered systems, including microbial metabolisms, water quality, ecological assessment, and wastewater treatment; the interaction between humans and chemicals in the environment including toxicology, exposure pathways, and risk assessment; treatment technologies; and the basis for environmental regulation of chemical exposure. Case studies illustrate concepts and issues. Concurrent enrollment in 1.080 and 1.107 recommended.
J. Germaine, S. Rudolph

1.095 Teaching Practicum in Civil and Environmental Engineering (New)
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Students work as unpaid laboratory, tutorial, or classroom assistants under supervision of a faculty member. Limited to undergraduate teaching fellows and graders in Course 1.
Staff

UNDERGRADUATE LABORATORY SUBJECTS

1.101 Introduction to Civil and Environmental Engineering Design I
Prereq: None. Coreq: 1.018, 1.050
U (Fall)
0-3-3 1/2 Institute LAB

Project-oriented introduction to the principles and practice of civil and environmental engineering design. First half of the term, students work in teams to apply the design process to an open-ended design/planning problem involving civil and environmental engineering aspects. In the second half, teams design and build a working model researching, in detail, an aspect of the planning/design project. Each team then presents the model and the results to the class. Regular written and oral presentations. Students also start on their design portfolio.
H. H. Einstein, P. Reis, A. Epstein, S. Rudolph

1.102 Introduction to Civil and Environmental Engineering Design II
Prereq: Permission of instructor and Coreq: 1.060
U (Spring)
1-3-2 1/2 Institute 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. Subject includes a major team project involving use and application of sensors, as well as environmentally-friendly, and energy-effective or energy-producing designs. Further development of hands-on, teamwork and communication skills. Enrollment limited; preference to Course 1 students.
H. F. Hemond, J. T. Germaine

1.106 Environmental Fluid Transport Processes and Hydrology Laboratory
Prereq: None. Coreq: 1.061, 1.070
U (Fall)
0-4-2 1/2 Institute LAB

Builds on the lecture subjects 1.061 and 1.070. Fundamentals of mass and flow measurements in field and laboratory settings, and application of these measurement techniques to analyze real and model environmental systems. Enrollment limited; preference to 1-E and 1-A students.
H. M. Nepf, D. Entekhabi

1.107 Environmental Chemistry and Biology Laboratory
Prereq: None. Coreq: 1.080
U (Spring)
0-4-2 1/2 Institute LAB

Laboratory and field techniques in biogeochemistry and environmental engineering and their application to the understanding of natural and engineered ecosystems. Exercises demonstrate data acquisition and modeling suited to identifying and quantifying physical, chemical, and biological processes that govern the effects of human activity on the functioning of natural systems and/or the efficacy of engineered approaches to environmental problems. Applications include chemical and biological remediation, measurement of contaminants, and detection of biogeochemical activity in natural environments. An independently designed final project is required. 1.018 and 1.061 strongly recommended. Enrollment limited; preference to 1-E students.
M. Polz, S. Frankel, P. Gschwend, J.Kroll, J. Thompson

ENGINEERING INFORMATION SYSTEMS AND COMPUTATION

1.124J Software and Computation for Simulation
(Same subject as 2.091J, ESD.51J)
Prereq: 1.00 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

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 dis-
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

1.125J Architecting and Engineering Software Systems
(Same subject as ESD.341J)
Prereq: 1.00, 1.124J, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.341J.
J. Williams, D. Hartzband, A. Sanchez

1.126J Pattern Recognition and Analysis
(Same subject as ESD.621J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.621J.
R. W. Picard

1.128J Computational Geometry
(Same subject as 2.089J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 2.089J.
N. M. Patrikalakis, D. C. Gossard

ENGINEERING ANALYSIS METHODS

1.133 MEng Concepts of Engineering Practice
Prereq: None
G (Fall)
3-0-6 H-LEVEL Grad Credit
Core requirement for the MEng program designed to teach students about the roles of today's professional engineer and expose them to team-building skills through lectures, team workshops, and seminars. Topics include: written and oral communication, job placement skills, trends in the engineering and construction industry, risk analysis and risk management, managing public information, proposal preparation, project evaluation, project management, liability, professional ethics, and negotiation. Draws on relevant large-scale projects to illustrate each component of the subject. Grading is based on both individual and team exercises involving written and oral presentations. Limited to Course 1 MEng students.

E. E. Adams

1.138J Wave Propagation
(Same subject as 2.062J, 18.376J)
Prereq: 2.003, 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.062J.
T. R. Akylas, R. R. Rosales

See also 1.351J, 1.541J, 1.56J, 1.63.

ENGINEERING SYSTEMS, ECONOMICS, AND OPTIMIZATION

1.145J Engineering Economy Module
(Same subject as ESD.70J)
Prereq: None
G (Fall; partial term)
1-0-2 [P/D/F]
See description under subject ESD.70J.
R. de Neufville

1.146 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject
(Subject meets with ESD.70J)
Prereq: 1.145 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.70J.
R. de Neufville

See also 1.103J.

1.149 Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Subject as 2.963, 6.938, 10.816, 11.544J, ESD.21J)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72
G. Apostolakis

1.151 Probability and Statistics in Engineering
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

D. Veneziano

1.155 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 2.963, 6.938, 10.816, 11.544J, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.
G. Apostolakis

See also 1.203J.

TRANSPORTATION

1.200J Transportation Systems Analysis: Performance and Optimization
(Subject as 11.544J, ESD.21J)
Prereq: 1.010, permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
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. Barnhart, A. R. Odoni

1.201J Transportation Systems Analysis: Demand and Economics
(Same subject as 11.545J, ESD.210J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit

Introduces transportation systems analysis, stressing demand and economic aspects. Covers the key principles governing transportation planning, investment, operations, and maintenance. 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 include congestion pricing, technological change, resource allocation, market structure and regulation, revenue forecasting, public and private transportation finance, and project evaluation; covering urban passenger transportation, freight, aviation and intelligent transportation systems.

N. H. M. Wilson, M. Ben-Akiva

1.202J Demand Modeling
(Same subject as ESD.212J)
Prereq: 1.201 or permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit

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.

M. Ben-Akiva

1.203J Logistical and Transportation Planning Methods
(Same subject as 6.281J, 15.073J, 16.76J, ESD.216J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit

Quantitative techniques of operations research with emphasis on applications in transportation systems analysis (urban, air, ocean, highway, and pickup and delivery systems) and in the planning and design of logistically oriented urban service systems (e.g., fire and police departments, emergency medical services, and emergency repair services). Unified study of functions of random variables, geometrical probability, multi-server queuing theory, spatial location theory, network analysis and graph theory, and relevant methods of simulation. Computer exercises and discussions of implementation difficulties.

R. C. Larson, A. R. Odoni, A. I. Barnett

1.204 Computer Modeling: From Human Mobility to Transportation Networks
Prereq: 1.001, 1.010; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Theory and application for modeling individual travels at a country scale. Reviews mathematical methods to describe random movement. Presents statistical methods to identify the structure inherent in daily behavior, with models that can accurately analyze, predict, and cluster multimodal data from individuals within a population; algorithms to model and characterize complex networks; applications of network theory to transportation and road networks; and models of aggregated travels and its implications in spreading dynamics. Lectures reinforced with case studies, which require analysis using data sets from actual applications.

M. C. Gonzalez

1.205J Advanced Demand Modeling
(Same subject as ESD.213J)
Prereq: 1.202 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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. E. Ben-Akiva

1.212J An Introduction to Intelligent Transportation Systems
(Same subject as ESD.221J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit

Presents basic elements of intelligent transportation systems. Considers technological, systems and institutional aspects of ITS, including system architecture, congestion pricing, public/private partnerships, network models, freight, public transportation, ITS and regional transportation strategy, environmental and safety aspects of ITS, developing country applications, and implementation case studies. Term project required.

J. Sussman

1.231J Planning and Design of Airport Systems
(Same subject as 16.781J, ESD.224J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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
1.232J The Airline Industry
(Same subject as 15.054J, 16.71j, ESD.217j)
Prereq: None
G (fall)
3-0-9
See description under subject 16.71j.

1.234J Airline Management
(Same subject as 16.75j)
Prereq: 16.71j
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.75j.
P. P. Belobaba

1.251J Comparative Land Use and Transportation Planning
(Same subject as 11.526j)
Prereq: Permission of instructor
G (spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.526j.
C. Zegras

1.252J Urban Transportation Planning
(Same subject as 11.540j, ESD.225j)
Prereq: Permission of instructor
G (fall)
3-0-9 H-LEVEL Grad Credit

History, policy, and politics of urban transportation. The role of the federal government and the "highway revolt." Public transit in the auto era. Analytic tools for transportation planning and policy analysis. The contribution of transportation to air pollution and climate change. Land use and transportation interactions. Bicycles, pedestrians, and traffic calming. Examples from the Boston area.
F. Salvucci, M. Murga

1.253J Transportation Policy and Environmental Limits
(Same subject as 11.543j, ESD.222j)
Prereq: Permission of instructor
G (spring)
3-0-9 H-LEVEL Grad Credit

Through a combination of lectures, cases, and class discussions the subject 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.
J. Coughlin, F. Salvucci

1.254J Transport Modeling Course
Prereq: Permission of instructor
G (spring)
3-0-9
Fosters practical experience with the concepts and approaches behind the analytical chain composed by GIS, four-step planning and traffic models. Study conducted in Greater Boston. Students develop road and street, pedestrian and public transportation networks. The latest CTPP data, and Boston home travel survey used to understand travel behavior and calibrate model. Final project involves the design of alternative futures for the metropolitan area with different transportation and land use policies. Basic programming experience required.
M. Murga

1.255J Transportation MEng Project
Prereq: 1.201
G (fall, iap, spring)
5-0-10 H-LEVEL Grad Credit

Students work on projects related to ongoing MIT research programs with agencies, industries and government, such as Transport for London, or related transportation projects in the Boston area. An in-depth planning and design study is carried out as a group effort, providing the background for individual student theses. Students must register for 1.255 for the fall term, IAP, and the spring term. Preference to Course 1 MEng students.
N. Wilson, J. Attanucci

1.258J Public Transportation Systems
(Same subject as 11.541j, ESD.226j)
Prereq: 1.201 or permission of instructor
G (spring)
3-0-9 H-LEVEL Grad Credit

Discusses evolution and role of urban public transportation modes, systems and services, focusing on bus and rail. Describes technological characteristics and their impacts on capacity, service quality, and cost. Current practice and new methods for data collection and analysis, performance monitoring, route and network design, frequency determination, and vehicle crew scheduling. Effect of pricing policy and service quality on ridership. Methods for estimating costs associated with proposed service changes. Organizational models for delivering public transportation service including finance and operations.
N. H. M. Wilson

1.260J Logistics Systems
(Same subject as 15.770j, ESD.260j)
Prereq: Permission of instructor
G (fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.260j.
Y. Sheffi, C. Caplice

1.261J Case Studies in Logistics and Supply Chain Management
(Same subject as 15.771j, ESD.261j)
Prereq: Permission of instructor
G (spring)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.261j.
J. Byrnes

1.262J Supply Chain Leadership
(Same subject as ESD.262j)
Prereq: ESD.260 or permission of instructor
G (iap)
2-0-7 [P/D/F]
See description under subject ESD.262j.
J. Goentzel, C. Caplice

1.264J Database, Internet, and Systems Integration Technologies
(Same subject as ESD.264j)
Prereq: Permission of instructor
G (fall)
5-0-7 H-LEVEL Grad Credit

Addresses information technology fundamentals, including project management and software processes, data modeling, UML, relational databases and SQL. Covers internet technologies, such as XML, web services, and service-oriented architectures. Provides an introduction to security and presents the fundamentals of telecommunications. Includes a project that involves requirements/design, data model, database implementation, website, security and data network. No prior programming experience required.
G. Kocur
1.265J International Supply Chain Management
(Same subject as 2.965J, 15.765J, ESD.265J)
Prereq: 1.260, 1.261, 1.262, 15.760, or permission of instructor
Acad Year 2011–2012: G (Spring; first half of term)
Acad Year 2012–2013: Not offered
2-0-4 H-LEVEL Grad Credit
An overview of globalization and the international environment: the international marketing, international finance and supply chain interface; global strategy for logistics and supply chain management; global supply chain models; role of government intervention and regulations; the role of international air and ocean carriers. Emphasis on both strategy formulation and implementation.

CIVIL AND ENVIRONMENTAL ENGINEERING

1.27 Studies in Transportation
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Individual advanced study of a topic in transportation systems, selected with the approval of the instructor.

Staff

1.270J Logistics and Supply Chain Management
(Same subject as ESD.270J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.273J.
D. Simchi-Levi

1.271J The Theory of Operations Management (New)
(Same subject as 15.764J, ESD.274J)
Prereq: 15.081J or 6.251J, 6.436J; or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 15.764J.
Fall: V. Farias
Spring: R. Levi

1.272J Design and Operation of Logistics Facilities and Networks
(Same subject as ESD.272J)
Prereq: 1.260J or permission of instructor
G (IAP)
2-0-1
See description under subject ESD.272J.
C. Caplice

1.273J Supply Chain Planning
(Same subject as 15.762J, ESD.267J)
Prereq: 1.260J, 15.760, or 15.761
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.762J.
S. C. Graves, D. Simchi-Levi

1.274J Manufacturing System and Supply Chain Design
(Same subject as 15.763J, ESD.268J)
Prereq: 1.260, 15.760, or 15.761
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.763J.
S. C. Graves, D. Simchi-Levi

1.275J Environmental Supply Chain Management
(Same subject as ESD.275J)
Prereq: 1.260, 15.760, or 15.761
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.765J.

1.276J Energy and Infrastructure Technologies
(Same subject as 11.486J)
Prereq: permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.486J.

1.277J Hazardous Waste Site Remediation and Risk Assessment
(Same subject as 11.486J)
Prereq: permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.486J.

1.278J Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 11.482J, ESD.193J)
Prereq: 1.481J or permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
See description under subject 11.482J.
K. R. Polenske

1.279J The Theory of Operations Management
(Same subject as 15.765J, ESD.275J)
Prereq: 1.260, 15.760, or 15.761
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.765J.
S. C. Graves, D. Simchi-Levi

1.280J Analyzing and Accounting for Regional Economic Change
(Same subject as 11.481J, ESD.192J)
Prereq: 14.03, 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.481J.
K. R. Polenske

1.281J Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 11.482J, ESD.193J)
Prereq: 1.481J or permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
See description under subject 11.482J.
K. R. Polenske

1.282J Energy and Infrastructure Technologies
(Same subject as 11.486J)
Prereq: permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.486J.

1.283J Urban and Regional Economics
(Same subject as 11.410J, 14.573J, ESD.191J)
Prereq: 14.03, 14.32
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.481J.
W. Wheaton

1.284J Analyzing and Accounting for Regional Economic Change
(Same subject as 11.481J, ESD.192J)
Prereq: 14.04, 14.32
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.481J.
K. R. Polenske

1.285J Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 11.482J, ESD.193J)
Prereq: 1.482J or permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
See description under subject 11.482J.
K. R. Polenske

1.286J Energy and Infrastructure Technologies
(Same subject as 11.477J)
Prereq: 11.481J or 11.482J
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.482J.
E. Kausel

1.287J Advanced Soil Dynamics
Prereq: Permission of Instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
E. Kausel

1.34 Waste Containment and Remediation Technology
Prereq: 1.72 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Hazardous waste site remediation and waste disposal facility design. Introduction to hazardous waste including definitions, US federal regulations, waste characteristics, environmental chemistry, hydrology, and contaminant transport. Characterization and remediation of contaminated sites, including preliminary site assessment, site investigation techniques, remediation technologies for soil and groundwater, risk assessment, and monitoring. Design,
construction, operation, and hydrology of waste disposal facilities.

D. Langseth

1.351 Theoretical Soil Mechanics
Prereq: 1.361
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit


A. J. Whittle

1.361 Advanced Soil Mechanics
(Subject meets with 1.032, 1.366)
Prereq: 1.035, 1.036
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 1.032.

L. C. Jen

1.364 Advanced Geotechnical Engineering
Prereq: None. Coreq: 1.361
G (Fall)
4-0-8 H-LEVEL Grad Credit

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 raftings) and deep (piles and caissons) foundations, excavation support systems, groundwater control, slope stability, soil improvement (compaction, soil reinforcement, etc.), and construction monitoring. Core requirement for Geotechnical MEng program.

A. J. Whittle

1.366 Geotechnical Engineering
(Subject meets with 1.032, 1.361)
Prereq: 1.035, 1.036
G (Fall)
3-0-6 H-LEVEL Grad Credit

See description under subject 1.032.

L. C. Jen

1.37 Geotechnical Measurements and Exploration
Prereq: 1.035
G (Fall)
3-4-2 H-LEVEL Grad Credit

Application of testing principles to the measurement of fundamental aspects of soil behavior from classification to engineering properties. Emphasis on rigorous techniques to measure mechanical behavior under various boundary conditions. Exposure to error estimation, research devices, geotechnical field exploration, and in situ testing. Extensive laboratory experiments to explore geotechnical test equipment and techniques. Laboratory use of testing automation and electronic instrumentation. Experiments include data analysis, evaluation, and presentation.

J. T. Germaine

1.38 Engineering Geology
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit

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: 1.38, 1.361
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6 H-LEVEL Grad Credit

Introduces theoretical and experimental aspects of rock mechanics and on this basis prepares the student for rock engineering. Includes review of laboratory and field testing; empirical and analytical methods for describing strength, deformability, and permeability of intact rock and rock masses; fracture mechanics and mechanics of discontinua including flow through discontinua; design and analysis of rock slopes and foundations on rock; and discussion of blasting design.

H. H. Einstein

1.383 Underground Construction
Prereq: 1.361, 1.38, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6 H-LEVEL Grad Credit

Provides familiarization with the most important aspects of planning, analysis, design, and construction of underground openings in soft ground 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.

H. H. Einstein

1.39 Studies in Geotechnical Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

For graduate students desiring further individual study of special topics.

Information: A. J. Whittle

CONSTRUCTION ENGINEERING AND MANAGEMENT

1.401J Project Management
(Same subject as ESD.018J)
(Subject meets with 1.040)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 1.040.

F. Moavenzadeh

1.462J Entrepreneurship in Construction and Real Estate Development
(Same subject as 11.345J)
Prereq: Permission of instructor
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit

See description under subject 11.345J.

J. F. Kennedy

1.463J Globalization and the Built Environment
(Same subject as 11.342J, ESD.53J)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit

Addresses the importance and pervasiveness of globalization in Architecture, Engineering and Construction Companies (AEC Firms). Covers strategies for a presence in the global market and the importance of the global financial mar-
MATERIALS AND STRUCTURES

1.541 Mechanics and Design of Concrete Structures
(Subject meets with 1.054)
Prereq: 1.051
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.054.
O. Buyukozturk

1.545 Atomistic Modeling and Simulation of Materials and Structures
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Covers multi-scale 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). Subject involves hands-on computational project.
M. J. Buehler

1.562 High-Performance Structures MEng Project
Prereq: None. Coreq: 1.561
G (Fall, IAP, Spring)
5-0-10 H-LEVEL Grad Credit
Core requirement for the High Performance Structures MEng program. Focus on the conceptual design of complex structures and the use of advanced technologies to improve the performance of structural systems with respect to their durability, constructability, efficiency and sustainability. An in-depth design study is carried out as a group effort and provides the background for individual student theses. Students must register for 1.562 for the Fall term, IAP, and the Spring term. Limited to Course 1 MEng students.
J. J. Connor, Jr.

1.56J Structural Mechanics in Nuclear Power Technology
(Same subject as 2.084a, 22.314j)
Prereq: 2.001 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.314j.
M. S. Kazimi, O. Buyukozturk

1.561 Motion-Based Design
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Presents a rational basis for the preliminary design of motion-sensitive structures. Topics include: analytical and numerical techniques for establishing the optimal stiffness distribution, the role of damping in controlling motion, tuned mass dampers, base isolation systems, and an introduction to active structural control. Examples illustrating the application of the motion-based design paradigm to building structures subjected to wind and seismic excitation are discussed.
J. J. Connor, Jr.

1.571 Structural Analysis and Control
Prereq: Permission of Instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
J. J. Connor, Jr.

1.572 Structural Systems
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Designed to complement general structural analysis classes. Provides an understanding of the full range of structures and structural forms, including how they are designed and built. Discusses the full range of structures and structural forms, including how they are designed and built.
their relative advantages in a qualitative manner. Case studies demonstrate how to conceive a structural form and consider its various options, and to understand assembly and construction methods intrinsic to the real behavior of the final structure.

E. Nelson

1.573J Structural Mechanics
(Same subject as 2.080J)
Prereq: 2.002 or 2.012
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 2.080J.
T. Wierzbicki, J. J. Connor, Jr., H. Schmidt

1.58 Steel Bridge Competition
(Subject meets with 1.055)
Prereq: None
G (Fall, IAP, Spring)
0-4-0
Can be repeated for credit
See description under subject 1.055.
J. J. Connor

1.581J Structural Dynamics and Vibrations
(Same subject as 2.060J, 16.221J)
(Subject meets with 1.058)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.058.
E. Kausel, J. K. Vandiver

1.582 Design of Steel Structures
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
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.
E. Nelson

1.589 Studies in Structural Design and Analysis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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

1.597 Studies in Construction Materials
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Advanced topics in construction materials selected by students for individual study with staff approval.
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
Meets with undergraduate subject 1.061. Graduate level includes additional homework in the form of reviews of relevant journal and practical articles. See description under subject 1.061.
H. M. Nepf

1.63J Advanced Fluid Dynamics
(Same subject as 2.26J)
Prereq: 18.085; 2.25 or permission of instructor.
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
4-0-8 H-LEVEL Grad Credit
See description under subject 2.26J.
T. R. Akylas, G. H. McKinley, R. Stocker

1.64 Physical Limnology
Prereq: 1.060, 1.061
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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; influence of vegetation. Begins with a review of Navier-Stokes equation.
H. M. Nepf

1.66 Problems in Water Resources and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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

1.67 Sediment Transport and Coastal Processes
Prereq: 1.061
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit
O. S. Madsen

1.685J Nonlinear Dynamics and Waves
(Same subject as 2.034J, 18.377J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.034J.
T. R. Akylas, R. R. Rosales

1.69 Introduction to Coastal Engineering
Prereq: 1.061
G (Fall)
4-0-8 H-LEVEL Grad Credit
Basic hydrodynamics of waves in deep and shallow water. Linear theory, dispersion, superposition, and spectral representation. Energy, energy transport, and dissipation by bottom friction. Refraction and diffraction by breakwaters. Some nonlinear aspects and wave breaking. Emphasizes physical interpretation of mathematical results and their engineering application. Storm surges, coastal circulation, and forecasting of...
wind-wave characteristics. Wind-wave statistics, wave forces on piles, and breakwater stability.

O. S. Madsen

1.692j Ocean Wave Interaction with Ships and Offshore Energy Systems
(Same subject as 2.24j)
Prereq: 2.20, 18.085
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-8 H-LEVEL Grad Credit
See description under subject 2.24j.
P. D. Sclavounos

1.699j Projects in Oceanographic Engineering
(Same subject as 2.689j)
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 2.689j.
T. K. Stanton, Woods Hole Staff

CIVIL AND ENVIRONMENTAL ENGINEERING

HYDROLOGY AND WATER RESOURCE SYSTEMS

1.714 Surface Hydrology
Prereq: 1.070
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

1.715 Environmental Data Analysis
Prereq: 1.010
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9
Covers probabilistic concepts and techniques that are useful for environmental data analysis. Topics include: random variables; hypothesis testing; linear regression; analysis of trends; space/time domain analysis; frequency domain analysis; simulation of random fields; Markovian processes; derived distributions; and stochastic differential equations. Problem sets emphasize environmental applications.

E. A. B. Eltahir

1.72 Groundwater Hydrology
Prereq: 1.061
G (Fall)
3-1-8 H-LEVEL Grad Credit
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. Core requirement for Environmental and Geoenvironmental MEng program.

C. Harvey, R. Juanes

1.721 Advanced Subsurface Hydrology
Prereq: 1.72, 18.075, permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

C. Harvey

1.723 Computational Methods for Flow in Porous Media
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

R. Juanes

1.725 Chemicals in the Environment: Fate and Transport
Prereq: Permission of instructor
G (Fall)
3-0-9
For MIT students in all departments interested in chemicals in the environment. Subject covers the movement of chemicals through water, air, and soil, and also addresses their eventual fate. Physical transport, as well as chemical and biological sources and sinks, are discussed. Emphasis on anthropogenic chemicals, though in the context of pre-existing natural chemical cycles. Linkages to health effects, sources and control, and policy aspects. Core requirement for Environmental MEng program.

H. Hemond, P. Shanahan

1.731 Water Resource Systems
Prereq: 1.070 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.

D. McLaughlin

AQUATIC SCIENCES, WATER QUALITY CONTROL, AND ENVIRONMENTAL MANAGEMENT

1.75 Limnology and Wetland Ecology
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Examines the major physical, chemical, and biological features of lakes and wetlands: basin geology, water budget, heat balance, thermal stratification, lake circulation, energy flow, biological communities, and cycles of major elements. Explores methodologies of limnology, including field methods and use of models, applications of modern sensor technology to lake and wetland studies and current issues in lake and wetland management.

H. F. Hemond
1.76 Aquatic Chemistry
Prereq: Chemistry (GIR) or 5.60
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Quantitative treatment of chemical processes in aquatic systems such as lakes, oceans, rivers, estuaries, groundwaters, and wastewater. 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

1.77 Water Quality Control
Prereq: 1.060
G (Spring)
3-0-9 H-LEVEL Grad Credit
Emphasis on mathematical models for predicting distribution and fate of effluents discharged into lakes, reservoirs, rivers, estuaries, and oceans. Focuses on formulation and structure of models as well as analytical and simple numerical solution techniques. Role of element cycles, such as oxygen, nitrogen, and phosphorus, as water quality indicators. Offshore outfalls and diffusion. Salinity intrusion in estuaries. Thermal stratification, eutrophication, and sedimentation processes in lakes and reservoirs. Core requirement for Environmental MEng program.
E. E. Adams

1.782 Environmental Engineering MEng Project
Prereq: Permission of instructor
G (Fall, IAP, Spring)
5-0-10 H-LEVEL Grad Credit
Core requirements for Environmental MEng program. Designed to teach about environmental engineering through the use of case studies, computer software tools, and seminars from industrial experts. Case studies provide basis for group project as well as individual thesis. Past case studies have included the MMR Superfund site on Cape Cod; restoration of the Florida Everglades; dredging of Boston Harbor; local watershed trading programs; appropriate wastewater treatment technology for Brazil; point-of-use water treatment for Nepal; Brownfields Development in Providence, RI, and water resource planning for the island of Cyprus. Students must register for 1.782 for Fall term, IAP, and Spring term. Limited to Course 1 MEng students.
E. E. Adams, P. Shanahan, S. Murcott

1.801J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 11.021J, 17.393J)
(Subject meets with 1.811J, 11.630J, ESD.133J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
Introduction to important issues in contemporary environmental law, policy, and economics. Discusses the roles and interactions of Congress, federal agencies, state governments, and the courts in dealing with environmental problems. Topics include common law, administrative law, environmental impact assessments required by the National Environmental Policy Act, and legislation and court decisions dealing with air pollution, water pollution, the control of hazardous waste, pollution and accident prevention, community right-to-know, and environmental justice. Explores the role of science and economics in legal decisions, and economic incentives as an alternative or supplement to regulation. Analyzes pollution as an economic problem and a failure of markets. Introduction to basic legal skills: how to read and understand cases, regulation, and statutes; how to discover the current state of the law in a specific area; and how to take action toward resolution of environmental problems. Students taking the graduate version are expected to explore the subject in greater depth.
N. Ashford, C. C. Caldart

1.802J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 11.631J, ESD.134J)
(Subject meets with 1.802J, 10.805J, 11.022J, ESD.136J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.802J.
N. A. Ashford, C. C. Caldart

1.811J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 11.630J, ESD.133J)
(Subject meets with 1.801J, 11.021J, 17.393J)
Prereq: Undergraduates require permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Reviews and analyzes federal and state regulation of air and water pollution and hazardous wastes. Analyzes pollution as an economic problem and the failure of markets. Emphasizes use of legal mechanisms and alternative approaches (such as economic incentives and voluntary approaches) to control pollution and to 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, community right-to-know, and environmental justice. Also provides an introduction to basic legal skills. Students taking the graduate version are expected to explore the subject in greater depth.
N. A. Ashford, C. C. Caldart

1.812J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 11.631J, ESD.134J)
(Subject meets with 1.802J, 10.805J, 11.022J, ESD.136J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.802J.
N. A. Ashford, C. C. Caldart

1.813J Sustainability, Trade, and the Environment
(Same subject as 11.466J, 15.657J, ESD.137J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.137J.
N. A. Ashford

1.814J Industrial Ecology
(Same subject as 3.560J, ESD.123J)
Prereq: ESD.10 or 3.56
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.123J.
R. Kirchain, J. Clark, F. Field
1.817J Planning, Participation, and Consensus Building for Sustainable Development
(Same subject as 11.366J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.366J.
Staff

1.818J Sustainable Energy
(Same subject as 2.65, 10.391J, 11.371J, 22.811J, ESD.166J)
Prereq: 5.60, 18.03
3-1-8 H-LEVEL Grad Credit
See description under subject 22.811J.
M. W. Golay

1.819J Design for Sustainability
(Same subject as 4.447J)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Teaches thought processes and quantitative tools, including life cycle assessment (LCA) and the LEED rating system, applicable to integrated/whole building design with the goal of minimizing the waste of materials, energy and water. Readings, lectures, site visits, and homework encourage systematic thinking and interdisciplinary collaboration to make sustainable design a reality. Includes a team project of students’ choice, such as a conceptual design of a sustainable new building, a “green” retrofit, or a comparative LCA.
J. Connor, J. Ochsendorf, E. Adams

1.82 Problems in Environmental Microbiology and Chemistry
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced topics in environmental microbiology, ecological genomics, microbial evolution and population genetics, oceanography, biogeochemical processes, environmental organic chemistry and aquatic chemistry. Includes independent study, seminar, laboratory, or field studies.

1.83 Environmental Organic Chemistry
(Subject meets with 1.831)
Prereq: 5.60, 18.03
G (Fall)
4-0-0 H-LEVEL Grad Credit
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 (related biological exposures) of anthropogenic and natural organic compounds. Graduate students taking 1.83 for H-level credit have additional reading and homework emphasizing structure-activity relationships.
P. M. Gschwend

1.831 Environmental Organic Chemistry
(Subject meets with 1.83)
Prereq: 5.60, 18.03
G (Fall)
4-0-8 H-LEVEL Grad Credit
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 (related biological exposures) of anthropogenic and natural organic compounds.
P. M. Gschwend

1.84J Atmospheric Chemistry
(Subject same as 10.817J, 12.807J)
Prereq: 5.60
G (Fall)
3-0-9 H-LEVEL Grad Credit
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 and photochemical smog; aerosol chemistry; and source and sinks of greenhouse gases.
J. H. Kroll

1.85 Water and Wastewater Treatment Engineering
Prereq: 1.061, 1.61, or 1.725
G (Fall)
3-0-9
Staff

1.851J Water and Sanitation Infrastructure in Developing Countries
(Same subject as 11.479J)
Prereq: None
G (Spring)
Units arranged
Principles of infrastructure planning in developing countries, with a focus on appropriate and sustainable technologies for water and sanitation. Incorporates technical, socio-cultural, public health, and economic factors into the planning and design of water and sanitation systems. Upon completion, students are able to plan simple, yet reliable, water supply and sanitation systems for developing countries that are compatible with local customs and available human and material resources. Graduate and upper division students from any department who are interested in international development at the grassroots level are encouraged to participate in this interdisciplinary subject.
S. Murcott

1.86J Methods and Problems in Microbiology
(Same subject as 7.492J, 20.445J)
Prereq: Permission of instructor or Coreq: 7.493
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 7.492J.
L. Samson, M. Polz

1.87J Microbial Genetics and Evolution
(Same subject as 7.493J, 20.446J)
Prereq: 7.03, 7.05, 7.28 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 7.493J.
A. D. Grossman, M. Polz, E. Alm
1.88 Physical Ecology at the Microscale
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Designed for students in fluid mechanics and engineering who want to explore applications of physics and fluids to biology and ecology, and for students in the biological sciences seeking to understand the physical constraints of life at the microscale. Topics include mass exchange and flow at the scale of microbes, motility and chemotaxis, encounter rates and predation, and small-scale turbulence. Emphasizes the application of physical and fluid dynamical principles to life at the microscale, in particular (but not limited to) aquatic systems.

R. Stocker

1.89 Environmental Microbiology
Prereq: 7.014
G (Fall)
3-0-9 H-LEVEL Grad Credit

A general introduction to the diverse roles of microorganisms in natural and artificial environments. Topics include: cellular architecture, energetics, and growth; evolution and gene flow; population and community dynamics; water and soil microbiology; biogeochemical cycling; and microorganisms in biodeterioration and bioremediation.

J. R. Thompson, M. F. Polz

1.899 Career Reengineering Program and Professional Development Workshops (New)
Prereq: Permission of instructor
G (Spring)
1-0-0 [P/D/F]

For students in the 10-month Career Reengineering Program sponsored by the School of Engineering. Limited to CRP fellows.

Staff

SPECIAL STUDIES

1.95J Teaching College-Level Science and Engineering (New)
(Same subject as 5.95J, 6.982J, 7.59J, 8.395J, 18.094J)
Prereq: None
G (Fall)
2-0-2 [P/D/F]

See description under subject 5.95J.

J. Rankin

1.968 Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

1.969 Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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, IAP, 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

1.983 Teaching in Civil and Environmental Engineering
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

For teaching assistants to recognize the educational value derived from satisfactory performance of assigned duties and for other qualified students interested in teaching as a career. Laboratory, tutorial, or classroom teaching under supervision of a faculty member. 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)
Units arranged H-LEVEL Grad Credit
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.

Information: H. Nepf

1.999 Undergraduate Studies in Civil and Environmental Engineering
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Individual study, research, or laboratory investigations under faculty supervision.

Consult Department Academic Programs Office

1.999 Undergraduate Studies in Civil and Environmental Engineering
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Consult Department Academic Programs Office

1.968 Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Consult Department Academic Programs Office

1.969 Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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, IAP, 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

1.983 Teaching in Civil and Environmental Engineering
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

For teaching assistants to recognize the educational value derived from satisfactory performance of assigned duties and for other qualified students interested in teaching as a career. Laboratory, tutorial, or classroom teaching under supervision of a faculty member. 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)
Units arranged H-LEVEL Grad Credit
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.

Information: H. Nepf

1.999 Undergraduate Studies in Civil and Environmental Engineering
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Individual study, research, or laboratory investigations under faculty supervision.

Consult Department Academic Programs Office

1.999 Undergraduate Studies in Civil and Environmental Engineering
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Consult Department Academic Programs Office

1.968 Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Consult Department Academic Programs Office

1.969 Graduate Studies in Civil and Environmental Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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, IAP, 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

1.983 Teaching in Civil and Environmental Engineering
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

For teaching assistants to recognize the educational value derived from satisfactory performance of assigned duties and for other qualified students interested in teaching as a career. Laboratory, tutorial, or classroom teaching under supervision of a faculty member. 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)
Units arranged H-LEVEL Grad Credit
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.

Information: H. Nepf
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 an SB 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.
Consult Department Academic Programs Office

1.5991 Special Undergraduate Subject in Civil and Environmental Engineering (1.991)
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

1.5978 Special Graduate Subject in Civil and Environmental Engineering (1.978)
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

1.5979 Special Graduate Subject in Civil and Environmental Engineering (1.979)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
### Bachelor of Science in Civil Engineering/Course 1-C

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 1.00, 1.018].</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 1.101 and 1.102 in the Departmental Program]</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**

17

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:

- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>159</td>
</tr>
<tr>
<td><strong>1.018</strong> Ecology I: The Earth System, 12, REST, CI-M</td>
<td></td>
</tr>
<tr>
<td><strong>1.020</strong> Ecology II: Engineering for Sustainability, 12; Physics I (GIR), 18.03*</td>
<td></td>
</tr>
<tr>
<td><strong>1.050</strong> Engineering Mechanics I, 12, REST; Physics I (GIR), Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td><strong>1.060</strong> Engineering Mechanics II, 12; permission of instructor*</td>
<td></td>
</tr>
<tr>
<td><strong>18.03</strong> Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td><strong>1.013</strong> Senior Civil and Environmental Engineering Design, 12, CI-M; permission of instructor</td>
<td></td>
</tr>
<tr>
<td><strong>1.00</strong> Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
<td></td>
</tr>
<tr>
<td><strong>1.010</strong> Uncertainty in Engineering, 12; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td><strong>Civil Engineering</strong></td>
<td></td>
</tr>
<tr>
<td><strong>1.011</strong> Project Evaluation, 9</td>
<td></td>
</tr>
<tr>
<td><strong>1.035</strong> Mechanics of Structures and Soils, 18; 1.050, 18.03</td>
<td></td>
</tr>
<tr>
<td><strong>1.036</strong> Structural and Geotechnical Engineering Design, 12; 1.035</td>
<td></td>
</tr>
<tr>
<td><strong>1.041</strong> Transportation Systems Modeling, 12; 1.00, 1.010*</td>
<td></td>
</tr>
<tr>
<td><strong>Laboratory</strong></td>
<td></td>
</tr>
<tr>
<td><strong>1.101</strong> Introduction to Civil &amp; Environmental Engineering Design I, 6, 1/2 LAB; 1.018, 1.050</td>
<td></td>
</tr>
<tr>
<td><strong>1.102</strong> Introduction to Civil &amp; Environmental Engineering Design II, 6, 1/2 LAB; 1.060, permission of instructor</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td>12</td>
</tr>
<tr>
<td>One advanced subject from the following list:</td>
<td></td>
</tr>
<tr>
<td><strong>1.015</strong> Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003; 2.671, 2.005*</td>
<td></td>
</tr>
<tr>
<td><strong>1.032</strong> Geomaterials and Geomechanics, 12; 1.010, 1.011, 1.035, 1.036</td>
<td></td>
</tr>
<tr>
<td><strong>1.054</strong> Mechanics and Design of Concrete Structures, 12; 1.035</td>
<td></td>
</tr>
<tr>
<td><strong>1.124</strong> Software and Computation for Simulation, 12; 1.00*</td>
<td></td>
</tr>
<tr>
<td><strong>1.200</strong> Transportation Systems Analysis: Performance and Optimization, 12; 1.010, permission of instructor</td>
<td></td>
</tr>
<tr>
<td><strong>1.205</strong> Transportation Systems Analysis: Demand and Economics, 12; permission of instructor</td>
<td></td>
</tr>
<tr>
<td><strong>1.252</strong> Urban Transportation Planning, 12; permission of instructor</td>
<td></td>
</tr>
<tr>
<td><strong>1.260</strong> Logistics Systems, 12; permission of instructor</td>
<td></td>
</tr>
<tr>
<td><strong>1.573</strong> Structural Mechanics, 12; 2.002*</td>
<td></td>
</tr>
</tbody>
</table>

Departmental Program Units That Also Satisfy the GIRs

(36)

**Unrestricted Electives**

48

**Total Units Beyond the GIRs Required for SB Degree**

183

No subject can be counted both as part of the 17-subject GIRs and as part of the 183 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

* Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
Bachelor of Science in Environmental Engineering Science/Course 1-E

General Institute Requirements (GIRs) Subjects
Science Requirement(i) 6
Humanities, Arts, and Social Sciences Requirement [one subject can be satisfied by 1.80J, 11.002, 11.122, or 14.01 in the Departmental Program] 8
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 1.018J, 1.050, and 18.03 in the Departmental Program] 2
Laboratory Requirement [can be satisfied by 1.101 and 1.102 in the Departmental Program] 1
Total GIR Subjects Required for SB Degree 17

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program
Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).

Required Subjects 168
Core
1.018J Ecology I: The Earth System, 12, REST, CI-M
1.020 Ecology II: Engineering for Sustainability, 12; Physics I (GIR), 18.03*
1.050 Engineering Mechanics I, 12, REST; Physics I (GIR), Calculus II (GIR)
1.060 Engineering Mechanics II, 12; permission of instructor*
18.03 Differential Equations, 12, REST; Calculus II (GIR)
1.013 Senior Civil and Environmental Engineering Design, 12, CI-M; permission of instructor

Environmental Engineering Science
1.061 Transport Processes in the Environment, 12; 1.060, 1.106 and 1.070, or permission of instructor
1.070 Introduction to Hydrology, 12; 1.060, 1.061, 1.106
1.080 Environmental Chemistry, 12; Chemistry (GIR)
1.083 Environmental Health Engineering and Biology, 12; 1.061, Chemistry (GIR), Biology (GIR)
1.106 Environmental Fluid Transport Processes and Hydrology Laboratory, 6, 1/2 LAB; 1.061, 1.070/
1.107 Environmental Chemistry and Biology Laboratory, 6, 1/2 LAB; 1.080

Economics and Public Policy
One of the following four subjects:
1.80J Environmental Law, Policy, and Economics: Pollution Prevention & Control, 12; HASS-S
11.002J Making Public Policy, 12; HASS-S, CI-H
11.122 Society and Environment, 12; HASS-S
14.01 Principles of Microeconomics, 12; HASS-S

Laboratory
1.101 Introduction to Civil and Environmental Engineering Design I, 6, 1/2 LAB; 1.018, 1.050
1.102 Introduction to Civil and Environmental Engineering Design II, 6, 1/2 LAB; 1.060, permission of instructor

Restricted Elective
One advanced subject from the following list:
1.071J Global Change Science, 12; 18.03, 5.60
1.64 Physical Limnology, 12; 1.060, 1.061
1.69 Introduction to Coastal Engineering, 12; 1.061
1.72 Groundwater Hydrology, 12; 1.061
1.731 Water Resource Systems, 12; 1.070*
1.77 Water Quality Control, 12; 1.060
1.83 Environmental Organic Chemistry, 12; 5.60, 18.03
1.89 Environmental Microbiology, 12; 7.014

Departmental Program Units That Also Satisfy the GIRs (48)
Unrestricted Electives 48

Total Units Beyond the GIRs Required for SB Degree 180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
* Alternate prerequisites and corequisites are listed in the subject description.
(i) Any of the subjects that fulfill the Institute Chemistry Requirement is satisfactory, though 5.111 or 5.112 is recommended.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
Bachelor of Science as Recommended by the Department of Civil and Environmental Engineering/Course 1-A

General Institute Requirements (GIRs)  Subjects
Science Requirement  6
Humanities, Arts, and Social Sciences Requirement  8
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 1.018J, 1.050, and 18.03 in the Departmental Program]  2
Laboratory Requirement [can be satisfied by 1.101 and 1.102 in the Departmental Program]  1
Total GIR Subjects Required for SB Degree  17

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program
Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).

Required Subjects  84
Core
1.018J Ecology I: The Earth System, 12, REST, CI-M
1.020 Ecology II: Engineering for Sustainability, 12; Physics I (GIR), 18.03*
1.050 Engineering Mechanics I, 12, REST; Physics I (GIR), Calculus II (GIR)
1.060 Engineering Mechanics II, 12; permission of instructor*
18.03 Differential Equations, 12, REST; Calculus II (GIR)
One of the following two subjects:
1.01 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)
1.010 Uncertainty in Engineering, 12; Calculus II (GIR)

Laboratory
1.101 Introduction to Civil and Environmental Engineering Design I, 6, 1/2 LAB; 1.018, 1.050
1.102 Introduction to Civil and Environmental Engineering Design II, 6, 1/2 LAB; 1.060, permission of instructor

Restricted Electives  84
Students are required to take a coherent set of seven full subjects that meet a well-defined educational goal. These electives may be from within or outside the Department of Civil and Environmental Engineering. Students must provide a clear rationale for their elective choices, which must be approved by their academic advisors and the undergraduate officer of the department.

Departmental Program Units That Also Satisfy the GIRs  (36)

Unrestricted Electives  48

Total Units Beyond the GIRs Required for SB Degree  180
No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
* Alternate prerequisites and corequisites are listed in the subject description.

(1) To satisfy the CI-M component of the Communication Requirement, students must take the department’s two CI-M subjects (1.013 and 1.018J) or, if appropriate, take one Course 1 CI-M subject and petition the Subcommittee on the Communication Requirement to substitute one CI-M from another science or engineering field. The outside CI-M must fit into the coherent program of electives approved by the student’s academic advisor.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
Course 2

Mechanical Engineering

Freshman Year
Introductory Subjects

2.00AJ Fundamentals of Engineering Design: Explore Space, Sea and Earth
(Same subject as 16.00AJ)
Prereq: None
U (Spring)
3-3-3

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 millfoil, 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.
A. H. Techet, D. Newman

2.00B Toy Product Design
Prereq: None
U (Spring)
3-5-1

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

Core Undergraduate Subjects

2.001 Mechanics and Materials I
Prereq: Physics I (GIR), Calculus II (GIR);
Coreq: 18.03
U (Fall, Spring)
3-2-7 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.
K. J. Bathe, A. E. Hosoi, C. Livermore

2.002 Mechanics and Materials II
Prereq: 2.001, Chemistry (GIR)
U (Fall, Spring)
3-3-6

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.
L. Anand, M. C. Boyce, K. Hamad-Schifferli, D. M. Parks

2.003J Dynamics and Control I
(Same subject as 1.053J)
Prereq: Physics I (GIR), 18.03
U (Fall, Spring)
4-1-7 REST

N. G. Hadjiconstantinou, J. K. Vandiver, N. C. Makris, N. M. Patrikalakis, T. Peacock

2.004 Dynamics and Control II
Prereq: 2.003, Physics II (GIR)
U (Fall, Spring)
4-2-6

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.

2.005 Thermal-Fluids Engineering I
Prereq: Physics II (GIR), Calculus II (GIR);
Coreq: 18.03
U (Fall, Spring)
5-0-7 REST

J. G. Brisson, J. Buongiorno, P. F. J. Lermusiaux, G. H. McKinley, A. Mitsos, E. N. Wang

J. G. Brisson, A. E. Hosoi, R. Karnik, G. H. McKinley

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.

D. Frey, D. Gossard, S. Kim

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.


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.

D. R. Wallace

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.

D. Hart

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.

D. Hart

Prereq: Physics II (GIR), 18.03

Principles of conservation of mass, momentum and energy in fluid mechanics. 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. Introduction to ocean acoustics; sound propagation and refraction. Sonar equation. Laboratory sessions in wave propagation, lift and drag forces on submerged bodies, and sound propagation.

A. H. Techet

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. Enrollment may be limited due to laboratory capacity.

F. S. Hover, J. J. Leonard

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. C. Chryssostomidis, M. S. Triantafyllou

DYNAMICS AND ACOUSTICS

2.032 Dynamics
Prereq: 2.003
G (Fall)
3-0-9 H-LEVEL Grad Credit


2.034j Nonlinear Dynamics and Waves
(Same subject as 1.685J, 18.377J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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. T. R. Akylas, R. R. Rosales

2.036j Nonlinear Dynamics and Chaos
(Same subject as 18.385J)
Prereq: 18.03 or 18.034
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 18.385J.
Information: R. R. Rosales

2.038j The Art of Approximation in Science and Engineering
(Same subject as 6.055J)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-0-9

See description under subject 6.055J.
S. Mahajan, R. Abeyaratne

2.050j Nonlinear Dynamics I: Chaos
(Same subject as 12.006J, 18.353J)
Prereq: 18.03 or 18.034; Physics II (GIR)
U (Fall)
3-0-9

See description under subject 12.006J.
L. Chumakova

2.06 Mechanical Vibration
Prereq: 2.003
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
4-0-8

Concepts of mechanical vibration, including free and forced vibration of single- and multi-degree of freedom systems. Modal analysis and matrix formulation of vibration problems. Approximate solution techniques. Vibration and modal analysis of continuous systems: beams, rods, and strings. Introduction to the response of linear systems to random excitation. Numerous examples and applications of vibration measurement and analysis, including vibration isolation and dynamic absorbers, ships, offshore structures, engines, and rotating machinery. J. K. Vandiver

2.062j Wave Propagation
(Same subject as 1.138J, 18.376J)
Prereq: 2.003, 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit


2.065 Acoustics and Sensing
(Subject meets with 2.066)
Prereq: 2.003, 6.003, 8.03, or 16.03
U (Spring)
3-0-9

2.066 Acoustics and Sensing
(Subject meets with 2.065)
Prereq: 2.003, 6.003, 8.03, 16.03, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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 H-LEVEL Grad Credit

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 plasticity. Mechanics of large deformation; nonlinear hyperelastic material behavior. Foundations and methods of deformable solids 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, M. C. Boyce, D. M. Parks

2.072 Mechanics of Continuous Media
Prereq: 2.071
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Physical basis of plastic/inelastic deformation of solids; metals, polymers, granular/rock-like materials. Continuum constitutive models for small and large deformation of elastic-viscoelastic plastic solids. Analytical and numerical solution of selected boundary value problems. Applications to deformation processing of metals.
L. Anand, M. C. Boyce, D. M. Parks

2.074 Solid Mechanics: Elasticity
Prereq: 2.002, Coreq: 18.03
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

D. M. Parks

2.080J Structural Mechanics
(Same subject as 1.573J)
Prereq: 2.002 or 2.012
G (Fall)
4-0-8 H-LEVEL Grad Credit

Fundamental concepts of structural mechanics with applications to marine, civil, and mechanical structures. Residual stresses. Thermal effects. Analysis of beams, columns, tensioned beams, trusses, frames, arches, cables, and shafts of general shape and material, including composites. Elastic buckling of columns. Exact and approximate methods, energy methods, principle of virtual work, introduction to computational structural mechanics. Examples from civil, mechanical, offshore, and ship structures.
T. Wierzbicki, J. J. Connor, Jr., H. Schmidt

2.081J Plates and Shells
(Same subject as 16.230J)
Prereq: 2.074, 2.080, or 16.21
G (Spring; first half of term)
3-0-3 H-LEVEL Grad Credit

T. Wierzbicki

2.082 Ship Structural Analysis and Design
Prereq: 2.081, 2.701
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit

Design application of analysis developed in 2.081J. 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

2.084J Structural Mechanics in Nuclear Power Technology
(Same subject as 1.56J, 22.314J)
Prereq: 2.001 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 22.314J.
M. S. Kazimi, O. Buyukozturk

2.085 Structural Impact
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring, second half of the term)
2-0-4 H-LEVEL Grad Credit

T. Wierzbicki

COMPUTATIONAL ENGINEERING

2.086 Numerical Computation for Mechanical Engineers
Prereq: 2.001, 2.003; Coreq: 2.005
U (Fall, Spring)
3-0-6

Introduction to programming concepts including variable types, data structures, flow control. Numerical methods relevant to MechE including approximation (interpolation, statistical regression); integration; solution of linear and nonlinear equations, eigenproblems, ordinary differential equations, partial differential equa-
2.089] Computational Geometry

(Same subject as 1.128J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit


N. M. Patrikalakis, D. C. Gossard

2.091J Software and Computation for Simulation

(Same subject as 1.124J, ESD.51J)
Prereq: 1.00 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 1.124J.
J. R. Williams

2.092 Finite Element Analysis of Solids and Fluids I

(Subject meets with 2.093)
Prereq: 2.001, 2.003
U (Fall)
3-0-9

2.093 Finite Element Analysis of Solids and Fluids I

(Subject meets with 2.092)
Prereq: 2.001, 2.003
G (Fall)
3-0-9 H-LEVEL Grad Credit

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

2.094 Finite Element Analysis of Solids and Fluids II

Prereq: 2.001
G (Spring)
3-0-9 H-LEVEL Grad Credit

Presents finite element theory and methods for general linear and nonlinear analyses. Reliable and effective finite element methods and their applications to solution of general problems in solid, structural and fluid mechanics, heat and mass transfer, and multiphysics problems including fluid-structure interactions. Formulation of governing continuum mechanics equations, conservation laws, virtual work, and variational principles for finite element solutions. Discretization of governing equations using finite element methods; stability, accuracy and convergence of methods. Solution of central problems and a term project using an existing general purpose finite element analysis program.

K. J. Bathe

2.096J Introduction to Numerical Simulation

(Same subject as 6.336J, 16.910J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 6.336J.
L. Daniel, J. K. White

2.097J Numerical Methods for Partial Differential Equations

(Same subject as 6.339J, 16.920J)
Prereq: 6.335J or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 16.920J.
A. T. Patera, J. K. White, K. E. Wilcox

2.099J Computational Mechanics of Materials

(Same subject as 16.225J)
Prereq: Permission of instructor, programming in either C++, C, or Fortran
G (Spring)
3-3-6 H-LEVEL Grad Credit

See description under subject 16.225J.
R. Radovitzky

2.110J Information, Entropy, and Computation

(Same subject as 6.050J)
Prereq: Physics I (GIR)
U (Spring)
4-0-5

See description under subject 6.050J.
P. Penfield, Jr., S. Lloyd

2.111J Quantum Computation

(Same subject as 8.411J, 18.435J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 18.435J.
I. Chuang, E. Farhi, S. Lloyd, P. Shor

2.12 Introduction to Robotics

Prereq: 2.004
U (Fall)
3-2-7

Overview of robot mechanisms, dynamics, and intelligent controls. Planar and spatial kinematics, motion planning; mechanism design for manipulators and mobile robots, multi-rigid-body dynamics, 3-D graphic simulation; control design, actuators, sensors; wireless networking, task modeling, human-machine interface, and imbedded software. Weekly laboratories for experience with servo drives, real-time control, and embedded software. Group term project requires design and fabrication of robotic systems.

H. Asada, I. J. Leonard

2.131 Advanced Instrumentation and Measurement

Prereq: Permission of Instructor
G (Fall)
3-6-3 H-LEVEL Grad Credit

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. 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
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 H-LEVEL Grad Credit

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.

D. Rowell, D. L. Trumper, K. Youcef-Toumi

2.141 Modeling and Simulation of Dynamic Systems
Prereq: 2.151
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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 electro-mechanical transducers, mechanisms, electronics, fluid and thermal systems, compressible flow, chemical processes, diffusion, and wave transmission.

N. Hogan

2.152 Nonlinear Control System Design
Prereq: 2.151, 6.241, 16.31, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit


J.-J. Slotine, J. J. Leonard

2.154 Maneuvering and Control of Surface and Underwater Vehicles
Prereq: 2.22
G (Fall)
3-0-9 H-LEVEL Grad Credit


M. S. Triantafyllou

2.156 Identification, Estimation, and Learning
Prereq: 2.151
G (Spring)
3-0-9 H-LEVEL Grad Credit

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, J.-J. Slotine

2.160 Identification, Estimation, and Learning
Prereq: Knowledge of system dynamics
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Provides a solid theoretical foundation for the analysis and processing of experimental data, and real-time experimental control methods. Includes spectral analysis, filter design, system identification, simulation in continuous and discrete-time domains. Emphasis on practical problems with laboratory exercises.

D. Rowell

2.165 Robotics
Prereq: 2.151 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit


J.-J. Slotine, H. Asada

2.166 Probabilistic Techniques for Mobile Robotics
Prereq: 6.041 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-1-8 H-LEVEL Grad Credit

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
2.170 Hands-On Marine Robotics
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Direct experience in developing marine robotic systems, from conceptualization and design through manufacture and testing. The class consists of a weekly seminar with readings and discussions, and significant outside work on student projects, culminating in a written report each term. Seminar topics include tools for unmanned marine work and their history, analysis of mission requirements, conceptual design and modeling of systems, experiments and proofs of concept, and project pacing and time management. A total of up to 12 hours credit may be taken over one or two terms; seminar topics repeat yearly.
F. S. Hover

2.171 Analysis and Design of Digital Control Systems (New)
Prereq: 2.14, 2.151, or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-3-6 H-LEVEL Grad Credit
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 Biomolecular Feedback Systems (New)
(Subject meets with 2.180)
Prereq: 18.03, Biology (GIR), or permission of instructor
G (Spring)
3-0-9 H-Level Grad Credit
2.180 Biomolecular Feedback Systems (New)
(Subject meets with 2.18)
Prereq: 18.03, Biology (GIR), or permission of instructor
U (Spring)
3-0-9
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 Biomechanics and Neural Control of Movement
(Subject meets with 2.184)
Prereq: 2.004 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
2.184 Biomechanics and Neural Control of Movement
(Subject meets with 2.183)
Prereq: 2.004 or permission of instructor
U (Spring)
3-0-9
Quantitative knowledge of human movement behavior is important in a growing number of engineering applications (medical & rehabilitation technology, athletic & 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 principles, impedance control, kinematic redundancy, optimization, intermittency, contact tasks and tool use. Students taking the graduate version will complete additional assignments.
F. S. Hover

2.195 Quantitative Design Strategies for Complex Systems
Prereq: 18.085
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines the synthesis of large-scale and complex engineered systems, such as flow networks, complex electromechanical machines, and groups of autonomous agents. Application examples are drawn from power systems, autonomous robots, and other areas. Covers various complex systems and their representations; analysis techniques, including parametric sensitivity analysis via Monte Carlo and collocation approaches; stability principles for large interconnections of dynamic elements; and robust load-flow design problems in distribution systems. Inherent complexity of large design problems, and stochastic synthesis approaches as an alternative to design-by-analysis.
F. S. Hover

FLUID MECHANICS AND COMBUSTION

2.20 Marine Hydrodynamics
Prereq: 2.006, 2.016, or 1.060
G (Fall)
4-1-7 H-LEVEL Grad Credit
D. K. P. Yue

2.22 Design Principles for Ocean Vehicles
Prereq: 2.20
G (Spring)
3-3-6 H-LEVEL Grad Credit
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, 18.085
G (Spring)
4-0-8 H-LEVEL Grad Credit
Develops theory and design of hydrofoil sections; lifting and thickness problems for subcavitated sections and unsteady flow problems. Computer-aided design of low drag, cavitation free sections. 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; computer-aided design of wake adapted propellers, steady and unsteady propeller thrust and torque; performance analysis and design of wind turbine rotors in steady and stochastic wind. Develops numerical principles of vortex lattice and lifting surface panel methods. Projects illustrate the development of computational methods for lifting, propeller and wind turbine flows; use of state-of-the-art simulation methods illustrates their use to lifting, propulsion and wind turbine applications.

P. D. Sclavounos

2.24j Ocean Wave Interaction with Ships and Offshore Energy Systems
(Same subject as 1.692j)
Prereq: 2.20, 18.085
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit

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 devices, 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; Coreq: 18.075 or 18.085
G (Fall)
4-0-8 H-LEVEL Grad Credit


A. F. Ghoniem, A. E. Hosoi, G. H. McKinley, A. T. Patera

2.26 Advanced Fluid Dynamics (2.21)
(Same subject as 1.63j)
Prereq: 18.085; 2.25 or permission of instructor.
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
4-0-8 H-LEVEL Grad Credit

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

2.27 Turbulent and Separated Flows
Prereq: 2.20 or 2.25; 18.075
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Governing equations, and statistical and dynamical theories of turbulence. Isotropic homogeneous turbulence, near wall turbulence, effects of free surface and surfactants and moving body boundary. Direct numerical simulations, large eddy simulations and sub-grid scale modeling, Reynolds-Average Navier-Stokes (RANS) equations and RANS turbulence models. Flow instability and transitions, almost parallel flows and inviscid and viscous instabilities. Laminar and turbulent separation, expansion flows, separated flows past bluff and streamlined bodies, flow induced vibrations.

D. Yue, A. Techet

2.28 Fundamentals and Applications of Combustion
Prereq: 2.006
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit


A. F. Ghoniem

2.29 Numerical Fluid Mechanics
Prereq: 2.006, 2.016, 2.20, or 2.25; 18.075
G (Fall)
4-0-8 H-LEVEL Grad Credit


P. F. J. Lermusiaux

2.341J Macromolecular Hydrodynamics
(Same subject as 10.531j)
Prereq: 2.25, 10.301, or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit

See description under subject 10.531j.

R. C. Armstrong, G. H. McKinley

MEMS AND NANOTECHNOLOGY

2.37 Fundamentals of Nanoengineering
(Subject meets with 2.370)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit

2.370 Fundamentals of Nanoengineering
(Subject meets with 2.37)
Prereq: 2.001; Chemistry (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8

Presents the fundamentals of molecular modeling in engineering in the context of nanoscale mechanical engineering applica-
MECHANICAL ENGINEERING

Applications to properties of materials, entropy, thermodynamic potential, and interactions 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

2.37J Design and Fabrication of Microelectromechanical Systems
(Same subject as 6.777J)
Prereq: 6.003 or 2.003, Physics II (GIR); or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.777J.
C. Livermore, D. Weinstein

2.374J Design and Fabrication of Microelectromechanical Systems
(Same subject as 6.717J)
Prereq: 6.003 or 2.003, Physics II (GIR); or permission of instructor
U (Fall)
3-0-9
See description under subject 6.717J.
C. Livermore, D. Weinstein

2.391J Nanostructure Fabrication
(Same subject as 6.781J)
Prereq: 6.152, 6.161, or 2.710; or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 6.781J.
H. I. Smith, G. Barbastathis, K. K. Berggren

THERMODYNAMICS

2.42 General Thermodynamics
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

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: 2.006, 1.020, 10.302, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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, electrodialysis, 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: 2.006 or permission of instructor
U (Fall)
3-0-9
Analysis, modeling, and design of heat and mass transfer processes with application to common technologies. Unsteady heat conduction in one or more dimensions, steady conduction in multidimensional configurations, numerical simulation; forced convection in laminar and turbulent flows; natural convection in internal and external configurations; phase change heat transfer; thermal radiation, black bodies, grey radiation networks, spectral and solar radiation; mass transfer at low rates, evaporation.
J. H. Lienhard, E. N. Wang

2.52J Modeling and Approximation of Thermal Processes
(Same subject as 4.424J)
Prereq: 2.51
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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)
3-0-9 H-LEVEL Grad Credit
Advanced treatment of fundamental aspects of heat and mass transport. Topics covered include: 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

2.56 Conduction and Change of Phase Heat Transfer
Prereq: 2.51, Coreq: 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit
J. H. Lienhard

2.57 Nano-to-Macro Transport Processes
(Same subject with 2.57)
Prereq: 2.005 or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

2.570 Nano-to-Macro Transport Processes
(Same subject with 2.57)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9
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 descrip-
tions. Applications in nanotechnology and microtechnology. Students taking the graduate version complete additional assignments. 

G. Chen

2.58j Radiative Transfer 
(Same subject as 10.74j) 
Prereq: 2.51, 10.302, or permission of instructor 
Acad Year 2011–2012: Not offered 
Acad Year 2012–2013: G (Spring) 
3-0-9 H-LEVEL Grad Credit

Principles of thermal radiation and their application to engineering heat and photon transfer problems. Quantum and classical models of radiative properties of materials, electromagnetic wave theory for thermal radiation, radiative transfer in absorbing, emitting, and scattering media, and coherent laser radiation. Applications cover laser-material interactions, imaging, infrared instrumentation, global warming, semiconductor manufacturing, combustion, furnaces, and high temperature processing.

G. Chen

2.59j Thermal Hydraulics in Power Technology 
(Same subject as 10.536j, 22.313j) 
Prereq: 2.006, 10.302, 22.312, or permission of instructor 
Acad Year 2011–2012: Not offered 
Acad Year 2012–2013: G (Spring) 
3-2-7 H-LEVEL Grad Credit

See description under subject 22.313j. 

N. E. Todreas, M. Podowski

ENERGY AND POWER SYSTEMS

2.60j Fundamentals of Advanced Energy Conversion 
(Same subject as 3.083j) 
Prereq: 2.006, 3.044, or permission of instructor 
U (Spring) 
4-0-8

Credit cannot also be received for 2.62

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. 

W. K. Cheng

2.61 Internal Combustion Engines 
Prereq: 2.006 
G (Spring) 
3-1-8 H-LEVEL Grad Credit

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. Enigne 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 H-LEVEL Grad Credit


M. Thomas, M. S. Triantafyllou

2.62 Fundamentals of Advanced Energy Conversion 
(Same subject as 3.64j, 10.392j, 22.40j) 
Prereq: 2.006, 3.044, or permission of instructor 
G (Spring) 
4-0-8 H-LEVEL Grad Credit

Credit cannot also be received for 2.60

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. 

W. K. Cheng

2.625j Electrochemical Energy Conversion and Storage: Fundamentals, Materials and Applications 
(Same subject as 10.625j) 
Prereq: 3.53, 2.005, 3.046, 10.40, or permission of instructor 
G (Fall) 
4-0-8 H-LEVEL Grad Credit

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 
G (Fall) 
4-0-8 H-LEVEL Grad Credit

2.627 Fundamentals of Photovoltaics 
(Subject meets with 2.626) 
Prereq: Permission of instructor 
U (Fall) 
4-0-8

Fundamentals of photovoltaic conversion: charge excitation, conduction, separation, and collection. Studies commercial and emerging photovoltaic technologies. Cross-cutting themes include conversion efficiencies, loss mechanisms, characterization, manufacturing, systems, reliability, life-cycle analysis, and risk analysis. Photovoltaic technology evolution in the context
of markets, policies, society, and environment. Graduate students complete additional work.

T. Buonassisi

**2.63 Applications of Technology in Energy and the Environment**

Engineering School-Wide Elective Subject

(Offered under: 1.149, 5.00, 10.579, 22.813, ESD.174)

Prereq: Permission of instructor

Acad Year 2011–2012: Not offered

Acad Year 2012–2013: G (Fall)

3-0-9 H-LEVEL Grad Credit

See description under subject 22.813.

J. Deutch, R. Lester

**2.64 Superconducting Magnets**

Prereq: 2.51

Acad Year 2011–2012: Not offered

Acad Year 2012–2013: G (Spring)

3-0-9 H-LEVEL Grad Credit

Covers design, manufacture, and operation issues of superconducting magnets for major engineering applications in biomedical science (NMR/MRI), high energy physics (dipole/quadrupole/detector), and electric power (motor/transformer/transmission cable). Begins with a review of superconductivity and its applications and electromagnetic theory. Topics include field analyses, mechanical and thermal stress analyses, stability analyses and protection design, cryogenics, experimental techniques, and harmonic analyses and active-passive shimming for NMR/MRI magnets.

Y. Iwasa, S. Hahn

**2.65] Sustainable Energy**

(Same subject as 1.818J, 10.391J, 11.371J, 22.811J, ESD.166J)

(Subject meets with 2.650J, 10.291J, 22.081J)

Prereq: Permission of instructor

G (Fall)

3-1-8 H-LEVEL Grad Credit

See description under subject 22.811J.

M. W. Golay

**2.650] Introduction to Sustainable Energy**

(Same subject as 10.291J, 22.081J)

(Subject meets with 1.818J, 2.65J, 10.391J, 11.371J, 22.811J, ESD.166J)

Prereq: Permission of instructor

U (Fall)

3-1-8

See description under subject 22.081J.

M. W. Golay

**2.66] Fundamentals of Energy in Buildings**

(Same subject as 1.044J, 4.42J)

Prereq: Physics I (GIR), Calculus II (GIR)

Acad Year 2011–2012: U (Fall)

Acad Year 2012–2013: Not offered

3-2-7 REST

See description under subject 4.42J.

L. R. Glicksman

**2.661] Architectural Thermal and Fluid Dynamics**

(Same subject as 4.423J)

Prereq: 2.005, 4.42, or 2.25

Acad Year 2011–2012: Not offered

Acad Year 2012–2013: G (Spring)

3-2-7 H-LEVEL Grad Credit

See description under subject 4.423J.

L. Glicksman, L. K. Norford

**2.67] Analysis and Design of Heating, Ventilating, and Air Conditioning Systems**

(Same subject as 4.427J)

Prereq: 2.06 or 4.42

Acad Year 2011–2012: G (Spring)

Acad Year 2012–2013: Not offered

3-0-9 H-LEVEL Grad Credit

See description under subject 4.427J.

L. K. Norford, L. Glicksman

**2.675 Micro/Nano Engineering Laboratory**

Prereq: None

U (IAP)

1-3-2

See description under subject 22.081J.

D. Frey, R. Fenner, B. J. Hughey

**2.676] Measurement and Instrumentation for NMR/MRI magnets.**

Harmonic analyses and active-passive shimming for NMR/MRI magnets.

L. Glicksman

**2.677 Micro/Nano Engineering Laboratory**

Prereq: None

U (Spring)

3-3-6 Institute LAB

See description under subject 22.813.

D. Frey, R. Fenner, B. J. Hughey

**2.678 Measurement and Instrumentation**

Prereq: 2.001, 2.003, 2.006, 2.671

0-3-3 1/2 Institute LAB

See description under subject 22.813.

I. W. Hunter, J. J. Leonard

**2.679] Project Laboratory**

Prereq: 2.001, 2.003, 2.006, 2.671

U (Fall, Spring)

Major emphasis on interplay between analytical and experimental methods in solution of research and development problems. Communication (written and oral) of results is also a strong component of the course. Groups of two or three students work together on three projects during the term. Enrollment limited.

W. Cheng, D. P. Hart

**2.68] Instrumentation and Measurement for Biological Systems**

(Same subject as 20.309J, MAS.402J)

(Subject meets with 20.409)

Prereq: Biology (GIR), Physics II (GIR), 6.00, 18.03; 2.001, 20.310, or 6.02; or permission of instructor; Coreq: 20.330

U (Fall)

3-6-3

See description under subject 20.309J.

Fell: S. Manalis, P. T. So, S. Wasserman

Spring: E. Boyden, S. Wasserman, M. F. Yanik

**2.69] Micro/Nano Engineering Laboratory**

Prereq: 2.25; 2.372 or permission of instructor

G (Spring)

1-3-2

**2.70] Micro/Nano Engineering Laboratory**

Prereq: 2.25; 2.372 or permission of instructor

G (Spring)

1-3-8 H-LEVEL Grad Credit

Concepts, ideas, and enabling tools of nanotechnology taught through lab modules and imaging tools, which include microfluidics, microthermal systems, MEMS, metamaterials, SEM, TEM, and AFM. Provides practical knowledge and experience via building, analyzing, and manipulating micro- and nanoscale structures. Teaches students how to apply engineering knowledge to practical fluid, thermal, and dynamic systems at small scales. Students taking the graduate version complete additional assignments.
Enrollment limited. 2.674 gives preference to Mechanical Engineering undergraduates.
S. G. Kim, C. Livermore, G. Chen, E. Wang, R. Karnik

OCEANOGRAPHIC ENGINEERING AND ACOUSTICS

2.681 Environmental Ocean Acoustics
Prereq: 2.066, 18.075 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
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
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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

2.685 Numerical Methods in Wave Scattering
Prereq: 2.066, 18.06
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Fundamental equations for acoustic and electromagnetic waves are derived from first principles. Boundary, or interface, conditions introduced. The development of numerical methods to solve wave equations in interior or exterior domains, using boundary-element and finite-element techniques, is emphasized. Spectral techniques are also developed. A number of technical computational issues are addressed, including discretization of geometry, order of approximation, efficiency, and analysis of numerical schemes. Validation is an essential exercise. Validation examples are drawn from analytical solutions for separable shapes. Applications of numerical methods are presented for acoustic scattering by marine organisms of complex shape and structure, and optical scattering by dielectric bodies. Assignments entail code development.
G. R. Feijoo, K. G. Foote, Woods Hole Staff

2.687 Time Series Analysis and System Identification
Prereq: 6.011, 18.06
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
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: 18.075, 2.671
G (Fall)
3-3-6 H-LEVEL Grad Credit

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.
M. A. Grosenbaugh, H. Singh, G. Terray, Woods Hole Staff
2.689] Projects in Oceanographic Engineering
(Same subject as 1.699I)
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
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.

T. K. Stanton, Woods Hole Staff

NAVAL ARCHITECTURE

2.700 Principles of Naval Architecture (New)
(Subject meets with 2.701)
Prereq: 2.002
U (Fall)
4-2-6
2.701 Principles of Naval Architecture
(Subject meets with 2.700)
Prereq: 2.002
G (Fall)
4-2-6
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. Graduates students complete additional assignments.

F. S. Hover, A. H. Techet, P. Small, P. D. Sclavounos

2.702 Systems Engineering and Naval Ship Design
Prereq: 2.701
G (Spring)
3-3-3 [P/D/F] H-LEVEL Grad Credit
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.

P. Small, M. Thomas

2.703 Principles of Naval Ship Design
Prereq: 2.082, 2.20, 2.611, 2.702
G (Fall)
4-2-6 H-LEVEL Grad Credit
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.

P. Small, M. Thomas

2.704 Projects in Naval Ship Conversion Design
Prereq: 2.703
G (Spring)
1-6-5 H-LEVEL Grad Credit
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.

M. Thomas, P. Small

2.705 Projects in New Concept Naval Ship Design
Prereq: 2.704
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.

M. Thomas, P. Small

2.707 Submarine Structural Acoustics
Prereq: 2.066
Acad Year 2011–2012: G (Spring; first half of term)
Acad Year 2012–2013: Not offered
2-0-4 H-LEVEL Grad Credit
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

OPTICS

2.71 Optics
(Subject meets with 2.710)
Prereq: Physics II (GIR); 18.03; 2.004 or permission of instructor
U (Spring)
3-0-9
2.710 Optics
(Subject meets with 2.71)
Prereq: Physics II (GIR); 18.03; 2.004 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to optical science with elementary engineering applications. Geometrical optics: ray-tracing, aberrations, lens design, apertures and stops, radiometry and photometry. Wave optics: basic electrodynamics, 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

2.715J Optical Microscopy and Spectroscopy for Biology and Medicine
(Same subject as 20.487J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9
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
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. Barbastathis

2.717 Optical Engineering
Prereq: 2.710 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

2.737 Mechatronics
Prereq: 6.071 or 6.002; 2.14, 6.302, or 16.30
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-5-4 H-LEVEL Grad Credit

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

2.739J Product Design and Development
(Same subject as 15.783J, ESD.32J)
Prereq: 2.009, 15.760, 15.761, or permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit

See description under subject 15.783J.

S. Eppinger, W. P. Seering

2.744J Product Design
(Same subject as ESD.64J)
Prereq: 2.009
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-1-8 H-LEVEL Grad Credit

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 processes, industrial design, visual communication, form-giving, mass production, marketing, and environmentally conscious design.

D. R. Wallace

2.745J Invention
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-2-7 H-LEVEL Grad Credit

Exposes students to the culture and methodology of the inventor. Examples of past invention and their impact on technology and society in their historical context. Examines the interplay between analysis and synthesis in the inventive process. Formal methods of promoting synthesis includes classic brainstorming, morphological analysis, and TRIZ theory. Through case studies, examine how feasibility study and proof of concept can be accomplished as well as the cyclical progression of a project through stages of synthesis, analysis and test. Elements of patent law. Majority of student effort is spent inventing. Laboratory time focused on proof of concept.

E. M. Sachs

2.75 Precision Machine Design
(Subject meets with 2.750)
Prereq: 2.72 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

2.750 Precision Machine Design
(Subject meets with 2.75)
Prereq: 2.72 or permission of instructor
U (Fall)
4-0-8

Intensive coverage of precision engineering theory, heuristics, and applications pertaining to the design of systems ranging from consumer products to machine tools and instruments. Topics covered include: economics, project management and design philosophy; principles of accuracy, repeatability, and resolution; error budgeting; sensors and sensor mounting; designs systems; bearings; actuators and transmissions; and system integration driven by functional requirements and operating physics. Emphasis on developing creative designs that are optimized by analytical techniques. Problem sets and test during first six weeks. Major team-based design project focus during last six weeks. Students taking the graduate version complete additional assignments. 2.750 provides instruction and practice in written and oral communication.

A. H. Slocombe, M. L. Culpepper

2.752 Development of Mechanical Products
(Subject meets with 2.753)
Prereq: 2.750, 2.009, or permission of instructor
U (Spring)
3-0-9

2.753 Development of Mechanical Products
(Subject meets with 2.752)
Prereq: 2.750, 2.009, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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 2.7H, Course 2 majors 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.

A. Slocum

2.76 Multi-Scale System Design and Manufacturing

(Subject meets with 2.760)
Prereq: 2.004, 2.008, or Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

2.760 Multi-Scale System Design and Manufacturing

(Subject meets with 2.76)
Prereq: 2.004, 2.008, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9

Multi-scale systems are complex with respect to traditional macro-scale systems in that the multi-scale systems use components from nano, micro, meso, and macro-scales. Subject provides the skills required to design and manufacture multi-scale systems. Emphasis is placed on understanding the systems design approach to multi-scale systems. Topics include design methodologies, modeling approaches, analytic tools, and manufacturing processes. Examples drawn from a diverse range of applications, including nanomanufacturing, nanoproducns, electronic test equipment, instrumentation, and nano/meso-scale machinery. Students master the materials through problem sets and a substantial term project, such as building a scanning tunneling microscope. Graduate students complete additional assignments.

S.-G. Kim, M. L. Culpepper

BIOENGINEERING

2.772J Thermodynamics of Biomolecular Systems

(Same subject as 20.110J)
Prereq: Calculus II (GIR), Chemistry (GIR)
U (Fall)
5-0-7 REST
See description under subject 20.110J.

E. Alm, K. Hamad-Schifferli

2.782J Design of Medical Devices and Implants

(Same subject as 3.961J, 20.451J, HST.524J)
Prereq: Chemistry (GIR), Biology (GIR), Physics I (GIR); or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit


I. V. Yannas, M. Spector

2.785J Cell-Matrix Mechanics

(Same subject as 3.97J, 20.411J, HST.523J)
Prereq: 2.001, Chemistry (GIR), Biology (GIR); or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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

2.789J Biomaterials: Tissue Interactions

(Same subject as 3.96J, 20.441J, HST.522J)
Prereq: Chemistry (GIR), Biology (GIR), Physics I (GIR); or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 20.441J.

I. V. Yannas, M. Spector

2.791J Cellular Biophysics

(Same subject as 6.021J, 20.370J)
Prereq: Physics II (GIR)), 2.005, 6.02, 6.003, 6.071, 10.301, 20.110, 20.111, or permission of instructor
G (Fall)
5-2-5
See description under subject 6.021J.

D. M. Freeman, J. Han, J. Voldman, M. F. Yanik

2.792J Quantitative Systems Physiology

(Same subject as 6.22J, 20.371J, HST.541J)
Prereq: Physics II (GIR)), 2.005, 6.021, 20.320 or permission of instructor
U (Spring)
4-0-8
See description under subject 6.22J.

R. G. Mark, C. M. Stultz

2.793J Fields, Forces and Flows in Biological Systems

(Same subject as 6.23J, 20.330J)
Prereq: 2.005, 6.021, 20.320 or permission of instructor
U (Spring)
4-0-8
See description under subject 20.330J.

J. Han, S. Manalis, N. Tedford

2.794J Cellular Biophysics

(Same subject as 6.521J, 20.470J, HST.541J)
Prereq: Physics II (GIR)), 2.005, 6.02, 6.003, 6.071, 10.301, 20.110, or permission of instructor
G (Fall)
5-2-5 H-LEVEL Grad Credit
See description under subject 6.521J.

D. M. Freeman, J. Han

2.795J Fields, Forces, and Flows in Biological Systems

(Same subject as 6.531J, 20.430J, HST.544J)
Prereq: Physics II (GIR)), 2.005, 6.02, 6.003, 6.071, 10.301, 20.110, 20.111, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.430J.

M. Bathe, A. J. Grodzinsky
2.796j Quantitative Physiology: Organ Transport Systems
(Same subject as 6.522J, 20.471J)
(Subject meets with 2.792J, 6.022J, 20.371J, HST.542J)
Prereq: 2.006 or 6.013; 6.021
G (Spring)
4-2-6 H-LEVEL Grad Credit
See description under subject 6.522J.
R. G. Mark, C. M. Stultz

2.797 Molecular, Cellular, and Tissue Biomechanics
(Same subject as 3.053J, 6.024J, 20.310J)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Spring)
4-0-8
See description under subject 20.310J.
Fall: R. D. Kamm
Spring: R. D. Kamm, A. J. Grodzinsky

2.798j Molecular, Cellular, and Tissue Biomechanics
(Same subject as 3.971J, 6.524J, 10.537J, 20.410J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.410J.
R. D. Kamm, K. Van Vliet

### MANUFACTURING

#### 2.813 Energy, Materials and Manufacturing
(Subject meets with 2.83)
Prereq: 2.008 or permission of instructor
U (Spring)
3-0-9
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. Class follows a mixed format with 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

#### 2.821j Materials Manufacturing
(Same subject as 3.371J)
Prereq: Permission of instructor
G (Summer)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.371J.
T. W. Eagar

#### 2.83 Energy, Materials and Manufacturing
(Subject meets with 2.813)
Prereq: 2.008 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.813.
T. G. Gutowski

#### 2.830j Control of Manufacturing Processes
(Same subject as 6.780J, ESD.63J)
Prereq: 2.008, 6.041, 6.152, or 15.064
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

#### 2.851j System Optimization and Analysis for Operations
(Same subject as 15.066J, ESD.750J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.066J.
V. Farias

#### 2.852 Manufacturing Systems Analysis
Prereq: 6.041 or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Models of manufacturing systems, including transfer lines and flexible manufacturing systems. Calculation of performance measures, including throughput, in-process inventory, and meeting production commitments. Real-time control of scheduling. Effects of machine failure, set-ups, and other disruptions on system performance.
S. B. Gershwin

#### 2.853 Introduction to Manufacturing Systems
(Subject meets with 2.854)
Prereq: 2.008
U (Fall)
3-0-9
2.854 Introduction to Manufacturing Systems
(Subject meets with 2.853)
Prereq: Undergraduate mathematics
G (Fall)
3-0-9 H-LEVEL Grad Credit
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

#### 2.875j Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development
(Same subject as ESD.875J)
Prereq: 2.008
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduces mechanical and economic models of assemblies and assembly automation on two levels. Assembly in the small comprises basic engineering models of rigid and compliant part
matting and explains the operation of the Remote Center Compliance. Assembly in the large takes a system view of assembly, including the notion of product architecture, feature-based design and computer models of assemblies, analysis of mechanical constraint, assembly sequence analysis, tolerances, system-level design for assembly and JIT methods, and economics of assembly automation. Case studies and current research included. Class exercises and homework include analyses of real assemblies, the mechanics of part mating, and a semester-long project.

D. E. Whitney

2.888 Professional Seminar in Global Manufacturing Innovation and Entrepreneurship
Prereq: None
G (Spring)
2-0-1
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. Opportunities for new ventures in manufacturing are explored. Intended primarily for Master of Engineering in Manufacturing students.

D. E. Whitney, S. B. Gershwin

2.890J Global Operations Leadership Seminar
(Same subject as 10.792J, 15.792J, 16.985J)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
See description under subject 15.792J.

D. B. Rosenfeld

ENGINEERING MANAGEMENT

2.96 Management in Engineering
Engineering School-Wide Elective Subject
(Offered under: 6.930, 10.806, 16.653)
Prereq: None
U (Fall)
3-1-8

2.961 Management in Engineering
Prereq: None
G (Fall)
3-1-8
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

2.963 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.

G. Apostolakis

2.965J International Supply Chain Management
(Same subject as 1.265J, 15.765J, ESD.265J)
Prereq: 1.260, 1.261, 1.262, 15.760, or permission of instructor
Acad Year 2011–2012: G (Spring; first half of term)
Acad Year 2012–2013: Not offered
2-0-4 H-LEVEL Grad Credit

An overview of globalization and the international environment: the international marketing, international finance and supply chain interface; global strategy for logistics and supply chain management; global supply chain models; role of government intervention and regulations; the role of international air and ocean carriers. Emphasis on both strategy formulation and implementation.

Staff

ADVANCED TOPICS AND SPECIAL SUBJECTS

2.993–2.994 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 J. H. Lienhard

2.996–2.998 Advanced Topics in Mechanical Engineering
Prereq: Permission of instructor
G (Fall, IAP, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

2.997–2.998 Graduate Special Subject in Mechanical Engineering (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit if subject matter is completely different

Advanced lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects. 2.972–2.974 are graded P/D/F.

Consult J. H. Lienhard

2.9997–2.9998 Graduate Special Subject in Mechanical Engineering (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit if subject matter is completely different

2-0-4 H-LEVEL Grad Credit

Advanced lecture, seminar or laboratory course consisting of material not offered in regularly scheduled subjects.

Consult D. H. Hardt

THESIS, RESEARCH AND PRACTICE

2.978 Instruction in Teaching Engineering
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F] H-LEVEL Grad Credit

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
Prerequisite: None
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.

J. H. Lienhard

2.999 Engineer's Degree Thesis Proposal Preparation
Prerequisite: Permission of instructor
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

For students who must do additional work to convert an SM thesis to an ME thesis, or for students who write an ME thesis after having received an SM degree.

D. Hardt, M. S. Triantafyllou

2.EPE UPOP Summer Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 22.EPE)
Prerequisite: 2.EPW or permission of instructor
Units arranged [P/D/F]
Can be repeated for credit twice for credit

Immerses engineering sophomores in the world of professional engineering experience by providing guided instruction in all aspects of the job acquisition process. Students complete a 10-12 week internship assignment during the summer, which includes maintaining a structured journal of observations and experiences, meeting with UPOP staff members, writing essays, and completing a self-evaluation. Spring term can be taken only in conjunction with fall term.

S. Luperfoy

2.EPR UPOP Reflective Learning Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR, 22.EPR)
Prerequisite: 2.EPE or permission of instructor
Units arranged [P/D/F]
Can be repeated for credit

Reflective learning experiences for engineering juniors that serve as the culmination of their sophomore year in the UPOP program. Students review their internship experiences through written and oral presentations and receive small-group and individualized coaching to reinforce the cognitive link between all aspects of the UPOP experience and their disciplinary field of study.

S. Luperfoy

2.EPW UPOP IAP Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prerequisite: None
Units arranged
Can be repeated for credit

Introduction to professional development skills for engineering practice. Experiential learning modules prepare sophomores for success in summer internship and beyond. Faculty and senior engineering professionals recruited from industry guide teams through learning activities, which include creative simulations, team competitions, oral presentations, and group problem-solving. Enrollment limited.

S. Luperfoy

2.THG Graduate Thesis
Prerequisite: Permission of advisor
Units arranged H-LEVEL Grad Credit
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 D. Hardt

2.THU Undergraduate Thesis
Prerequisite: None
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 J. H. Lienhard

2.URG Undergraduate Research in Mechanical Engineering
Prerequisite: None
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. Hardt
# Bachelor of Science in Mechanical Engineering/Course 2

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td></td>
</tr>
<tr>
<td>[can be satisfied by 2.001 and 18.03 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>2</td>
</tr>
<tr>
<td>[can be satisfied by 2.671 in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M) [satisfied by 2.009 and 2.671 in the Departmental Program].

## PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Departmental Core Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.001 Mechanics and Materials I, 12; REST; Physics I (GIR), Calculus II (GIR), 18.03</td>
<td>159</td>
</tr>
<tr>
<td>2.002 Mechanics and Materials II, 12; 2.001, Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>2.003 Dynamics and Control I, 12; REST; Physics I (GIR), 18.03</td>
<td></td>
</tr>
<tr>
<td>2.004 Dynamics and Control II, 12; 2.003J, Physics II (GIR)</td>
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<tr>
<td>2.005 Thermal-Fluids Engineering I, 12; REST; Physics II (GIR), Calculus II (GIR), 18.03</td>
<td></td>
</tr>
<tr>
<td>2.006 Thermal-Fluids Engineering II, 12; 2.005, 18.03</td>
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<tr>
<td>2.008 Design and Manufacturing II, 12; 1/2 LAB; 2.001; 2.005; 2.007 or 2.027</td>
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<tr>
<td>2.009 The Product Engineering Process, 12, CI-M; 2.001, 2.003J, 2.005; 2.008 or 2.670; senior standing or permission of instructor</td>
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<tr>
<td>2.086 Numerical Computation for Mechanical Engineers, 12; 2.001, 2.003J; 2.005</td>
<td></td>
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<tr>
<td>2.670 Measurement and Instrumentation, 12, LAB, CI-M; 2.001, 2.003J, Physics II (GIR)</td>
<td></td>
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<tr>
<td>2.671 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
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<tr>
<td>2.71 Undergraduate Thesis, 6th</td>
<td></td>
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<tr>
<td>and 2.007 Design and Manufacturing I, 12; 2.001</td>
<td></td>
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<tr>
<td>or 2.037 Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J; 2.005 or 2.016; 2.671</td>
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<tr>
<td>2.672 Project Laboratory, 6, 1/2 LAB; 2.001, 2.003J, 2.006, 2.671</td>
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<tr>
<td>or 2.674 Micro/Nano Engineering Laboratory, 6; 2.001, 2.003J, 2.005; 2.671*</td>
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</tbody>
</table>

### Restricted Elective Subjects

Students are required to take two of the following elective subjects (substitutions by petition to the MechE Undergraduate Office):

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.016 Hydrodynamics, 12; Physics II (GIR), 18.03</td>
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<tr>
<td>2.017 Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J; 2.005 or 2.016; 2.671</td>
<td></td>
</tr>
<tr>
<td>2.019 Design of Ocean Systems, 12, CI-M; 2.001; 2.003J; 2.005 or 2.016; senior standing or permission of instructor</td>
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<tr>
<td>2.050 Nonlinear Dynamics I: Chaos, 12; 18.03 or 18.034; Physics II (GIR)</td>
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<tr>
<td>2.092 Computer Methods in Dynamics, 12; 2.001, 2.003J</td>
<td></td>
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<tr>
<td>2.12 Introduction to Robotics, 12; 2.004</td>
<td></td>
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<tr>
<td>2.14 Analysis and Design of Feedback Control Systems, 12; 2.004</td>
<td></td>
</tr>
<tr>
<td>2.184 Biomechanics and Neural Control of Movement, 12; 2.004*</td>
<td></td>
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<tr>
<td>2.370 Molecular Mechanics, 12; 2.001; Chemistry (GIR)</td>
<td></td>
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<tr>
<td>2.41 Intermediate Heat and Mass Transfer, 12; 2.006*</td>
<td></td>
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<tr>
<td>2.46 Fundamentals of Advanced Energy Conversion, 12; 2.006*</td>
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<tr>
<td>2.71 Optics, 12; Physics II (GIR); 18.03; 2.004*</td>
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<tr>
<td>2.72 Elements of Mechanical Design, 12; 2.005, 2.007, 2.671</td>
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</tr>
<tr>
<td>2.799 Field, Forces and Flows in Biological Systems, 12; 2.005*</td>
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</tr>
<tr>
<td>2.799 Molecular, Cellular, and Tissue Biomechanics, 12; 18.03 or 3.016; Biology (GIR); 2.370 or 2.772</td>
<td></td>
</tr>
<tr>
<td>2.833 Environmentally Benign Design and Manufacturing, 12; 2.008*</td>
<td></td>
</tr>
<tr>
<td>2.96 Management in Engineering, 12</td>
<td></td>
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</tbody>
</table>

### Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>(36)</td>
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</tbody>
</table>

### Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
</tr>
</tbody>
</table>
Total Units Beyond the GIRs Required for SB Degree

195

No subject can be counted both as part of the 17-subject GIRs and as part of the 195 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes

* Alternate prerequisites or corequisites are listed in the subject description.

(1) Students who have completed a subject that provides equivalent experience (e.g., 2.00B) may petition to substitute; contact the MechE Undergraduate Office, Room 1-110, for information.

(2) To encourage more substantial research, design, or independent study, the department permits up to 15 units of 2.77U credit, subject to approval of the student’s thesis advisor.

(3) The department suggests that students elect a basic electronics subject (e.g., 6.002 or 6.071) as early as possible in their program.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
Bachelor of Science in Engineering as Recommended by the Department of Mechanical Engineering/Course 2-A

General Institute Requirements (GIRs)  
Subjects | Subjects
--- | ---
Science Requirement | 6
Humanities, Arts, and Social Sciences Requirement | 8
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 2.001 and 18.03 in the Departmental Program] | 2
Laboratory Requirement [satisfied by 2.671 in the Departmental Program] | 1
Total GIR Subjects Required for SB Degree | 17

Communication Requirement
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M) [satisfied by 2.009 and 2.671 in the Departmental Program].

PLUS Departmental Program  
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

Required Departmental Core Subjects  
Units | Units
--- | ---
2.001 Mechanics and Materials I, 12, REST; Physics I (GIR), Calculus II (GIR), 18.03 | 75
2.003J Dynamics and Control I, 12, REST; Physics I (GIR), 18.03 | 
2.005 Thermal-Fluids Engineering I, 12, REST; Physics II (GIR), Calculus II (GIR), 18.03 | 
2.009 The Product Engineering Process, 12, CI-M; 2.001, 2.003J, 2.005; 2.670 or 2.00B; senior standing or permission of Instructor | 
2.670 Mechanical Engineering Tools, 3(1) | 
2.671 Measurement and Instrumentation, 12, LAB, CI-M; 2.001, 2.003J, Physics II (GIR) | 
18.03 Differential Equations, 12, REST; Calculus II (GIR) | 
Two Additional Mechanical Engineering Subjects | 24
2.002 Mechanics and Materials II, 12; 2.001, Chemistry (GIR) | 
2.004 Dynamics and Control II, 12; 2.003J, Physics II (GIR) | 
2.006 Thermal-Fluids Engineering II, 12; 2.005, 18.03 | 
2.007 Design and Manufacturing I, 12; 2.001 | 
2.008 Design and Manufacturing II, 12, 1/2 LAB; 2.001; 2.005; 2.007 or 2.017 | 
2.086 Numerical Computation for Mechanical Engineers, 12; 2.001, 2.003J, 2.005 | 
2.ThU Undergraduate Thesis, 12 | 
Elective Subjects with Engineering Content (2) | 72
Departmental Program Units That Also Satisfy the GIRs | (36)
Unrestricted Electives | 48
Total Units Beyond the GIRs Required for SB Degree | 183

No subject can be counted both as part of the 17-subject GIRs and as part of the 183 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

Notes
* Alternate prerequisites and corequisites are listed in the subject description.
(1) Students who have completed a subject that provides equivalent experience (e.g., 2.00B) may petition to substitute; contact the MechE Undergraduate Office, Room 1-110, for information.
(2) These electives define a concentrated area of study and must be chosen with the written approval of the MechE Undergraduate Office. A minimum of 69 units of engineering topics must be included in the 72 units of concentration electives. Engineering topics are usually obtained from engineering courses, but in some cases, non-engineering subjects may be necessary for the particular engineering program defined by the concentration (e.g., management subjects for an engineering management concentration). In all cases, the relationship of concentration subjects to the theme of the concentration must be obvious. A thesis (2.ThU) of up to 12 units may be included among the concentration subjects if not already applied to the second-level requirement.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
# Bachelor of Science in Mechanical and Ocean Engineering/Course 2-OE

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 2.001 and 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 2.671 in the Departmental Program]</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**

17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M) [satisfied by 2.019 and 2.671 in the Departmental Program].

## PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Departmental Subjects

<table>
<thead>
<tr>
<th>Subject Names</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.001 Mechanics and Materials I, 12, REST; Physics I (GIR), Calculus II (GIR), 18.03</td>
<td>147</td>
</tr>
<tr>
<td>2.002 Mechanics and Materials II, 12; 2.001, Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>2.003J Dynamics and Control I, 12, REST; Physics I (GIR), 18.03</td>
<td></td>
</tr>
<tr>
<td>2.004 Dynamics and Control II, 12; 2.003J, Physics II (GIR)</td>
<td></td>
</tr>
<tr>
<td>2.005 Thermal-Fluids Engineering I, 12, REST; Physics II (GIR), Calculus II (GIR), 18.03</td>
<td></td>
</tr>
<tr>
<td>2.016 Hydrodynamics, 12; Physics II (GIR), 18.03</td>
<td></td>
</tr>
<tr>
<td>2.017J Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J; 2.016 or 2.005; 2.671</td>
<td></td>
</tr>
<tr>
<td>2.019 Design of Ocean Systems, 12, CI-M; 2.001; 2.003J; 2.005 or 2.016; senior standing or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>2.086 Numerical Computation for Mechanical Engineers, 12; 2.001, 2.003J, 2.005</td>
<td></td>
</tr>
<tr>
<td>2.612 Marine Power and Propulsion, 12; 2.005</td>
<td></td>
</tr>
<tr>
<td>2.670 Mechanical Engineering Tools, 3*</td>
<td></td>
</tr>
<tr>
<td>2.671 Measurement and Instrumentation, 12, LAB, CI-M; 2.001, 2.003J, Physics II (GIR)</td>
<td></td>
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<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
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</tbody>
</table>

### Restricted Elective Subjects

<table>
<thead>
<tr>
<th>Subject Names</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.006 Thermal Fluids Engineering II, 12; 2.005, 18.03</td>
<td>24</td>
</tr>
<tr>
<td>2.007 Design and Manufacturing I, 12; 2.001</td>
<td></td>
</tr>
<tr>
<td>2.008 Design and Manufacturing II, 12, 1/2 LAB; 2.001; 2.005; 2.007 or 2.017J</td>
<td></td>
</tr>
<tr>
<td>2.065 Acoustics and Sensing, 12; 2.003J*</td>
<td></td>
</tr>
<tr>
<td>2.092 Computer Methods in Dynamics, 12; 2.001, 2.003J</td>
<td></td>
</tr>
<tr>
<td>2.12 Introduction to Robotics, 12; 2.006</td>
<td></td>
</tr>
<tr>
<td>2.14 Analysis and Design of Feedback Control Systems, 12; 2.004</td>
<td></td>
</tr>
<tr>
<td>2.51 Intermediate Heat and Mass Transfer, 12; 2.006*</td>
<td></td>
</tr>
<tr>
<td>2.60 Fundamentals of Advanced Energy Conversion, 12; 2.006*</td>
<td></td>
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<tr>
<td>2.70 Principles of Naval Architecture, 12; 2.002</td>
<td></td>
</tr>
<tr>
<td>2.72 Elements of Mechanical Design, 12; 2.005, 2.007, 2.671</td>
<td></td>
</tr>
<tr>
<td>2.96 Management in Engineering, 12</td>
<td></td>
</tr>
<tr>
<td>2.7U Undergraduate Thesis, 12</td>
<td></td>
</tr>
</tbody>
</table>

### Departmental Program Units That Also Satisfy the GIRs

(36)

### Unrestricted Electives

48

## Total Units Beyond the GIRs Required for SB Degree

183

No subject can be counted both as part of the 17-subject GIRs and as part of the 183 units required beyond the GIRs. Every subject in the student’s Departmental Program will count toward one or the other, but not both.

### Notes

* Alternate prerequisites and corequisites are listed in the subject description.

** Students who have completed a subject that provides equivalent experience (e.g., 2.008) may petition to substitute; contact the MechE Undergraduate Office, Room 1-110, for information.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
3.003 Principles of Engineering Practice
(Subject meets with 3.004)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
1-2-6
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 freshmen.
L. Kimerling, R. Kirchain, C. Weaver, W. Uricchio, H. Einstein

3.004 Principles of Engineering Practice (New)
(Subject meets with 3.003)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-3-6
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. Preference to freshmen.
L. Kimerling

3.012 Fundamentals of Materials Science and Engineering
Prereq: None. Coreq: 18.03, 18.034, or 3.016
U (Fall)
5-0-10 REST
Describes the fundamentals of structure and energetics that underpin materials science. Introduction to thermodynamic functions and laws governing equilibrium properties, relating macroscopic behavior to atomistic and molecular models of materials. Materials phenomena, such as heat capacities, phase transformations, multiphase equilibria, chemical reactions, and magnetism. 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. Real-world examples such as materials for fuel cells and batteries, engineered alloys, electronic and magnetic materials, ionic and network solids, polymers, and biomaterials.
S. Gradecak, J. Grossman

3.014 Materials Laboratory
Prereq: None
U (Fall)
1-4-7 Institute LAB
Experimental exploration of the connections between energetics, bonding and structure of materials, and application of these principles in instruments for materials characterization. Demonstration of the wave-like nature of electrons. Hands-on experience with techniques to quantify energy (DSC), bonding (XPS, AES, FTIR, UV/vis and force spectroscopy), and degree of order (x-ray scattering) in condensed matter. Investigation of structural transitions and structure-property relationships through practical materials examples. Practice in oral and written technical communication. It is strongly recommended that 3.012 and 3.014 are taken simultaneously.
L. Hobbs, L. Kimerling

3.016 Mathematical Methods for Materials Scientists and Engineers
Prereq: Calculus II (GIR)
U (Fall)
3-1-8
Mathematical techniques necessary for materials science and engineering topics such as energetics, materials structure and symmetry, materials response to applied fields, mechanics and physics of solids and soft materials. Mathematical concepts and materials-related problem solving skills. Symbolic algebraic computational methods, programming, and visualization techniques. Topics include linear algebra, quadratic forms, tensor operations, symmetry operations, calculus of several variables, eigensystems, introduction to complex analysis, systems of ordinary and partial differential equations, phase plane analysis, beam theory, resonance phenomena, special functions, numerical solutions, statistical analysis, Fourier analysis, and random walks.
W. C. Carter

3.021 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject
(Offered under: 1.021, 10.333, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 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, J. Grossman

3.022 Microstructural Evolution in Materials
Prereq: 3.012
U (Spring)
3-3-6
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 electrochemical 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.
M. Cima, L. Hobbs, G. Beach, C. Carter
3.024 Electronic, Optical and Magnetic Properties of Materials
Prereq: 3.012
U (Spring)
3-3-6
Describes how the electronic, optical and magnetic properties of materials originate from their electronic and molecular structure and how these properties can be designed for particular applications, for instance in optical fibers, magnetic data storage, solar cells, transistors and other devices. Experimental exploration of the electronic, optical and magnetic properties of materials. Includes hands-on experimentation using spectroscopy, resistivity, impedance and magnetometry measurements, behavior of light in waveguides, and other characterization methods. Investigation of structure-property relationships through practical materials examples.
A. Belcher, L. Gibson, M. F. Rubner, K. Van Vliet

3.032 Mechanical Behavior of Materials
Prereq: Physics I (GIR); 3.016 or 18.03
U (Fall)
4-2-6
Basic concepts of solid mechanics and mechanical behavior of materials, stress-strain relationships, stress transformation, elasticity, plasticity and fracture. Case studies include materials selection for bicycle frames, stress shielding in biomedical implants; residual stresses in thin films; and ancient materials. Lab experiments and demonstrations give hands-on experience of the physical concepts at a variety of length scales. Use of facilities for measuring mechanical properties including standard mechanical tests, bubble raft models, atomic force microscopy and nanoindentation.
A. Belcher, L. Gibson, M. Rubner, K. J. Van Vliet

3.034 Organic and Biomaterials Chemistry
Prereq: 3.012
U (Fall)
4-2-6
Focuses on the chemistry and chemical structure-property relationships of soft synthetic and biologically derived materials. Topical coverage includes: methods for preparing synthetic polymers by step and chain growth polymerizations; polymerization reaction kinetics; chemistry of proteins, nucleic acids, polysaccharides and lipids, and their incorporation into biomaterials and biosensors; enzymatic reactions and ligations; chemical modification and patterning of organic and inorganic surfaces using organosilane and self-assembled monolayer chemistries, radiation grafting, physisorption and microcontact printing; organic systems as templates for inorganic materials; sol gel syntheses, polymer precursor conversions, polymer vesicle naroreactors; chemical degradation of soft materials through readiation, hydrolysis, and thermolysis; electroactive organic materials. First-hand application of lecture topics is obtained through design-oriented experiments.
A. Belcher, L. Gibson, M. F. Rubner, K. Van Vliet

3.035 Problems in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
B. Wuensch

3.036, 3.037 Problems in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
H. L. Tuller

3.038, 3.039, 3.04 Problems in Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, IAP, 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.
B. J. Wuensch

3.042 Materials Project Laboratory
Prereq: 3.014, 3.032, or 3.044
U (Fall, Spring)
1-6-5
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.
Fall: E. Fitzgerald
Spring: Y. Chiang

3.044 Materials Processing
Prereq: 3.012, 3.022
U (Spring)
4-0-8
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.
C. Schuh

3.046 Thermodynamics of Materials
Prereq: 18.03, 18.034, or 3.016
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
4-0-8 REST
The laws of thermodynamics and their application to equilibrium and the properties of materials. Foundation to treat general phenomena in materials science and engineering, including chemical reactions, magnetism, polarizability, and elasticity. Relations pertaining to multiphase equilibria as determined by a treatment of solution thermodynamics. Graphical constructions that are essential for the interpretation of phase diagrams. Electrochemical equilibria and surface thermodynamics. Aspects of statistical thermodynamics as they relate to macroscopic equilibrium phenomena.
W. C. Carter

3.048 Advanced Materials Processing
Prereq: 3.022, 3.044
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
Fundamentals of materials processing. Building engineering structures from the atomic- and nano-scales to macroscopic levels. Case studies illustrating application of processing science to creation of modern metallic, ceramic, polymeric and biomaterials devices and components.
Staff
3.051J Materials for Biomedical Applications
(Subject meets with 3.962J, 20.462J)
Prereq: Chemistry (GIR), Biology (GIR), 3.034, 3.012 or 3.046; or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9
D. Irvine

3.052 Nanomechanics of Materials and Biomaterials
Prereq: 3.032 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
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

3.053J Molecular, Cellular, and Tissue Biomechanics
(Subject meets with 2.797J, 6.024J, 20.310J)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Spring)
4-0-8
See description under subject 20.310J.
Fall: R. D. Kamm
Spring: R. D. Kamm, A. J. Gradzinsky

3.054 Cellular Solids: Structure, Properties, Applications (New)
(Subject meets with 3.36)
Prereq: 3.032
U (Spring)
3-0-9
Begins with a review of the structure and mechanical behavior of cellular solids as they are created from polymers, metals, ceramics, glasses, and composites. Exploits the unique properties of honeycombs and foams through applications such as lightweight structural panels, energy absorption devices and thermal insulation. Second half of the term discusses applications of cellular solids in medicine as it relates to increased fracture risk due to trabecular bone loss in patients with osteoporosis, the development of metal foam coatings for orthopaedic implants, and designing porous scaffolds for tissue engineering that mimic the extracellular matrix. Modelling of cellular materials applied to natural materials and biomimicking. Students taking graduate version complete additional assignments.
L. Gibson

3.055J Biomaterials Science and Engineering (New)
(Subject meets with 20.363J)
Prereq: 3.034, 20.110, or permission of instructor
U (Fall)
3-0-9
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

3.063 Polymer Physics
Prereq: 3.012
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8
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.
A. Alexander-Katz

3.064 Polymer Engineering
Prereq: 3.032, 3.044
U (Fall)
3-0-9
Overview of engineering analysis and design techniques for synthetic polymers. Treatment of materials properties selection, mechanical characterization, and processing in design of load-bearing and environment-compatible structures.
D. Roylance

3.07 Introduction to Ceramics
Prereq: 3.012
U (Fall)
3-0-9
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

3.072 Symmetry, Structure, and Tensor Properties of Materials
(Subject meets with 3.60)
Prereq: 3.016 or 18.03
U (Fall)
4-0-8
Addresses the structure of crystalline materials and the role of crystal symmetries in controlling their properties. Topics include lattices, point groups, space groups, and their properties; use of symmetry in tensor representation of crystal properties, including transport properties, piezoelectricity and elasticity; crystallographic texture, microstructure, and anisotropy; and design of microstructures comprising anisotropic crystals. Students taking graduate version complete additional assignments.
C. Schuh
3.073 Diffraction and Structure
(Subject meets with 3.271)
Prereq: 18.03, 3.024
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8

Staff

3.074 Imaging of Materials
(Subject meets with 3.34)
Prereq: 3.024, 3.073, or permission of instructor
U (Spring)
3-0-9
See description under subject 3.34.
S. Gradecak

3.080 Economic and Environmental Materials Selection
Prereq: 3.012, 3.014, 3.022, 3.024, or permission of instructor
U (Fall)
3-0-9
Provides a survey of methods for evaluating choice of material and explores the implications of that choice. Topics include choice of materials, manufacturing economics, and life-cycle environmental evaluation. Students carry out a group project selecting materials technology options based on economic and environmental characteristics.

Staff

3.083j Fundamentals of Advanced Energy Conversion
(Same subject as 2.60j)
Prereq: 2.006, 3.044, or permission of instructor
U (Spring)
4-0-8
See description under subject 2.60j.
A. F. Ghoniem, M. Kazimi, Y. Chiang

3.091 Introduction to Solid-State Chemistry
(Subject meets with CC.3091, ES.3091)
Prereq: None
U (Fall, Spring)
5-0-7 CHEMISTRY
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 (including proteins). 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).

Fall: M. Cima
Spring: D. Paul

3.094 Materials in Human Experience
Prereq: None
U (Spring)
2-3-4 HASS-S (HASS-E)
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: glass in ancient Egypt and Rome; 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.

D. Hosler, L. W. Hobbs, H. N. Lechtman

3.14 Physical Metallurgy
(Subject meets with 3.40j, 22.71j)
Prereq: 3.022, 3.032
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9
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. Schuh

3.15 Electrical, Optical, and Magnetic Materials and Devices
Prereq: 3.024
U (Fall)
4-0-8
Explores the relationships between the performance of electrical, optical, and magnetic devices and the microstructural characteristics of the materials from which they are constructed. Features a device-motivated approach that places strong emphasis on emerging technologies. Applications include diodes, transistors, photodetectors, solar cells (photovoltaics), displays, light emitting diodes, lasers, optical fibers and optical communications, photonic devices, magnetic data storage and spintronics.

C. A. Ross

3.153 Nanoscale Materials
Prereq: 3.024
U (Fall)
4-0-8
Introduction to the most recent advances in the synthesis, lithographic patterning and characterization of nanomaterials and to their physical and electronic properties. The materials presented include semiconductor and metal nanoparticles and nanowires, carbon fullerenes and nanotubes, organic nanoparticles and dendrimers. Fundamental concepts of surface physics and chemistry used to explain the working principles of devices such as nanotransistors and nanosensors.

Y. Fink

3.155j Micro/Nano Processing Technology
(Same subject as 6.152j)
Prereq: Permission of instructor
U (Fall, Spring)
3-4-5
See description under subject 6.152j.
M. A. Schmidt, L. A. Kolodziejski, J. Michel, C. A. Ross

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 H-LEVEL Grad Credit
Laws of thermodynamics: general formulation and applications to mechanical, electromagnetic and electrochemical systems, solutions,
3.207 Innovation and Commercialization

Prereq: None
G (Spring)
4-0-8

Explores in-depth projects on a particular materials-based technology. Students investigate 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. A. Fitzgerald

3.21 Kinetic Processes in Materials

Prereq: 3.012, 3.022, 3.044, or permission of instructor
G (Spring)
5-0-10 H-LEVEL Grad Credit

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. Emphasis on analysis and development of rigorous comprehension of fundamentals. Topics include: irreversible thermodynamics; diffusion; nucleation; capillarity; grain growth; phase transformations; and morphological instabilities; gas-solid, liquid-solid, and solid-solid reactions.

Staff

3.22 Mechanical Behavior of Materials

Prereq: 3.032
G (Spring)
4-0-8 H-LEVEL Grad Credit

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.

M. J. Demkowicz, L. Gibson

3.23 Electrical, Optical, and Magnetic Properties of Materials

Prereq: 8.03, 18.03
G (Fall)
4-0-8 H-LEVEL Grad Credit

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 variational principle as a method for the calculation of wavefunctions. Investigation of how and why materials respond to different electrical, magnetic and electromagnetic fields and probes. Study of the conductivity, dielectric function, and magnetic permeability in metals, semiconductors, and insulators. Survey of common devices such as transistors, magnetic storage media, optical fibers.

G. Beach

3.271 Diffraction and Structure

(Subject meets with 3.073)
Prereq: 18.03, 3.024
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit

See description under subject 3.073.

B. J. Wuensch

3.320 Atomistic Computer Modeling of Materials

Prereq: 3.022, 3.20, 3.23 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit


G. Ceder, J. Grossman

3.33 Defects in Materials

Prereq: 3.21, 3.22
G (Fall)
3-0-9 H-LEVEL Grad Credit

Examines point, line, and surface defects in materials. Relates their properties to diffusion, deformation, radiation response, phase transformations, microstructure evolution, and corrosion in solids. Focuses on atomic defects in crystals, with special attention to optical properties, dislocation dynamics, and charged defects. Examples also drawn from other systems, e.g., disclinations in liquid crystals, domain walls in ferromagnets, and flaws in periodic network foams. Uses atomistic modeling to examine defect structure.

M. Demkowicz

3.34 Imaging of Materials

(Subject meets with 3.074)
Prereq: 3.23 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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. Graduate students complete additional assignments.

S. Gradecak

3.36 Cellular Solids: Structure, Properties, Applications (New)

(Subject meets with 3.054)
Prereq: 3.032 or permission of instructor
G (Spring)
3-0-9 H-Level Grad Credit

See description under subject 3.054.

L. Gibson

3.370 Manufacturing and Use of Structural Materials (New)

Prereq: Permission of instructor
G (Spring)
5-0-7

Discusses a range of technologies related to structural materials, including welding, brazing, soldering, wear, corrosion, non-destructive testing, and fracture. Emphasizes the underlying
science of a given process rather than a detailed description of the technique or equipment.
T. Eagar

3.371j Materials Manufacturing
(Same subject as 2.821j)
Prereq: Permission of instructor
G (Summer)
3-0-9 H-LEVEL Grad Credit

Discusses selection design and processing for structural materials—including casting, forging, rolling, drawing, extrusion, powder consolidation, welding, brazing, soldering, wear, corrosion, non-destructive testing and fracture—related to structural materials. Emphasizes the underlying science of a given process rather than a detailed description of the technique or equipment. Credit cannot also be received for 3.370 or 3.372
T. W. Eagar

3.372 Selection and Processing of Structural Materials (New)
Prereq: Permission of instructor
G (Fall)
5-0-7

Discusses selection design and processing for structural materials, including casting, forging, rolling, drawing, extrusion, and powder consolidation. Emphasizes the underlying science of a given process rather than a detailed description of the technique or equipment.
T. Eagar

3.40j Modern Physical Metallurgy
(Same subject as 22.71j)
(Subject meets with 3.14)
Prereq: 3.022, 3.032
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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. Schuh

3.42 Electronic Materials Design
Prereq: 3.23
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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

3.43j Integrated Microelectronic Devices
(Same subject as 6.720j)
Prereq: 6.012 or 3.42
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 6.720j.
J. A. del Alamo, H. L. Tuller

3.44 Materials Processing for Micro- and Nano-Systems
Prereq: 3.20, 3.21
G (Fall)
3-0-9 H-LEVEL Grad Credit

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, integrated sensors, and data storage systems.
C. V. Thompson

3.45 Magnetic Materials
Prereq: 3.23
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Foundation topics include magnetostatics, origin of magnetism in materials, magnetic domains and domain walls, magnetic anisotropy, reversible and irreversible magnetization processes; hard and soft magnetic materials and magnetic recording. Special topics are selected from magnetism at nanoscale (thin films, surfaces, particles); amorphous and nanocrystalline magnetic materials; electronic transport in ferromagnets including magnetoresistive, spin-valve and spin-tunnel junction sensors.
C. Ross

3.46 Photonic Materials and Devices
Prereq: 3.23
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

L. C. Kimerling, P. Anikeeva

3.47 Processing of Materials on the Nanoscale
Prereq: 3.20, 3.21; or 3.44
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Coverage includes techniques and underlying principles for synthesis and assembly of materials with one or more nanoscale dimensions, in the form of individual molecules, dots, wires, tubes, or sheets. Focuses on materials with applications arising from size-dependent electronic, magnetic, photonic, chemical, or mechanical properties. Synthesis via both physical processes (e.g. lithography, physical vapor deposition) and chemical processes (e.g. chemical vapor deposition, growth from liquid and solid solutions) are discussed. Thermodynamically-driven and kinetically-driven self-assembly processes are described as illustrations of fundamental assembly mechanisms. The formation of hierarchical ordered structures by templated self assembly are also discussed. Lectures complemented by case studies given by the instructors and by outside speakers.
C. A. Ross, C. V. Thompson

3.53 Electrochemical Processing of Materials
Prereq: 3.044
G (Spring; partial term)
3-0-6 H-LEVEL Grad Credit

Thermodynamic and transport properties of aqueous and nonaqueous electrolytes. The electrode/electrolyte interface. Kinetics of


3.54J Corrosion: The Environmental Degradation of Materials
(Same subject as 22.72J)
Prereq: 3.012
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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.

R. G. Ballinger

3.560J Industrial Ecology
(Same subject as 1.814J, ESD.123J)
Prereq: ESD.10 or 3.56
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject ESD.123J.

R. Kirchain, J. Clark, F. Field

3.57J Materials Selection, Design, and Economics
(Same subject as ESD.73J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

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.

j. Clark

3.60 Symmetry, Structure, and Tensor Properties of Materials
(Subject meets with 3.072)
Prereq: 3.016 or 18.03
G (Fall)
4-0-8 H-LEVEL Grad Credit

See description under subject 3.072.

C. Schuh

3.64J Fundamentals of Advanced Energy Conversion
(Same subject as 2.62J, 10.392J, 22.40J)
Prereq: 2.006, 3.044, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

See description under subject 2.62J.

A. F. Ghoniem, M. Kazimi, Y. Chiang

3.69 Teaching Fellows Seminar
Prereq: None
G (Fall)
2-0-1
Can be repeated for credit

Provides instruction to help prepare students for teaching at an advanced level. 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, and working with colleagues.

S. Allen, G. Ceder

3.691–3.699 Teaching Materials Science and Engineering
Prereq: None
G (Fall, Spring)
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.

C. Schuh

3.903 Student Seminar in Polymer Science and Technology
(Same subject as 10.960J)
Prereq: None
G (Fall, Spring)
2-0-0 [P/D/F]
Can be repeated for credit

See description under subject 10.960J.


3.91 Mechanical Behavior of Polymers
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Influence of processing and structure on mechanical properties of synthetic and natural polymers: Hookean and entropic elastic deformation, linear viscoelasticity, composite materials and laminates, yield and fracture. Introductory subjects in solid mechanics and polymers recommended, e.g. 3.032, 3.034.

Staff

3.930 Industrial Practice
Prereq: None
U (Summer)
0-6-0 [P/D/F]

Provides academic credit for first approved work assignment at a company. For reporting requirements, consult faculty industrial practice coordinator. Limited to students in Course 3.

D. Roylance

3.931 Industrial Practice
Prereq: 3.930
U (Summer)
0-6-0

Provides academic credit for second approved work assignment at a company. For reporting requirements consult faculty industrial practice coordinator. Limited to students in Course 3.

D. Roylance

3.932 Industrial Practice
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Provides academic credit for graduate students for approved work assignments at companies.

C. Schuh

3.94 Morphology of Polymers
Prereq: 3.063
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6

Structure of noncrystalline, crystalline, and liquid crystalline polymers, including polymers blends, and block copolymers. Texture development from processing operations, mechanical deformation, and applied electric and magnetic fields. Hybrid organic-inorganic nano and microcomposites. Phase transformations, including classical nucleation theory and spinodal decomposition. Use
of morphological characterization methods such as wide- and small-angle x-ray scattering and 
scanning, transmission electron microscopy and 
atomic force microscopy are also covered. 

Staff

3.941j Statistical Mechanics of Polymers 
(Same subject as 10.668j) 
Prereq: 10.568 or permission of instructor 
G (Spring) 
3-0-9 H-LEVEL Grad Credit 
See description under subject 10.668j. 
G. C. Rutledge, P. S. Doyle

3.96j Biomaterials: Tissue Interactions 
(Same subject as 2.79j, 20.441j, HST.522j) 
Prereq: Chemistry (GIR), Biology (GIR), Physics I 
(GIR); or permission of instructor 
G (Fall) 
3-0-9 H-LEVEL Grad Credit 
See description under subject 2.79j. 
I. V. Yannas, M. Spector

3.961j Design of Medical Devices and Implants 
(Same subject as 2.782j, 20.451j, HST.524j) 
Prereq: Chemistry (GIR), Biology (GIR), Physics I 
(GIR); or permission of instructor 
G (Spring) 
3-0-9 H-LEVEL Grad Credit 
See description under subject 2.782j. 
I. V. Yannas, M. Spector

3.962j Molecular Principles of Biomaterials 
(Same subject as 20.462j) 
(Subject meets with 3.051j, 20.340j) 
Prereq: Permission of instructor 
G (Spring) 
3-0-9 H-LEVEL Grad Credit 
See description under subject 20.462j. 
Staff

3.963j Biomaterials Science and Engineering (New) 
(Same subject as 20.463j) 
(Subject meets with 3.055j, 20.363j) 
Prereq: 3.034j, 20.110, or permission of instructor 
G (Fall) 
3-0-9 H-LEVEL Grad Credit 
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

3.97j Cell-Matrix Mechanics 
(Same subject as 2.785j, 20.411j, HST.523j) 
Prereq: 2.001, Chemistry (GIR), Biology (GIR); or 
permission of instructor 
G (Spring) 
3-0-9 H-LEVEL Grad Credit 
See description under subject 2.785j. 
I. V. Yannas, M. Spector

3.971j Molecular, Cellular, and Tissue 
Biomechanics 
(Same subject as 2.798j, 6.524j, 10.537j, 
20.410j) 
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 
10.301, or 10.302 
Acad Year 2011–2012: Not offered 
Acad Year 2012–2013: G (Fall) 
3-0-9 H-LEVEL Grad Credit 
See description under subject 20.410j. 
R. D. Kamm, K. Van Vliet

3.98 Polymer Synthetic Chemistry 
Prereq: One basic polymer chemistry subject 
G (Spring) 
3-0-6 H-LEVEL Grad Credit 
An examination of the fundamental reaction 
mechanisms and chemistry of polymerization 
reactions with an emphasis on the synthesis of 
new advanced polymers and their properties. 
M. F. Rubner

ARCHAEOLOGY AND 
ARCHAEOLOGICAL SCIENCE

3.982 The Ancient Andean World 
Prereq: None 
U (Fall) 
3-0-6 HASS-S (HASS-E) 
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. 
H. N. Lechtman

3.983 Ancient Mesoamerican Civilization 
Prereq: None 
U (Fall) 
3-0-6 HASS-S (HASS-E) 
Examines origins, florescence and collapse of 
selected civilizations of ancient Mesoamerica 
using archaeological and ethnohistorical evidence. 
Focus on Olmec, Maya, Teotihuacan and Aztec, 
considering key technological, environmental, 
social organizational and ideological variables. 
Investigates contacts between South America 
and Western Mexico. 
D. Hosler

3.984 Materials in Ancient Societies: Ceramics 
Prereq: Permission of instructor 
Acad Year 2011–2012: Not offered 
Acad Year 2012–2013: G (Fall) 
3-6-3 
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. Seniors may register for subject under special topics number: consult instructor. 
H. N. Lechtman; L. Hobbs

3.985j Archaeological Science 
(Same subject as 5.24j, 12.011j) 
Prereq: Chemistry (GIR) or Physics I (GIR) 
U (Spring) 
3-1-5 HASS-S (HASS-E) 
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 analyses, GIS and other remote sensing 
techniques for site location, soil micromorphology and site formation, sourcing of metal 
artifacts, and microstructural and mechanical analyses of cementitious materials used in 
ancient monumental buildings. 
H. N. Lechtman, J. Stubbe, F. A. Frey

3.986 The Human Past: Introduction to Archaeology 
Prereq: None 
U (Fall) 
3-2-7 HASS-S (HASS-D 4); CI-H 
Archaeology reconstructs ancient human activities 
and their environmental contexts. Examines
these activities and the forces that shaped them, drawing on case studies in contrasting environmental settings from the Near East and Mesoamerica. In laboratory sessions, students learn to manage various classes of archaeological data and analyze archaeological artifacts made from materials such as stone, bone, and ceramics. These analyses help reconstruct the past.

_H. V. Merrick, D. Hosler_

**3.987 Human Origins and Evolution**
Prereq: None
U (Spring)
3-0-6 HASS-S (HASS-E)

Examines the dynamic interrelations among physical and behavioral traits of humans and environment and culture to provide an integrated framework for studying human biological evolution and modern diversity. Topics include issues in morphological evolution and adaptation; fossil and cultural evidence for human evolution from earliest times through the Pleistocene; evolution of tool use and social behavior; modern human variation and concepts of race. Includes study of stone artifacts and fossil specimens.

_H. V. Merrick_

**3.988 Africa—Past and Present: An Archaeological and Ethnographic Materials Perspective**
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-6 HASS-S (HASS-E)

Examines prehistory and modern ethnographic diversity of technology on the African continent, with particular emphasis on the sub-Saharan region. Traces the course of human technological evolution from the earliest Plio-Pleistocene tool-making hominids to the modern ethnically diverse inhabitants of the continent, by way of topical case studies. These cases are centered on subsistence adaptations and technological responses. Includes lectures, experience handling prehistoric stone artifacts and modern ethnographic items, and ethnographic films.

_H. V. Merrick_

**3.989 Materials in Ancient Societies: Ceramics Laboratory**
Prereq: Permission of instructor
G (Spring)
3-6-3

Laboratory analysis of archaeological artifacts of ceramics. Follows on 3.984.

_H. N. Lechtman, L. Hobbs_

**3.990 Seminar in Archaeological Method and Theory**
Prereq: 3.986, 3.985, 21A.100
U (Fall, Spring)
3-0-6

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, H. Merrick_

**3.993 Archaeology of the Middle East**
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-6 HASS-S (HASS-E)

Focus on the rise of settled communities, cities, and empires and their technological achievements in various areas of the Middle East including Anatolia, the Levant, and Mesopotamia. Using archaeological and written sources, examines why such complex societies arose in this area. Considers the technological basis of these societies; the role of temples and religious hierarchies, of crafts and trade in luxury goods, of writing and bureaucracies, and of class stratification in the rise of early civilizations.

_H. Merrick_

**3.997 Graduate Fieldwork in Materials Science and Engineering**
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit 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_

**3.997 Graduate Fieldwork in Materials Science and Engineering (New)**
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit 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.

_S. Luperfoy_

**3.570–3.575 Special Subject in Materials Science and Engineering (New)**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit

Covers advanced topics in Materials Science and Engineering that are not included in the permanent curriculum.

_Staff_

**3.576–3.579 Special Subject in Materials Science and Engineering (New)**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit

Covers advanced topics in Materials Science and Engineering that are not included in the permanent curriculum.

_Staff_

**3.570–3.575 Special Subject in Materials Science and Engineering (New)**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit

Covers advanced topics in Materials Science and Engineering that are not included in the permanent curriculum.

_Staff_

**3.576–3.579 Special Subject in Materials Science and Engineering (New)**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit

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, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.
C. Schuh

3.THU Undergraduate Thesis
Prereq: None
U (Fall, 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.
Consult L. C. Kimerling

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

3.URG Undergraduate Research
Prereq: None
U (Fall, 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.
B. J. Wuensch
# Bachelor of Science in Materials Science and Engineering/Course 3

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
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<tbody>
<tr>
<td>Science Requirement</td>
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<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
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<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 3.012 and 3.022] in the Departmental Program</td>
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<tr>
<td>Laboratory Requirement [can be satisfied by 3.014 in the Departmental Program]</td>
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<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
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</tbody>
</table>

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
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<tbody>
<tr>
<td>3.012 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*</td>
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<tr>
<td>3.014 Materials Laboratory, 12, LAB, CI-M</td>
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<tr>
<td>One of the following three subjects:</td>
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<tr>
<td>3.016 Mathematical Methods for Materials Scientists and Engineers, 12; Calculus II (GIR)</td>
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<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
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<tr>
<td>18.036 Differential Equations, 12, REST; Calculus II (GIR)</td>
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<tr>
<td>One of the following four subjects:</td>
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<tr>
<td>3.021J Introduction to Modeling and Simulation, 12, REST; 18.03*</td>
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<tr>
<td>3.041 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
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<tr>
<td>3.016 Mathematical Methods for Materials Scientists and Engineers, 12; Calculus II (GIR)</td>
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<tr>
<td>3.022 Microstructural Evolution in Materials, 12; 3.012</td>
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<tr>
<td>3.024 Electronic, Optical, and Magnetic Properties of Materials, 12; 3.012</td>
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<tr>
<td>3.024 Mechanical Behavior of Materials, 12; Physics I (GIR), 3.016*</td>
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<tr>
<td>3.034 Organic and Biomaterials Chemistry, 12; 3.012</td>
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<tr>
<td>3.042 Materials Project Laboratory, 12, CI-M; 3.014*</td>
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<tr>
<td>3.044 Materials Processing, 12; 3.012, 3.022</td>
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<tr>
<td>3.050 Thesis, 9(2) or 3.930 Industrial Practice, 6 plus 3.931 Industrial Practice, 6</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td>48</td>
</tr>
<tr>
<td>3.004 Principles of Engineering Practice, 12; Physics I (GIR), Calculus I (GIR)</td>
<td></td>
</tr>
<tr>
<td>3.016 Mathematical Methods for Materials Scientists and Engineers, 12; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>3.021J Introduction to Modeling and Simulation, 12, REST; 18.03*</td>
<td></td>
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<tr>
<td>3.046 Thermodynamics of Materials, 12; REST; 18.03*</td>
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<tr>
<td>3.048 Advanced Materials Processing, 12; 3.022, 3.044</td>
<td></td>
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<tr>
<td>3.051 Materials for Biomedical Applications, 12; Chemistry (GIR)*</td>
<td></td>
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<tr>
<td>3.052 Nanomechanics of Materials and Biomaterials, 12; 3.032*</td>
<td></td>
</tr>
<tr>
<td>3.053 Molecular, Cellular, and Tissue Biomechanics, 12; 18.03*, Biology (GIR), 2.370*</td>
<td></td>
</tr>
<tr>
<td>3.055 Biomaterials Science and Engineering, 12; 3.056*</td>
<td></td>
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<tr>
<td>3.063 Polymer Physics, 12; 3.012</td>
<td></td>
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<tr>
<td>3.064 Polymer Engineering, 12; 3.032, 3.044</td>
<td></td>
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<tr>
<td>3.076 Introduction to Ceramics, 12; 3.012</td>
<td></td>
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<tr>
<td>3.077 Symmetry, Structure, and Tensor Properties of Materials, 12; 3.016*</td>
<td></td>
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<tr>
<td>3.073 Diffraction and Structure, 12; 18.03, 3.024</td>
<td></td>
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<tr>
<td>3.074 Imaging of Materials, 12; 3.024*</td>
<td></td>
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<tr>
<td>3.080 Economic and Environmental Materials Selection, 12; 3.012*</td>
<td></td>
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<tr>
<td>3.14 Physical Metallurgy, 12; 3.013, 3.022, 3.032</td>
<td></td>
</tr>
<tr>
<td>3.15 Electrical, Optical, and Magnetic Materials and Devices, 12; 3.024</td>
<td></td>
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<tr>
<td>3.153 Nanoscale Materials, 12; 3.024</td>
<td></td>
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<tr>
<td>3.155J Micro/Nano Processing Technology, 12, CI-M; permission of instructor</td>
<td></td>
</tr>
<tr>
<td><strong>Departmental Program Units That Also Satisfy the GIRs</strong></td>
<td>39</td>
</tr>
</tbody>
</table>

**Unrestricted Electives**

48

**Total Units Beyond the GIRs Required for SB Degree**

185–195

No subject can be counted both as part of the 17-subject GIRs and as part of the 185–188 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

* Alternate prerequisites are listed in the subject description.

(1) These subjects can count as part of the required subjects or as restricted electives, but not both.

(2) Students may elect 9–12 units.

(3) Substitution of similar subjects may be permitted by petition.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
## Bachelor of Science in Archaeology and Materials as Recommended by the Department of Materials Science and Engineering/Course 3-C

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Requirement (can be satisfied by 3.014 or 12.119 in the Departmental Program)</td>
<td>1</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (can be satisfied by 3.012, 3.021J or 12.001 in the Departmental Program)</td>
<td>2</td>
</tr>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement (can be satisfied by 3.986, 3.987, 3.985J, and 21A.100; and 3.982, 3.983, or 3.988 in the Departmental Program)</td>
<td>8</td>
</tr>
</tbody>
</table>

### Total GIR Subjects Required for SB Degree

17

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Subjects

3.012 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*

One of the following three subjects:

- 3.016 Mathematical Methods for Materials Scientists and Engineers, 12; Calculus II (GIR)
- 18.03 Differential Equations, 12, REST; Calculus II (GIR)
- 18.034 Differential Equations, 12, REST; Calculus II (GIR)

One of the following three subjects:

- 3.021J Introduction to Modeling and Simulation, 12, REST; 18.03*
- 1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)
- 6.01 Introduction to EECS I, 1, 1/2 LAB; Physics II (GIR)

3.022 Microstructural Evolution in Materials, 12; 3.012

3.023 Mechanical Behavior of Materials, 12; Physics I (GIR), 3.016*

or

3.044 Materials Processing, 12; 3.012, 3.022

3.ThU Thesis, 9(1)

3.985J Archaeological Science, 9, HASS-S, Chemistry (GIR)*

3.987 Human Origins and Evolution, 9, HASS-S

3.990 Seminar in Archaeological Method and Theory, 9, CI-M; 3.986, 3.985J, 21A.100

12.001 Introduction to Geology, 12, REST

12.110 Sedimentary Geology, 12; 12.001

or

12.119 Analytical Techniques for Studying Environmental and Geologic Samples, 12, LAB

21A.100 Introduction to Anthropology, 12, HASS-ST

### Restricted Electives

One subject from the following list:

- 3.07 Introduction to Ceramics, 12; 3.012
- 3.14 Physical Metallurgy, 12; 3.012, 3.022, 3.032
- 3.051J Materials for Biomedical Applications, 12; Chemistry (GIR)*
- 3.052 Nanomechanics of Materials and Biomaterials, 12; 3.032*

One subject from the following list:

- 3.982 The Ancient Andean World, 9, HASS-S
- 3.983 Ancient Mesoamerican Civilization, 9, HASS-S
- 3.984 Materials in Ancient Societies: Ceramics, 12; permission of instructor
- 3.988 Africa—Past and Present: An Archaeological and Ethnographic Materials Perspective, 9, HASS-S

### Departmental Program Units That Also Satisfy the GIRs

(90)

### Unrestricted Electives

97

### Total Units Beyond the GIRs Required for SB Degree

180–193

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

* Alternate prerequisites are listed in the subject description.
† Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.
‡ Students may elect up to 9–12 units.
§ Substitution of similar subjects may be permitted by petition.
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).


ARCHITECTURE DESIGN

4.001J CityScope
(Same subject as 11.004j)
Prereq: None
U (Spring)
3-0-9 HASS-E (HASS-E)

Project-based introduction to the contemporary city as a complex system within a context of limited resources and competing interests. Learn to assess scenarios for the purpose of formulating social, economic and design strategies that provide optimized solutions that are humane and sustainable. Group projects develop and advocate visions for housing, urban planning, regeneration of natural ecologies and other sectors of the city. Travel may be involved that will be funded, but not required. Includes exercises in written and oral communication and team building. Limited to 15 participants. Preference to freshmen.

J. Fernandez, P. Thompson

4.100 Architecture Workshop: Form and Material (New)
Prereq: None
U (IAP)
3-0-0 [P/D/F]

Intensive design and fabrication workshop in which students create models and half-size prototypes that explore the characteristics of concrete and wood. Examines the behavior of these materials and their inherent structural qualities. Studies how architectural detail can impact the perception and creation of larger qualities. Studies how architectural detail can impact the perception and creation of larger qualities. Includes exercises in the interrogation of the geometric principles that lie at the core of each skill. Skills covered range from techniques of hand drafting, to generation of 3-D computer models, physical model-building, sketching, and diagramming. Weekly lectures and pin-ups address the conventions associated with modes of architectural representation and their capacity to convey ideas. Restricted to level one MArch students.

Architecture Design Staff

4.102 Sketching for Architects
Prereq: 4.111
U (IAP)
0-3-0 [P/D/F]

Introduces students to the concepts and practice of freehand drawing. Presents spatial ideas and forms found in architecture, making distinctions between representation, analysis, and expression. Explores concepts of touch, narrative and structure in depth. During site visits, students draw significant local architectural works to illustrate architectural meaning through the discipline of perceptual drawing. Limited to 15.

Architecture Design Staff

4.103 Freehand Drawing
Prereq: None
G (Fall)
0-3-0 [P/D/F]

Focuses on drawing as a translation from three-dimensional form and space to two-dimensional representation. Expands critical and organizational skills for seeing and drawing. Explores a full range of drawing techniques, materials, and image-making strategies. Fortifies the use of drawing in the architecture studio practice, through a multidisciplinary understanding of freehand drawing, in the context of both art and architecture. Limited to first year MArch students.

Architecture Design Staff

4.105 Geometric Disciplines and Architecture Skills
Prereq: Permission of instructor
G (Fall)
2-2-5

Intensive introduction to architectural design tools and process, taught through a series of short exercises. The conceptual basis of each exercise is in the interrogation of the geometric principles that lie at the core of each skill. Skills covered range from techniques of hand drafting, to generation of 3-D computer models, physical model-building, sketching, and diagramming. Weekly lectures and pin-ups address the conventions associated with modes of architectural representation and their capacity to convey ideas. Restricted to level one MArch students.

Architecture Design Staff

4.108 BSA Portfolio Workshop
Prereq: 4.113
U (Spring)
2-0-1 [P/D/F]

Covers the skills needed to design a successful portfolio that can be used to apply for internships and graduate study. Topics include design aesthetics, graphics, book assemblage, binding techniques, and various computer applications. Preference to Course 4 majors and minors.

Architecture Design Staff

4.109 Complete Fabrications Workshop (New)
Prereq: None
G (IAP)
0-3-6

Two-part introduction that provides students with the tools for developing complex geometries from flat components; fine-tuning press fit construction, molding and casting; and making repeatable molds for customization. First half contextualizes contemporary tools and techniques using historical case studies of building. Second half addresses the problems of fabrication with focused exercises that create reciprocity between skills and design. Preference given to first-year MArch students.

Architecture Design Staff

4.111 Introduction to Architecture and Environmental Design
Prereq: None
U (Spring)
3-3-6 HASS-A (HASS-E)
Credit cannot also be received for 4.11A

4.11A Introduction to Architecture and Environmental Design Intensive (New)
Prereq: None
U (IAP)
3-3-3 HASS-A (HASS-E)
Credit cannot also be received for 4.111

Provides a foundation to the design of the built environment, from the scale of the object, to the building, to the larger territory. Focuses on the shared foundations of the allied design disciplines of architecture, landscape, and urbanism, developing skills in critical thinking and analysis, spatial representation and design methodologies. Examines the larger influences of the arts and sciences on these disciplines. Through lectures and design exercises, students are provided an opportunity to establish a reference for understanding the discipline of architecture and environmental design, and are provided an introduction to design fundamentals and design process.

M. Yoon
Course 4.

4.112 Architecture Design Fundamentals I
Prereq: None
U (Fall)
3-3-6
Provides the foundations for architectural design, introducing design logic and skills that enable design thinking, representation, and development. Beginning with spatially abstract exercises, provides studio instruction in the architectural design process. Introduces techniques for describing form, space, and architecture. Focuses on the translation of conceptual strategies into more integrated design propositions through both digital and analog means. Preference to Course 4 majors and minors.

Architecture Design Staff

4.113 Architecture Design Fundamentals II
Prereq: 4.111 or 4.11A; 4.112
U (Spring)
3-6-6
Focuses on the translation of conceptual strategies of form and space into more complex design propositions that engage a larger set of architectural issues, including technological, social, cultural, experiential and environmental determinants. Students work on the integration of architecture with program, structure, materiality, and site. Preference to Course 4 majors and minors.

Architecture Design Staff

4.114 Architecture Design Studio I
Prereq: 4.113, 4.302, 4.401, 4.500, 4.605
U (Fall)
0-12-9
Focuses on how to design in a natural or urban site through analysis of landscape and urban form. Students conceptualize design decisions through drawings and models. Working directly with materials and fabrication techniques, they gain experience in the tectonics of architecture. Several design assignments lead to a final integrated design project. Instruction and practice in oral and written communication provided. Preference to Course 4 majors and minors.

Architecture Design Staff

4.115 Architecture Design Studio II
Prereq: 4.114
U (Spring)
0-12-9
Introduces skills needed to build within contemporary cities, extending from the historical center to expanding edges. Students analyze an existing environment and design a built structure that fosters relationships between its intended activities and the larger urban landscape and redefines the urban environment. Design project emphasizes social, cultural or civic programs. Preference to Course 4 majors. Mandatory lottery.

Architecture Design Staff

4.116 Architecture Design Studio III
Prereq: 4.115, 4.440
U (Fall)
0-12-9
Projects develop more advanced design skills engaging complex issues of program, site, and form. Focuses on how architecture creates environments for living, working and learning in varied settings. Integrates architectural theory, building technology and computation into the design process. Preference to Course 4 majors.

Architecture Design Staff

4.119 Preparation for Undergraduate Architecture Design Thesis
Prereq: 4.115
U (Fall, Spring)
1-0-2
Selection of thesis topic, defining method of approach, and preparation of thesis proposal for BSAD degree in architecture design. Weekly class meeting as well as individual conference with faculty.

Architecture Design Staff

4.121 Workshop in Making and Designing Space
(Subject meets with 4.122)
Prereq: 4.123 or permission of instructor
G (Fall)
0-6-3
Interactive architecture design workshop focuses on the logistics of designing. Examines a variety of spaces and studies space design through material exploration and building techniques. Students develop a design project by joining wood, forging and welding steel, and casting concrete. Additional work required of students taking the graduate version.

C. Dewart, J. Wampler

4.140J How to Make (Almost) Anything (New)
(Same subject as MAS.863J)
Prereq: Permission of instructor
G (Fall)
3-9-0 H-LEVEL Grad Credit
See description under subject MAS.863J.
N. Gershenfeld, J. DiFrancesco

4.145 Architecture of Territory Design Studio
Prereq: 4.153 or permission of instructor
G (Spring)
0-10-11 H-LEVEL Grad Credit
Establishes a relationship between architecture and urbanism, focusing on concerns for the condition of American suburbs: its tracts, infrastructures and landscapes. Exercises introduce architectural aspects of planning, infrastructure design, and landscape conception. Projects focus on designing morphologies beyond the single building, inventing building types, and crafting architectural responses to complex sites of multiple scales, development types, and transportaton logics. Mandatory lottery process. Limited to second- and third-year MArch, and qualified SMArchS, students.

Architecture Design Staff

4.151 Architecture Design Core Studio I (4.123)
Prereq: Permission of instructor
G (Fall)
0-12-9
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. Must be taken in sequence. Limited to first-year MArch students.

Architecture Design Staff

4.152 Architecture Design Core Studio II (4.124)
Prereq: 4.151
G (Spring)
0-12-9
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. *Architectural Design Staff*

**4.153 Architecture Design Core Studio III (4.143)**
Prereq: 4.152
G (Fall)
0-12-9 H-LEVEL Grad Credit

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. *Architectural Design Staff*

**4.154 Architecture Design Option Studio (4.155)**
Prereq: 4.145 or 4.153
G (Fall, Spring)
0-10-11 H-LEVEL Grad Credit
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. *Architectural Design Staff*

**4.162 Introductory Urban Design Studio**
Prereq: Permission of instructor
G (Fall)
0-10-11 H-LEVEL Grad Credit
Can be repeated for credit

Project-based introduction to urban observation, research, analysis, and design. Focuses on urban elements, urban and architectural interventions, and landscape in existing cities. Emphasizes city form, sustainability, and social conditions. Projects require both conventional and digital techniques. Preference to Urbanism SMArchS students. *M. Dennis, J. Beinart, A. D’Hooghe*

**4.163J Urban Design Studio**
(Same subject as 11.332J)
Prereq: 4.145, 4.162, or permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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. *A. Berger, M. Dennis, A. D’Hooghe*

**4.166 Beijing Urban Design Studio**
(Subject meets with 11.307)
Prereq: 4.144
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Design and development studio that involves architects and planners, working in teams on a contemporary design project of importance in Beijing, China. Students analyze conditions, explore alternatives, and synthesize architecture, city design, and implementation plans. Supplemented by lectures and brief study tours that expose students to history and contemporary issues of urbanism in China. Offered every other summer in residence at Tsinghua University, Beijing, involving students and faculty from both schools. Limited to 10. *J. Wampler, D. Frenchman*

**4.170 International Architecture Design Workshop**
Prereq: Permission of instructor
U (Fall)
3-2-7
Can be repeated for credit

Interactive design research in developing areas outside of the USA. Assist in drawing, modeling and constructing small buildings appropriate for the culture, climate and specific population under consideration. *J. Wampler*

**4.171 Design Workshop: The Space Between**
Prereq: Permission of instructor
G (Fall)
3-2-4 H-LEVEL Grad Credit
Can be repeated for credit

Design research into the space between and the space within buildings and cities. Projects include the development and understanding of existing space in buildings and cities, as well as designing new structures looking at the space first and the object second. *J. Wampler*

**4.180 Architectural Design Workshop**
Prereq: 4.113 or permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

**4.181 Architectural Design Workshop**
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

**4.182–4.185 Architectural Design Workshop**
Prereq: 4.115, 4.143 or permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
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. *Architectural Design Staff*

**4.189 Preparation for MArch Thesis**
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-1-5 H-LEVEL Grad Credit
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. *Architectural Design Staff*
ARCHITECTURE STUDIES

4.210 Precedents in Critical Practice
Prereq: None
G (Fall)
3-0-6
Provides students the opportunity to develop a map of contemporary architectural practice and discourse. Seminar examines six 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. Students study buildings and read relevant texts in order to place recent architectural projects in disciplinary and cultural context. Restricted to year-one MArch students.
A. Miljacki

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

(Same subject as 11.308J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.308J.
A. Spirn

4.214J Water, Landscape and Urban Design
(Same subject as 11.314J)
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
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. Limited to 15.
J. Wescoat

4.217 Disaster Resilient Design (New)
(Same subject as 11.315J)
Prereq: None
G (Fall)
3-0-6
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. Limited to 15.
J. Wescoat

Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Analysis of the development of housing models and their urban implications in Paris, London, and New York City from the 17th century to the present. Focus on the French hotel, London row house, and New York City tenement and apartment building; 20th-century housing reform movements and work by the London County...
4.221 Architecture Studies Faculty Colloquium  
Prereq: Permission of instructor  
G (Fall)  
2-0-1  
Presentations by faculty from different discipline groups on a theme derived from their research or practice followed by discussion. Requirements include active student participation and a final paper or presentation reviewing the theoretical issues raised by the colloquium discussions in the context of the research themes set by the instructors.  
Architectural Staff

4.222 Professional Practice  
Prereq: Permission of instructor  
G (Fall)  
3-0-3 H-LEVEL Grad Credit  
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.  
P. Freelon

4.224 Advanced Research in Contemporary Architecture  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-6 H-LEVEL Grad Credit  
Students research the contemporary conditions of producing architecture, the contemporary role of the architect, and the contemporary production of architectural discourse. Seminar embraces “operative criticism” as the key mode of generating knowledge and clarifying positions. Limited to 18.  
A. Miljacki

4.225 Urban Design Theory  
Prereq: Permission of instructor  
G (Fall)  
3-0-6  
Introduces theories, concepts and precedents in urban design. Emphasizes traditional, modern and contemporary values and approaches to urban design. Research projects required. Preference to Urbanism SMArchS students.  
M. Dennis

4.230 SIGUS Workshop  
(Same subject as 11.468J)  
(Subject meets with 4.231)  
Prereq: Permission of instructor  
G (IAp, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

4.231 SIGUS Workshop  
(Same subject with 4.230, 11.468J)  
Prereq: Permission of instructor  
U (IAp, Spring)  
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

4.232 The New Global Planning Practitioner  
(Same subject as 11.444J)  
(Subject meets with 4.233)  
Prereq: Permission of instructor  
G (Spring)  
3-0-6 H-LEVEL Grad Credit

4.233 The New Global Planning Practitioner  
(Same subject with 4.232, 11.444J)  
Prereq: Permission of instructor  
U (Spring)  
3-0-6

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. Additional work required of students taking the graduate version.  
R. Goethert

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

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

4.241 Theory of City Form  
(Same subject as 11.330J)  
Prereq: 4.252 or 11.001  
G (Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

Theories about the form that settlements should take. Attempts a distinction between descriptive and normative theory by examining examples of various theories of city form over time. Concentrates on the origins of the modern city and theories about its emerging form, including the transformation of the 19th century city and its organization. Analyzes current issues of city form in relation to city-making, social structure, and physical design.  
J. Beinart

4.242 Advanced Seminar in City Form  
(Same subject as 11.331J)  
Prereq: 4.241  
G (Fall)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

Examines in greater depth themes from the basic subject in city form theory. Introduces new concepts from current research and practice for analysis by the seminar participants. Requirements include presentation to the seminar of a theoretical project undertaken by each student.  
J. Beinart

4.243 Media Technology and City Design and Development  
(Same subject as 11.310J)  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9

See description under subject 11.310J.  
A. Spirn, C. McDowell
4.244J Urban Design Seminar: New Century Cities
(Same subject as 11.333J)
Prereq: None
G (Spring)
2-0-7
See description under subject 11.333J.
D. Frenchman

4.247J Urban Design Ideals and Action
(Same subject as 11.337J)
Prereq: 11.301 or permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
See description under subject 11.337J.
B. Ryan

4.250J Introduction to Urban Design and Development
(Same subject as 11.001J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
See description under subject 11.001J.
L. Vale

4.252J Introduction to Urban Design and Development
(Same subject as 11.301J)
Prereq: Permission of instructor
G (Fall)
3-0-9
See description under subject 11.301J.
D. Frenchman

4.253J Urban Design Politics
(Same subject as 11.302J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 11.302J.
L. Vale

4.254J Real Estate Development Studio: Complex Urban Projects
(Same subject as 11.303J)
Prereq: Permission of instructor
G (Spring)
6-0-9 H-LEVEL Grad Credit
See description under subject 11.303J.
D. Frenchman, P. Roth

4.255J Site and Environmental Systems Planning
(Same subject as 11.304J)
Prereq: Permission of instructor
G (Spring)
6-0-9
See description under subject 11.304J.
E. Ben-Joseph

4.262J Ideal Forms of Contemporary Urbanism
(Same subject as 11.311J)
Prereq: 4.645, 4.241, or permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
Advanced seminar about an architectural approach to the problems of disurbanization. Focuses on texts and projects of a particular lineage of architects and planners, who are pursuing ‘metropolitan urbanity’ through a series of concrete, discrete, tangible interventions from 1944 to 1999. Studies the organization of flows and the articulation of public spaces within various projects seeking a definition of “urbanity” using analytical diagrams. Relates this architectural definition to more theoretical definitions in philosophy and anthropology.
A. D’Hooghe

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

4.274 Design Innovation for Distributed Energy
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit
Explores technical challenges and design opportunities in the vertical integration of energy sector materials in the built environment. Interdisciplinary design approach provides an understanding of the basic performance attributes and manufacturing and/or production processes of the selected energy material. Students investigate the spatial, social and architectural impacts of decentralized energy distribution through the development of design proposals and proof-of-concept application prototypes capable of providing measurable results. Engages research faculty outside of the School of Architecture and Planning. Limited to 20.
S. Kennedy

4.280 Undergraduate Architecture Internship
Prereq: 4.114
U (IAP)
0-0-6 [P/D/F]
Can be repeated for credit
Students work in an architect’s office to gain experience, improve skills, and see the inner workings of an everyday architectural practice. Internships possible in all sizes of firms and in public and nonprofit agencies. Requires full-time work for the entire IAP.
J. Fernandez

4.287 Graduate Architecture Internship
Prereq: 4.123
G (IAP)
0-0-6 [P/D/F]
Can be repeated for credit
Work in an architect’s office to gain experience, improve skills, and see the inner workings of an everyday architectural practice. Internships possible in all sizes of firms and in public and nonprofit agencies. Internships require full-time work for the entire IAP.
J. Fernandez

4.288 Preparation for SMArchS Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
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.
Staff
4.291 Independent Study in Architecture Studies
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

4.292, 4.293 Independent Study in Architecture Studies
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

4.294 Independent Study in Architecture Studies
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

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

4.299 Summer Research Topics
Prereq: Permission of instructor
G (Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
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.S20 Special Subject: Architecture Studies (New)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

4.S21 Special Subject: Architecture Studies (New)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.S25 Special Subject: Urban Housing (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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. Architecture Staff

4.S26 Special Subject: City Form (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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. Architecture Staff

ART, CULTURE AND TECHNOLOGY

4.301 Introduction to Visual Arts
Prereq: None
U (Fall, Spring)
3-3-6 HASS-A (HASS-D 3)
Credit cannot also be received for 4.302
Introduces artistic practice and critical visual thinking through three studio-based projects: Body Extension, Shaping Time, and Made Public. Each project concludes with a final presentation and critique. Students explore sculptural, architectural, or 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. Offers an index to the historic, cultural and environmental forces that affect both the development of an artistic vision and the reception of a work of art. Lab fee. Art, Culture and Technology Staff

4.302 Foundations in the Visual Arts and Design for Majors
Prereq: None
U (Spring)
3-3-6
Credit cannot also be received for 4.301
Offers a foundation in artistic practice and its critical analysis. Emphasizes the development of artistic approaches and methods and their analogies to architectural thinking and design practice. Develops skills in how to communicate ideas and experiences through two-dimensional, three-dimensional, time-based media, and through new genres. This includes engaging in spatial, sculptural, performative and process-oriented artistic methods. Video screenings, guest lectures, visiting artist presentations, field trips, and readings supplement studio practice. Instruction and practice in written and oral communication provided. Lab fee. Preference to Course 4 majors.
G. Urbonas

4.303 Art, Architecture, and Urbanism in Dialogue
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
Units arranged
Engages dialogue between architecture, urbanism and contemporary art from the perspective of the artistic field. Thematically investigates ideas from early modernist practices to recent examples of contemporary production and site. Examples of artistic practice along with architectural and urban approaches. Focuses on interventions by practitioners who intertwine the three disciplines. Readings provide theoretical background. Lectures, screenings, readings and discussions with guests and faculty lead to the development and realization of group and individual projects for final presentations. Lab fee. Art, Culture and Technology Staff.
Art, Culture and Technology Staff

4.310 Contemporary Curatorial Practice
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Addresses curatorial practice as an activity that intertwines theory and practice, and reflects the sociopolitical context of artistic and cultural production. Examines the history of exhibitions in the field of art, architecture and design, and the impact of site, both local and global, and discusses the role of the curator. Examines 20th- and 21st-century exhibitions, exploring the exhibition as dispositif. Based on case studies students explore and develop individual and collective exhibition concepts and alternative formats of display and dissemination. Lab fee.
U. M. Bauer

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 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-3-3 HASS-A (HASS-E)
Can be repeated for credit
4.313 Advanced Studio on the Production of Space
(Subject meets with 4.312)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Introduces historical and contemporary spatial concepts for various cultures and geo-political settings, and examines how they relate to artistic process and production. Explores 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 the “real” versus “virtual” space. Screenings, guest speakers from various disciplines, readings and in-class presentations support the development of individual and collective projects. Additional work required of students taking the graduate version. Lab fee. Enrollment limited.
Art, Culture and Technology Staff

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)
3-3-6 HASS-A (HASS-E)
Can be repeated for credit
4.315 Advanced Workshop in Artistic Practice and Transdisciplinary Research
(Subject meets with 4.314)
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
Examines artistic practice as a form of critical inquiry and knowledge production. Evaluates models of experimentation, individual research, and collaboration with other disciplines in arts, culture, science and technology. Supports the development and supervision of individual and collective artistic research projects between students, research fellows and faculty from various fields. Additional work required of students taking the graduate version. Lab fee. Enrollment limited.
U. M. Bauer

4.322 Introduction to Three-Dimensional Art Work
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
2-4-6 HASS-A (HASS-E)
Presents three-dimensional artwork, such as sculpture and installations, taken from idea to model to 3-D form. Addresses concept, design, material and fabrication, process, context and site, and an object’s relation to the body and the environment. Lectures, screenigs, and field trips, readings and debates supplement studio practice. Lab fee. Enrollment limited.
J. Jonas

4.330 Introduction to Networked Cultures and Participatory Media
(Subject meets with 4.331)
Prereq: None
U (Fall)
3-3-6 HASS-A (HASS-E); CI-H
4.331 Introduction to Networked Cultures and Participatory Media
(Subject meets with 4.330)
Prereq: None
G (Fall)
Units arranged
Overview of participatory art practices, early net-art, net-activism, and current online practices in art and culture. Explores cultural, social and political impacts of mediated communication.

4.332 Advanced Seminar in Networked Cultures and Participatory Media
(Subject meets with 4.333)
Prereq: 4.330 or permission of instructor
U (Spring)
3-3-3
4.333 Advanced Seminar in Networked Cultures and Participatory Media
(Subject meets with 4.332)
Prereq: 4.330, 4.331, or permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Teaches skills to create networked platforms and participatory media. Explores the development of new critical platforms and strategies such as independent and alternative media, hybrid TV, blogs, and other social media. Develops advanced skills in media literacy and communications. Students implement, critique, and discuss design exercises and experiments. Additional work required of students taking the graduate version. Lab fee.
Art, Culture and Technology Staff

4.341 Introduction to Photography and Related Media
(Subject meets with 4.342)
Prereq: None
U (Fall, Spring)
3-3-6 HASS-A (HASS-E)
4.342 Introduction to Photography and Related Media (New)
(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, visiting professionals, group discussions, readings, and field trips. Fosters visual literacy and aesthetic appreciation of photography/digital imaging as well as a critical awareness of how images in our culture are produced and constructed. Provides practical instruction in the fundamentals of different camera formats, film exposure and development, lighting, black and white darkroom printing, and digital imaging. Assignments addressing a term-specific topic explore a range of traditional and experimental techniques,
develop technical skills, and provide opportunity for personal exploration. Projects continuously presented and discussed in a critical forum. Additional work required of students taking the graduate version. Lab fee. Enrollment limited.

A. Frank

4.343 Advanced Photography and Related Media
Prereq: 4.342 or permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Fosters a critical awareness of how images in our culture are produced and constructed. Topical focus changes from term to term. Exploration centers on student-initiated term project with emphasis on conceptual and technical development. Special consideration of sociopolitical and psychological aspects as well as questions of context and space. Students work with a range of experimental techniques and camera formats, from cell phone to 4x5 view cameras. Practical instruction in film exposure and development, traditional and experimental black-and-white darkroom printing, studio lighting, and all aspects of digital imaging and output. Includes individual reviews, field trips, and visits from outside professionals. Equipment available for checkout. Lab fee. Enrollment limited; preference to current MArch students.

A. Frank

4.350 Introduction to Video and Related Media (New)
(Subject meets with 4.351)
Prereq: Permission of instructor
G (Spring)
Units arranged

4.351 Introduction to Video and Related Media (Subject meets with 4.350)
Prereq: None
U (Spring)
3-3-6 HASS-A (HASS-E)

Covers the technical and conceptual variables and strategies inherent in video for visual art production. Analyzes structural concepts of time, space, perspective, sound, and materiality. Builds on the art-historical legacy specific to the moving image and video, and examines the contemporary moment. Considers self-exploration, performance, social critique, and the manipulation of raw experience into aesthetic form. Emphasizes practical knowledge of professional-level software, video capturing and editing, montage, and lighting. Alternates presentation and critique of student work with technical workshops and screenings. Student taking graduate version complete additional assignments. Lab fee. Enrollment limited.

Art, Culture and Technology Staff

4.352 Advanced Video and Related Media (Subject meets with 4.353)
Prereq: 4.351 or permission of instructor
U (Fall)
3-3-3 HASS-A (HASS-E)

4.353 Advanced Video and Related Media (Subject meets with 4.352)
Prereq: Permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit

Introduction to advanced strategies of image/sound manipulation, both technical and conceptual. Covers pre-production planning (storyboards, scripting), refinement of digital editing techniques, visual effects such as chroma-keying, and post-production and audio. 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 those taking the graduate version. Lab fee.

Art, Culture and Technology Staff

4.360 Performance Art Workshop (Subject meets with 4.361)
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit

4.361 Performance Art Workshop (New) (Subject meets with 4.360)
Prereq: Permission of instructor
U (Fall)
3-3-6

Surveys performance in relation to media and to spatial structures imagined as settings for narrative movements. Uses video to explore perception of sound and image 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. Includes 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 the graduate version. Lab fee.

A. Muntadas

4.365 Advanced Projects in Visual Arts (Prereq: Permission of instructor)
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

4.366 Advanced Projects in Visual Arts
Prereq: Permission of instructor
U (Fall, Spring)
2-4-6 HASS-A (HASS-E)
Can be repeated for credit

Investigates conceptual and formal issues in different media or between media such as sculpture, photography, and video. Explores issues of representation, interpretation, and meaning, and how they relate to historical, social, and cultural context.

Art, Culture and Technology Staff

4.367 Studio Seminar in Public Art/Public Sphere (Subject meets with 4.368)
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit

4.368 Studio Seminar in Public Art/Public Sphere (Subject meets with 4.367)
Prereq: Permission of instructor
U (Spring)
3-3-6 HASS-A (HASS-E)

Focuses on the production of artistic intervention in public space beyond the gallery/museum context. Students develop a project throughout the term for public placement during finals. Aesthetic, social, and political issues in the urban setting in various geographies and cultures are analyzed vis-à-vis enforced public policy. Traditional forms of commemoration are examined, in comparison to temporal and critical forms of public art and action. Historical models include the Russian Constructivists, the Situationists International, Conceptual Art, and recent interventionist tactics and artistic strategies. Readings assigned to help assess the understanding, meaning and intention of each individual’s project. Additional work required of students taking the graduate version. Lab fee.

A. Muntadas
4.370 Interrogative Design Workshop
(Subject meets with 4.371)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-3-6 H-LEVEL Grad Credit

4.371 Interrogative Design Workshop
(Subject meets with 4.370)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-3-6 HASS-A (HASS-E)
Addresses design media and technology as both ethical and aesthetic practice. Development of projects finalized as working tools, instruments, implements, and equipment is supported by relevant theoretical study, presentations and informed discussion. Workshop poses new questions, exposes hidden issues, and creates inspirational and experimental situations for designers and artists as cultural agents. Additional work required of students taking the graduate version. Lab fee.
Art, Culture & Technology Staff

4.388 Preparation for SMACT Thesis
Prereq: Permission of instructor
G (Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Selection of topic, definition of method of approach, preparation of proposal, and development of outline for thesis. Discusses artistic practice as method of critical inquiry. Examines artists’ writing, studies academic requirements and standards. Regular group meetings, including peer reviews, supplemented by independent study and individual conferences with faculty. Restricted to of SMACT program students. Art, Culture and Technology Staff

4.389 Tutorial for SMACT Thesis
Prereq: 4.388; Coreq: 4.THG
G (Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Includes regular presentations of students’ writing, group meetings and critiques by thesis class. Supports independent thesis research and thesis project by providing methodology and focus supplemented by regular individual conference with thesis committee members. Restricted to of SMACT program students. Art, Culture and Technology Staff

4.390 Art, Culture and Technology Studio
Prereq: Permission of instructor
G (Fall, Spring)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
Addresses inquiry and debate about art, culture and technology in relation to contemporary artistic practice, critical design, and media. Considers methods of investigating, documenting and display. Discusses the notion of individual and collaborative work and examines modes of communication across disciplines. Students develop projects in which they organize research methods and goals, cultivate a context for their practice, and explore how to successfully explain, display and document their work. Regular presentations and critiques by peers, ACT faculty and fellows, and external guest reviewers. Restricted to of SMACT program students. Art, Culture and Technology Staff

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

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

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

4.394 Independent Study in Art, Culture and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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 and Technology Staff

4.395 Independent Study in Art, Culture and Technology (New)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

4.S31 Special Subject: Art, Culture and Technology (New)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

4.S32–4.S33 Special Subject: Art, Culture and Technology (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

4.S34 Special Subject: Art, Culture and Technology (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
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 and Technology Staff

BUILDING TECHNOLOGY

4.401 Architectural Building Systems
(Subject meets with 4.461)
Prereq: None
U (Fall)
3-2-7
Introduction to modern architectural systems and the materials and construction of their components and assemblies. Covers in detail building enclosure, structure, interior space, circulation and conveyance systems, and power and water distribution systems. Reviews technologies for response to climate, intelligent systems integration, passive and active heating and cooling, lighting and acoustics. Additional work required of students taking the graduate version.
J. Fernandez

4.411 Building Technology Laboratory
Prereq: Physics II (GIR), Calculus II (GIR)
U (Fall)
2-4-6 Institute LAB
Concepts of building technology and experimental methods. Projects vary yearly and have included design and test of strategies for day-
4.42J Fundamentals of Energy in Buildings
(Same subject as 1.044J, 2.66J)
Prereq: Physics I (GIR), Calculus II (GIR)
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-2-7 H-LEVEL Grad Credit

Introduction to energy fundamentals and thermo-sciences with applications to sustainable, energy-efficient architecture and building technology. Topics include air-water vapor mixtures, thermal comfort, heat pumps and refrigeration cycles, limiting thermodynamic performance, and heat transfer within buildings and major components. Several creative design projects are assigned.

L. R. Glicksman

4.430 Daylighting
Prereq: 4.401 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6 H-LEVEL Grad Credit

Provides the tools necessary for an efficient integration of daylighting issues in the overall design of a building. Fundamentals of daylighting and electric lighting are introduced and their relevance to design decisions emphasized: benefits and availability of daylight, solar radiation and sun course, photometry, vision and color perception, daylighting metrics, visual and thermal comfort, electric lighting. More advanced topics are presented and practiced through the design project and homework assignments, such as primary and advanced lighting design strategies, and design and assessment tools for lighting management.

Building Technology Staff

4.431 Architectural Acoustics
Prereq: 4.401
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
Units arranged H-LEVEL Grad Credit

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.

C. J. Rosenberg

4.440J Building Structural Systems I
(Same subject as 1.056J)
Subject meets with 4.462
Prereq: Calculus II (GIR); 4.401 or permission of instructor
U (Spring)
3-3-6 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.

J. Ochsendorf

4.444 Analysis of Historic Structures
Prereq: None
U (Spring)
3-0-9

Technical and historical study of structures in architecture and engineering. Focuses on the design and assessment of historic structures in masonry, timber, concrete, and metal. Course is driven by student research proposals. Previous student projects have researched Gothic flying buttresses, wooden covered bridges, Roman aqueducts, and iron train stations.

J. Ochsendorf

4.445 Analysis of Historic Structures
Prereq: None
G (Spring)
3-0-6

Technical and historical studies of structures in architecture and engineering. Focuses on the design and assessment of historic structures in masonry, timber, concrete, and metal. Assignments include problem sets and presentations, with a major focus on a final research paper. Previous student projects have researched Gothic flying buttresses, wooden covered bridges, Roman aqueducts, iron train stations, etc. Term project should result in a publishable paper.

J. Ochsendorf

4.447J Design for Sustainability
(Same subject as 1.819J)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit

See description under subject 1.819J.

J. Connor, J. Ochsendorf, E. Adams
4.461 Architectural Building Systems
(Subject meets with 4.401)
Prereq: None
G (Fall)
3-1-5
See description under subject 4.401.
J. Fernandez

4.462 Building Structural Systems I
(Subject meets with 1.056, 4.440)
Prereq: 4.461 or permission of instructor
G (Spring)
3-2-4
See description under subject 4.440).
J. Ochsendorf

4.463 Building Structural Systems II
Prereq: 4.440, 4.462, or permission of instructor
G (Fall)
3-2-4
Addresses advanced structures, exterior env- 
lopes, and contemporary production technolo-
gies. Continues the exploration of structural ele-
ments and systems, expanding to include more 
complex determinate, indeterminate, long-span, 
and high-rise systems. Topics include reinforced 
cement, steel structures, wood design, and an 
introduction to tensile systems. The con-
temporary exterior envelope is discussed with an 
emphasis on the classification of systems, 
their performance attributes, and advanced 
manufacturing technologies.
J. Fernandez, J. Ochsendorf

4.464 Energy in Building Design
Prereq: 4.463 or permission of instructor
G (Spring)
3-2-4
Presents concepts and methods for energy-effi-
cient and environmentally responsible building 
design. Topics include climate, thermal comfort, 
heat flows through building materials, natural 
ventilation, passive, active and renewable 
energy systems, and environmental implications 
of building. Emphasizes practical applications 
for environmental design through analysis of 
precedent buildings and design projects.
L. Glicksman, L. Norford

4.472 Design Workshop for a Sustainable Future
(Subject meets with 4.473)
Prereq: 4.111; 4.401, 4.411 or 4.42
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-6
Can be repeated for credit
4.473 Design Workshop for a Sustainable Future
(Subject meets with 4.472)
Prereq: 4.124; 4.461 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit
Focuses on strengthening the link between 
design and technology with an emphasis on 
sustainability concepts. Introduces theories 
behind resource-efficient built environments 
and how they can enhance the design process. 
Students explore ways to effectively integrate 
built environment with such as energy-effi-
ciency, efficient material use, structural stability 
and occupant comfort into the design process. 
Additional work required of those taking the 
graduate version. Limited to 16 in each subject; 
preference to Course 4 majors and minors.
J. Ochsendorf

4.474 Design for Sustainable Urban Futures
(Subject meets with 4.475)
Prereq: 4.111; 4.401, 4.411 or 4.42
U (Spring)
3-0-6
4.475 Design for Sustainable Urban Futures
(Subject meets with 4.474)
Prereq: 4.124; 4.461 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Focuses on understanding and assessing the 
resource intensity of urban centers. Introduces 
key concepts from ecological economics, and 
urban economics and ecology, while surveying 
the state of global resource extraction and con-
sumption. Students develop focused, alternative 
urban scenarios that offer practical and effective 
potential for greater resource efficiencies. 
Explores the urban built environment, urban 
mobility, decentralized infrastructure, and other 
important alternative modes for production and consumption. Additional work required of those 
taking the graduate version.
Building Technology Staff

4.481 Building Technology Seminar
Prereq: Permission of instructor
G (Fall)
2-0-1 H-LEVEL Grad Credit
Introduction to ongoing research activities in 
built environment and development of student 
research projects. Topics drawn from indoor air 
quality and thermal comfort, building systems 
analysis and control, building energy uses, 
daylighting, structures, and new building ma-
terials and construction techniques. Organized 
as a series of two- to three-week sessions that 
consider topics through readings, discussions, 
design and analysis projects, and student 
presentations.
J. Fernandez, L. R. Glicksman, L. Norford, J. Ochsendorf

4.488 Preparation for SMBT Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Selection of thesis topic, definition of method of 
approach, and preparation of thesis proposal. 
Independent study supplemented by individual 
conference with faculty.
Building Technology Staff

4.489 Preparation for Building Technology PhD 
Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Selection of thesis topic, definition of method of 
approach, and preparation of thesis proposal. 
Independent study supplemented by individual 
conference with faculty.
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
4.492 Independent Study in Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
4.493 Independent Study in Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
4.494 Independent Study in Building Technology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
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

4.545 Special Subject: Building Construction (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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

4.56 Special Subject: Energy in Buildings (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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

4.557 Special Subject: Architectural Lighting (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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

4.558 Special Subject: Structural Design (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.

Building Technology Staff

4.500 Introduction to Design Computing
Prereq: None
U (Fall)
2-2-8
Introduces students to architectural design and computation through the use of computer modeling, rendering, and digital fabrication. Focus on the exploration of space- and place-making through the use of computer rendering and design construction through CAD/CAM fabrication. Students design a small building using computer models leading to a full package of physical and virtual materials, from computer generated drawings to rapid, prototyped models. Preference to Course 4 majors and minors. L. Sass

4.501 Materializing Design
(Subject meets with 4.510)
Prereq: 4.500
U (Spring)
3-3-6
Introduces advanced computing, rapid prototyping, and CAD/CAM fabrication for architects. Focuses on the relationship between design and various forms of computer modeling/CAD CAM tools for material output. Presents the process of design and construction, using CAD files for construction. Begins with CAD/CAM and ends with rapid prototyping of building components fabricated from CAD files. Additional work required of students taking the graduate version. Preference to Course 4 majors and minors for 4.501. L. Sass

4.503 Advanced Visualization: Architecture in Motion Graphics
(Subject meets with 4.562)
Prereq: 4.500 or permission of instructor
U (Fall)
2-2-8
Advanced projects in architectural visualization with an emphasis on the use of computer graphics animation and video production media. Workshop introduces advanced visualization software and teaches exploration of spatial expressions in motion graphics format. Students review and discuss selected literature and video materials on architecture and film. Additional work required of students taking the graduate version. T. Nagakura
4.504 Design Scripting
(Subject meets with 4.564)
Prereq: 4.500
U (Spring)
2-2-8
Introduces fundamental ideas of computer programming and demonstrates their application to the process of visual and spatial design. Teaches methods for algorithmically modeling visual and spatial forms, evaluating their conditions, building interface, and processing formal data for prototyping, manufacturing, rendering, and other design tools. Proceeds through a sequence of scripting exercises in application programming environments. Each exercise requires a student to articulate computational tasks in the context of a design, and to write codes that produce graphic solutions. Additional work required of students taking the graduate version.
T. Nagakura

4.505 Computation Design Workshop
Prereq: 4.501, 4.503, 4.504
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-3-6
Project-based subject that provides opportunities to explore and integrate the various skills, theories, and technologies introduced in prerequisite subjects. Strategies and computational tools for rule-based and parametric design are introduced, critically examined, and explored through application to practical design tasks. Students gain experience with techniques of design synthesis, performance analysis and simulation, visualization, fabrication, and assembly, and with strategies for collaboration and coordination. Emphasis on creative response to challenging design problems.
T. Knight

4.510 Materializing Design
(Subject meets with 4.501)
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
See description under subject 4.501.
L. Sass

4.517 Digital Fabrication and Construction: Professional Applications
Prereq: 4.500, 4.560, or permission of instructor
G (Fall)
3-2-7 H-LEVEL Grad Credit
Addresses contemporary construction systems and technologies, and practical applications of geometry and digital modeling used to realize built complex forms. Surveys digitally founded professional engineering, construction and fabrication practices through case studies, shop visits, and on-campus and videoconference lectures. Includes modeling and making exercises, case studies, and a final project that addresses digital system design, analysis, and fabrication. Limited to 20.
D. Shelden

4.520 Computational Design I: Theory and Applications
(Subject meets with 4.521)
Prereq: None
U (Fall)
3-0-9
4.521 Computational Design I: Theory and Applications
(Subject meets with 4.520)
Prereq: None
G (Fall)
3-0-6
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.

4.522 Computational Design II: Theory and Applications
(Subject meets with 4.523)
Prereq: 4.520 or permission of instructor
U (Spring)
3-0-9
4.523 Computational Design II: Theory and Applications
(Subject meets with 4.522)
Prereq: 4.520, 4.521 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Introduces advanced topics in shape grammar theory and applications. Includes an introductory component on shape grammars for students new to the area. Discusses generalizations of the shape grammar formalism that provide alternative ways of computing and representing designs. These include parametric grammars and parametric design, parallel grammars, and color grammars. Presents material through lectures and in-class, applied exercises. Additional work required of students taking the graduate version.
T. Knight

4.540 Introduction to Shape Grammars I
Prereq: None
G (Fall)
3-0-6
4.541 Introduction to Shape Grammars II
Prereq: 4.540
G (Spring)
3-0-6 H-LEVEL Grad Credit
An in-depth introduction to shape grammars and their applications in architecture and related areas of design. Shapes in the algebras Ui j, in the algebras Vi j and Wi j incorporating labels and weights, and in algebras formed as composites of these. Rules and computations. Shape and structure. Designs.
G. Stiny

4.542 Background to Shape Grammars
Prereq: 4.541 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor
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.
G. Stiny

4.550–4.555 Workshop in Architectural Computation
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity for group exploration of a special topic in computation through research-focused design projects or exercises. Registration subject to prior arrangement of topic and supervision by staff.
Computation Staff

4.552–4.555 Workshop in Architectural Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for group exploration of a special topic in computation through research-focused design projects or exercises. Registration subject to prior arrangement of topic and supervision by staff.
Computation Staff
4.556J Design Without Boundaries
(Same subject as MAS.551J)
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit
See description under subject MAS.551J.
F. Casalegno

4.557J New Urban Village: Mobility-on-Demand
(Same subject as MAS.552J)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject MAS.552J.
F. Casalegno

4.561 Introduction to Computation in Architecture (4.106)
Prereq: 4.105
G (Spring)
2-3-4
Addresses fundamental methods, theories, and practices that engage computing in the context of spatial design. Introduces selected academic and professional topics through lectures, demonstrations, and small assignments. Topics include modeling, generative methods, prototyping, shape calculation, and simulations. Initiates intellectual explorations in the use of computation in research projects and design practices. Restricted to first-year MArch students.
K. Larson

4.562 Advanced Visualization: Architecture in Motion Graphics
(Subject meets with 4.503)
Prereq: Permission of instructor
G (Fall)
2-2-8 H-LEVEL Grad Credit
See description under subject 4.503.
T. Nagakura

4.564 Design Scripting
(Subject meets with 4.504)
Prereq: Permission of instructor
G (Spring)
2-2-8 H-LEVEL Grad Credit
See description under subject 4.504.
T. Nagakura

4.566 Advanced Projects in Digital Media
Prereq: 4.562, 4.564, or permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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, design knowledge representation and media interface.
T. Nagakura

4.568 Inquiry into Computation and Design
Prereq: None
G (Fall)
3-0-9
Explores the varied nature 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.
T. Nagakura

4.567 SMArchS Computation Pre-Thesis Preparation
Prereq: 4.221 or permission of instructor
G (Spring)
3-0-3 [P/D/F] H-LEVEL Grad Credit
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

4.580 Inquiry into Computation and Design
Prereq: None
G (Fall)
3-0-9
Explores the varied nature 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.
T. Knight

4.581 Proseminar in Computation
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 [P/D/F] H-LEVEL Grad Credit
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] H-LEVEL Grad Credit
Can be repeated for credit
In-depth presentations of current research in design and computation.
Computation Staff

4.583 Forum in Computation
Prereq: Permission of instructor
G (Fall, Spring)
3-0-0 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Group discussions and presentation of ongoing graduate student research in the Computation program.
Computation Staff

4.584 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
4.550 Special Subject: Architectural Computation (New)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
4.551 Special Subject: Architectural Computation (New)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
4.552 Special Subject: Architectural Computation (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
4.553 Special Subject: Architectural Computation (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
4.554 Special Subject: Architectural Computation (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
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

4.555 Special Subject: Digital Fabrication (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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

4.556 Special Subject: Shape Grammars (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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
3-2-7 HASS-A (HASS-D 3)
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.
K. Smentek

4.602 Modern Art and Mass Culture
Prereq: None
4-0-8 HASS-A (HASS-D 3); CI-H
Introduction to modern art and theories of modernism and postmodernism. Focuses on the way artists use the tension between fine art and mass culture to mobilize a critique of both. Examines objects of visual art, including painting, sculpture, architecture, photography, prints, performance and video. These objects are viewed in their interaction with advertising, caricature, comics, graffiti, television, fashion, folk art, and “primitive” art.
C. Jones

4.603 Analysis of Contemporary Architecture (4.205)
(Subject meets with 4.604)
Prereq: None
3-0-9 HASS-A (HASS-E)
4.604 Analysis of Contemporary Architecture (New)
(Subject meets with 4.603)
Prereq: Permission of instructor
G (Fall)
Units arranged
Explores pivotal events and buildings that have shaped today’s understanding and approach to contemporary architecture. Emphasis placed on buildings and works of individual architects, as given from a practicing architect’s perspective. Site visits used to help evaluate a building’s significance or lack thereof. Students analyze these buildings through drawing, modeling, reading, and writing. Provides a general framework in which to understand contemporary architectural design and to build a visual vocabulary to help communicate more effectively about design. 4.603 give registration preference to Course 4 majors.
S. Anderson

4.605 Introduction to the History and Theory of Architecture
Prereq: None
4-0-8 HASS-A (HASS-D 3)
Provides an outline of the history of architecture and urbanism from Ancient Egypt to the present. Analyzes buildings as the products of culture and in relation to the special problems of architectural design. History of architecture with an urbanist perspective that stresses the cultural and political context from which building arises. Designed to develop critical tools used in the analysis and appreciation of architecture for its role in creating the intellectual environment in which we conduct our lives. Instruction and practice in oral and written communication provided. HTC Staff

4.606 Visual Perception and Art
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-2-7 HASS-A (HASS-E); CI-H
Visual perception from neurological, cultural, and artistic vantage points. Students examine aspects of visual culture ranging from body adornment to public spaces, and from logotypes to moving images. Lectures, oral presentations, field trips, and written essays develop tools of visual analysis and interpretation. Topics range from ritual space to forensics to machine-aided vision (cameras, radar devices, robotic scanners). Enrollment limited.
C. Jones

4.607 Thinking About Architecture: In History and At Present
Prereq: 4.645 or permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
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

4.609 Seminar in the History of Art and Architecture
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9

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. Emphasis on critical reading and viewing and direct tutorial guidance. Extensive discussion.

HTC Staff

4.611 Civic Architecture in Islamic History
(Subject meets with 4.613)
Prereq: None
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
Units arranged

4.613 Civic Architecture in Islamic History
(Subject meets with 4.611)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-A (HASS-E)

In-depth review of palatial, residential, governmental, military, commercial, and landscape architecture in the Islamic world from the 7th to the 21st century. Analysis the effects of politics, culture, religion and technology on the formation and development of Islamic architectural traditions, and their possible models and regional transformations. Additional work required of students taking the graduate version.

N. Rabbat

4.614 Religious Architecture and Islamic Cultures
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-D 3)

Introduces the history of Islamic cultures through their most vibrant material signs: the religious architecture that spans fourteen centuries and three continents — Asia, Africa, and Europe. Studies a number of representative examples from the House of the Prophet to the present in conjunction with their social, political, and intellectual environments. Presents Islamic architecture both as a full-fledged historical tradition and as a dynamic and interactive cultural catalyst that influenced and was influenced by the civilizations with which it came in contact.

N. Rabbat

4.615 The Architecture of Cairo
(Subject meets with 4.618)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-A (HASS-E)

Studies Cairo as a major cultural, political, and economic center that influences Africa and the Arab and Islamic world. Narrates the history of the city from initial settlement (640s) to the present, reviews its urban and architectural developments, and connects time to their Islamic and Mediterranean architectural and cultural contexts. Additional work required of students taking the graduate version.

N. Rabbat

4.616 Selected Topics on Culture and Architecture
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
Units arranged H-LEVEL Grad Credit

Seminar on how culture interacts with architecture with a focus on Islamic architecture. Establishes historical and theoretical frameworks for investigations of chosen period and/or domain. Analyzes architecture as a conveyer 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.

N. Rabbat

4.617 Issues in Islamic Urbanism
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
Units arranged H-LEVEL Grad Credit

Seminar on selected topics from 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, especially in the Persian Gulf. 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 subsumed under the term “Islamic city.” Research paper or design project required.

N. Rabbat

4.618 The Architecture of Cairo
(Subject meets with 4.615)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
Units arranged H-LEVEL Grad Credit

See description under subject 4.615.

N. Rabbat

4.619 Historiography of Islamic Architecture
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Critical review of literature on Islamic architecture in the last two centuries. Highlights the major figures in the field and analyzes the cultural and disciplinary background. Challenges the tacit assumptions and biases of standard studies of Islamic architecture and addresses historiographic and critical questions concerning how knowledge of a field is defined, produced, and reproduced.

N. Rabbat

4.621 Orientalism and Representation
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
Units arranged H-LEVEL Grad Credit

Seminar on the historiography and politics of representation with special focus on Orientalist traditions in architecture, art, literature, and scholarship. Critically analyzes pivotal texts, projects, and images that informed the cross-cultural encounters between Europe and the “Orient” from Antiquity to the present. Discusses how political and ideological attitudes and religious beliefs informed both the construction and reproduction of Western knowledge about the Islamic world as well as the revisionist “Oriental” self-representations. Research paper required.

N. Rabbat

4.623 Mughal Landscapes: History, Heritage, and Design
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Seminar focuses on environmental design in the Mughal empire of South Asia, a dynasty of Central Asian origins that extended over the current territories of India, Pakistan, Bangladesh, and Afghanistan. Topics include gardens, cities, cultural landscapes, and political territories, along
Course 4

with their contemporary significance for cultural heritage conservation and design. Limited to 15.

J. Wescoat

4.625 Water Reading Group
(Same subject as 11.378j)
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Interdisciplinary focus on water in environmental history, planning, policy, and design. Draws together faculty and students who are working on water-related research projects to develop and maintain a broad and current perspective on the field. Limited to 15.

J. Wescoat

4.634 Renaissance Architecture
(Subject meets with 4.635)
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
Units arranged

4.635 Renaissance Architecture
(Subject meets with 4.634)
Prereq: 4.605
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-A (HASS-E)

A history of architectural design, architectural practice, and the role of architecture in the culture and society of Renaissance Italy. Topics include the formation and development of the modern classical style, the new techniques of architectural drawing, the relationship of architecture to the new visual culture, the role of architecture in the transformation of the political structure of Italy. Graduate students are expected to complete additional assignments.

D. H. Friedman

4.640 Advanced Study in Critical Theory of Architecture
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Seminar on a selected topic in critical theory. Requires original research and presentation of oral and written report.

A. Dutta

4.641 19th-Century Art
(Subject meets with 4.644)
Prereq: None
U (Spring)
4-0-8 HASS-A (HASS-E)

4.644 19th-Century Art
(Subject meets with 4.641)
Prereq: None
G (Spring)
Units arranged

Survey of visual culture from the late 18th-century Europe and its non-European points of contact. Topics include art and revolution, empire and its image, mythologies of the artist, gender and representation, public exhibitions and the dealer/critic system, and the emergence of the avant-garde. Strikes a balance between historical and contemporary critical perspectives to assess art's engagement with social and political experience. Additional work required of students taking the graduate version.

K. Smentek

4.645 Selected Topics in Architecture: 1750 to the Present
Prereq: 4.210 or permission of instructor
G (Spring)
3-0-6

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 Research Programs in Modern Architecture (New)
Prereq: 4.645 or permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit

Explores architectural positions developed in modern times, whether by individual architects or by groups of architects/researchers. Seminar offers a construction in the discipline of architecture parallel to the epistemology cast by Imre Lakatos of science as a system of competing research programs. Participants explore and present notable positions within the discipline in modern times, mainly the 20th century. Limited to 15; preference to MArch students.

S. Anderson

4.647 Technopolitics, Culture, Intervention (New)
Prereq: 4.645 or permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit

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, C. Jones

4.651 Art Since 1940
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-A (HASS-E)

Critical examination of major developments in European, Asian, and American art from 1940 to the present. Surveys the effects of art’s engagements with modernization, radical politics, utopianism, mass culture, changing conceptions of mind and human nature, new technologies, colonialism and postcolonialism, and other significant aspects of recent history.

C. Jones

4.661 Theory and Method in the Study of Architecture and Art
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.

H.T. Staff

4.663 History of Urban Form
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
Units arranged H-LEVEL Grad Credit

Studies in the history of the physical city from Antiquity to the present, with points of special focus determined by the instructor. Analyzes the typologies of urban buildings, public places, and city plans in their relation to changing contexts of culture, politics, and the structure of public and private institutions.

D. H. Friedman
4.670 Nationalism, Internationalism, and Globalism in Modern Art
(Subject meets with 4.671)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
Units arranged
4.671 Nationalism, Internationalism, and Globalism in Modern Art
(Subject meets with 4.670)
Prereq: 4.601 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-1-8

Students study how international modernism interacted with the concept of “nation” and how contemporary discourses concerning globalization changes that dynamic in relation to modern art. Seminar attendance, visits to art museums, and a research paper required. Additional work required of students taking the graduate version.
C. Jones

4.672 Installation Art
(Subject meets with 4.673)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
Units arranged
4.673 Installation Art
(Subject meets with 4.672)
Prereq: 4.601 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9

Focuses on a specific genre of contemporary art that produces environments rather than portable “art objects.” Installation art is viewed from a historical perspective, as a rejection of the modernist aesthetic of purity and the neutral white gallery space. This site-specific art is also seen to develop previous exhibition models such as natural history displays or merchandising conventions.
C. Jones

4.680 Preparation for History, Theory, and Criticism—PhD Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
HTC Staff

4.689 Independent Study in the History, Theory, and Criticism of Architecture and Art
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Can be repeated for credit
4.692 Independent Study in the History, Theory, and Criticism of Architecture and Art
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Can be repeated for credit
4.693 Independent Study in the History, Theory, and Criticism of Architecture and Art
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Can be repeated for credit
4.694 Independent Study in the History, Theory, and Criticism of Architecture and Art
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Can be repeated for credit
Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.
HTC Staff

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

4.S60 Special Subject: History, Theory and Criticism of Architecture and Art (New)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
4.S64 Special Subject: History, Theory and Criticism of Architecture and Art (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
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: Islamic and Non-Western Architecture (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 and/or design projects, varying at the discretion of the instructor.
HTC Staff

4.S66 Special Subject: History, Theory and Criticism of Art (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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: Advanced Study in Modern Art (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.
_HTC Staff_

4.S68 Special Subject: Advanced Study in Modern Architecture (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.
_HTC Staff_

4.S69 Special Subject: Advanced Study in the History of Urban Form (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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_

4.THT Thesis Research Design Seminar
(Same subject as 11.THT)
Prereq: None
U (Fall)
3-0-9
Can be repeated for credit
See description under subject 11.THT.
_C. Abbanat_

4.THU Undergraduate Thesis
Prereq: 4.ThT or 4.119
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.URJ Undergraduate Research in Architecture
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. Students who wish a letter grade option for their work must register for 4.URG.
_L. Sass_
### Bachelor of Science in Architecture/Course 4

#### General Institute Requirements (GiRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement (one subject can be satisfied by a subject in the Departmental Program)</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**: 17

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

<table>
<thead>
<tr>
<th>Subject Names Below are Followed by Credit Units, and by Prerequisites, If Any (Corequisites in Italics)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Subjects</strong></td>
</tr>
<tr>
<td>4.111 Introduction to Architecture and Environmental Design, 12, HASS-A</td>
</tr>
<tr>
<td>or 4.11A Introduction to Architecture and Environmental Design Intensive, 9, HASS-A</td>
</tr>
<tr>
<td>4.112 Architecture Design Fundamentals I, 12</td>
</tr>
<tr>
<td>4.302 Foundations in the Visual Arts and Design for Majors, 12, CI-M</td>
</tr>
<tr>
<td>4.401 Architectural Building Systems, 12</td>
</tr>
<tr>
<td>4.500 Introduction to Design Computing, 12</td>
</tr>
</tbody>
</table>

#### Discipline Stream Subjects

By the beginning of their junior year, students are expected to begin concentrating in one of the five discipline streams.

**Architectural Design Discipline Stream**

<table>
<thead>
<tr>
<th>Subject Names Below are Followed by Credit Units, and by Prerequisites, If Any (Corequisites in Italics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.113 Architecture Design Fundamentals II, 15; 4.111*, 4.112</td>
</tr>
<tr>
<td>4.114 Architecture Design Studio I, 21, CI-M; 4.113, 4.302, 4.401, 4.500, 4.605</td>
</tr>
<tr>
<td>4.115 Architecture Design Studio II, 21; 4.114</td>
</tr>
<tr>
<td>4.440J Building Structural Systems I, 12, REST; Calculus II (GIR), 4.401*</td>
</tr>
<tr>
<td>4.505 Introduction to the History and Theory of Architecture, 12, HASS-A</td>
</tr>
<tr>
<td>4.116 Architecture Design Studio III, 21; 4.115, 4.440</td>
</tr>
<tr>
<td>or Two subjects from any one of the other four discipline streams</td>
</tr>
</tbody>
</table>

**Building Technology Discipline Stream**

<table>
<thead>
<tr>
<th>Subject Names Below are Followed by Credit Units, and by Prerequisites, If Any (Corequisites in Italics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.411 Building Technology Laboratory, 12, LAB; Physics II (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>4.440J Building Structural Systems I, 12, REST; Calculus II (GIR), 4.401*</td>
</tr>
<tr>
<td>4.505 Introduction to the History and Theory of Architecture, 12, HASS-A</td>
</tr>
<tr>
<td>4.THTJ Thesis Research Design Seminar, 12, CI-M</td>
</tr>
<tr>
<td>4.THU Undergraduate Thesis, 12; 4.THT</td>
</tr>
<tr>
<td>Four additional subjects in Building Technology</td>
</tr>
<tr>
<td>One additional subject from any of the other four discipline streams</td>
</tr>
</tbody>
</table>

**Computation Discipline Stream**

<table>
<thead>
<tr>
<th>Subject Names Below are Followed by Credit Units, and by Prerequisites, If Any (Corequisites in Italics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.501 Materializing Design, 12; 4.500</td>
</tr>
<tr>
<td>4.503 Advanced Visualization: Architecture in Motion Graphics, 12; 4.500*</td>
</tr>
<tr>
<td>4.504 Design Scripting, 12; 4.500</td>
</tr>
<tr>
<td>4.505 Computation Design Workshop, 12; 4.501, 4.503, 4.504</td>
</tr>
<tr>
<td>4.505 Introduction to the History and Theory of Architecture, 12, HASS-A</td>
</tr>
<tr>
<td>4.THTJ Thesis Research Design Seminar, 12, CI-M</td>
</tr>
<tr>
<td>4.THTJ Undergraduate Thesis, 12; 4.THT</td>
</tr>
<tr>
<td>One additional subject in Computation</td>
</tr>
</tbody>
</table>

**History, Theory, and Criticism of Architecture and Art Discipline Stream**

<table>
<thead>
<tr>
<th>Subject Names Below are Followed by Credit Units, and by Prerequisites, If Any (Corequisites in Italics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.601 Introduction to Art History, 12, HASS-A</td>
</tr>
<tr>
<td>4.605 Introduction to the History and Theory of Architecture, 12, HASS-A</td>
</tr>
<tr>
<td>4.602 Modern Art and Mass Culture, 12, HASS-A, CI-H</td>
</tr>
<tr>
<td>or 4.641 19th-Century Art, 12, HASS-A</td>
</tr>
<tr>
<td>or 4.651 Art Since 1940, 12, HASS-A</td>
</tr>
<tr>
<td>or 4.613 Civic Architecture in Islamic History, 12, HASS-A</td>
</tr>
<tr>
<td>or 4.614 Religious Architecture and Islamic Cultures, 12, HASS-A</td>
</tr>
<tr>
<td>4.THTJ Thesis Research Design Seminar, 12, CI-M</td>
</tr>
<tr>
<td>4.THU Undergraduate Thesis, 12; 4.THT</td>
</tr>
<tr>
<td>Three additional subjects in History, Theory, and Criticism of Architecture and Art</td>
</tr>
<tr>
<td>One additional subject in Art, Culture, and Technology</td>
</tr>
</tbody>
</table>
### Art, Culture, and Technology Discipline Stream 120

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Requirement(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.322</td>
<td>Introduction to Three-Dimensional Art Work, 12, HASS-A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.341</td>
<td>Introduction to Photography and Related Media, 12, HASS-A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.351</td>
<td>Introduction to Video and Related Media, 12, HASS-A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.601</td>
<td>Introduction to Art History, 12, HASS-A†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.THJ</td>
<td>Thesis Research Design Seminar, 12, CI-M</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Three intermediate/advanced-level subjects in Art, Culture, and Technology

One additional subject in History, Theory, and Criticism of Art

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### Total Units Beyond the GIRs Required for SB Degree 192

- **Departmental Program Units That Also Satisfy the GIRs** (36)
- **Unrestricted Electives** 48–57

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**Notes**

* Alternate prerequisites are listed in the subject description.

† Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.

‡ Only three subjects required by the department may also satisfy the General Institute Requirements.

Students in the Art, Culture, and Technology departmental discipline stream may not have a HASS concentration in Art, Culture, and Technology; nor may History, Theory, and Criticism of Architecture and Art discipline stream students concentrate in the HASS field of History of Architecture and Art.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
5.00 Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.63, 10.579, 22.813, ESD.174)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.813.
J. Deutch, R. Lester

5.03 Principles of Inorganic Chemistry I
Prereq: 5.12
U (Spring)
5-0-7
Presents principles of chemical bonding and molecular structure, and their application to the chemistry of representative elements of the periodic system.
C. C. Cummins, D. G. Nocera

5.04 Principles of Inorganic Chemistry II
Prereq: 5.03
U (Fall)
4-0-8
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.
D. G. Nocera, M. Dinca

5.05 Principles of Inorganic Chemistry III
Prereq: 5.03, 5.04
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
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 (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
A comprehensive treatment of organometallic compounds of the transition metals with emphasis on structure, bonding, synthesis, and mechanism.
R. Schrock

5.062 Principles of Bioinorganic Chemistry
Prereq: 5.03
G (Fall; first half of term)
3-0-3 H-LEVEL Grad Credit
Delineates principles that form the basis for understanding how metal ions function in biology. Includes the choice, uptake and assembly of metal-containing units; metal-induced folding of biomolecules; control of metal ion concentrations in cells; electron-transfer chemistry; atom and group transfer chemistry; protein tuning of metal properties; and applications to diagnosis and treatment of disease.
E. Nolan

5.063 Organometallic Compounds in Catalytic Reactions
Prereq: 5.061
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
An exploration of organometallic chemistry from the perspective of catalytic reactions in organic and polymer chemistry.
R. Schrock

5.067 Crystal Structure Refinement
Prereq: 5.068, 5.069, or permission of instructor
G (Fall)
3-2-1 H-LEVEL Grad Credit
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, 5.04
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Discussion of physical methods used to probe the electronic and geometric structures of inorganic compounds. Included are resonance Raman spectroscopy, solid state and solution magnetochemical methods, electron paramagnetic resonance spectroscopy, advanced EPR methods (ENDOR AND ESEEM), cryoreduction to create EPR-active states, X-ray absorption spectroscopy (XANES and EXAFS), Mössbauer spectroscopy, and advanced kinetic and electrochemical methods. Applications to current research problems in inorganic and bioinorganic chemistry.
M. Dinca

5.069 Crystal Structure Analysis
Prereq: 5.03, 5.04
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
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

5.07J Biological Chemistry I
(Same subject as 20.507J)
Prereq: 5.12
U (Fall)
5-0-7 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.
J. Essigmann, J. Stubbe
More advanced treatment of biochemical mechanisms that underlie biological processes. Topics include macromolecular machines such as the ribosome, the proteosome, fatty acid syntheses 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.

A. Y. Ting, E. Nolan

5.111 Principles of Chemical Science
(Subject meets with ES.5111)
Prereq: None
U (Fall, Spring)
5-0-7 CHEMISTRY
Credit cannot also be received for 5.112
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.
Fall: C. Drennan, K. Nelson
Spring: A. Klibanov, E. Taylor

5.112 Principles of Chemical Science
(Subject meets with ES.5112)
Prereq: None
U (Fall)
5-0-7 CHEMISTRY
Credit cannot also be received for 5.111
Introduction to chemistry for students with an unusually strong background in chemistry. Knowledge of calculus equivalent to 18.01 is recommended. 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. Lippard, K. Nelson

5.12 Organic Chemistry I
Prereq: Chemistry (GIR)
U (Fall, Spring)
5-0-7 REST
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.
Fall: T. M. Swager
Spring: R. L. Danheiser, T. F. Jamison

5.13 Organic Chemistry II
Prereq: 5.12
U (Fall)
5-0-7
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

5.24J Archaeological Science
(Same subject as 3.985J, 12.011J)
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 HASS-S (HASS-E)
See description under subject 3.985J.
H. N. Lechtmann, J. Stubbe, F. A. Frey

5.301 Chemistry Laboratory Techniques
Prereq: Chemistry (GIR), permission of instructor
U (IAP)
1-4-1 [P/D/F]
This 12-unit subject consists of 3 modules, which may be taken during different terms. Modules and prerequisites are as follows:
—Module 1 (Prereq: 5.111, 5.112 or 3.091)
Survey of spectroscopy.
Module 2 (Prereq: 5.111, 5.112 or 3.091; Module 1) Synthesis of coordination compounds and kinetics.
—Module 3 (Prereq: 5.111, 5.112 or 3.091; 5.12, Module 2) Fabrication of a polymeric light-emitting device.
Enrollment limited; preference to Course 5 majors.
Fall: K. Nelson (Module 1), M. Twardowski (Module 2), T. Swager (Module 3)
Spring: Staff (Modules 1 & 2), T. Swager (Module 3)

5.35U Introduction to Experimental Chemistry
(Subject meets with 5.35)
Prereq: See module descriptions under subject 5.35
U (Fall, Spring)
Units arranged
Can be repeated for credit
For students who might not take all modules of 5.35. Consult department when choosing a version of 5.35. May be taken for 8 or 4 units and repeated for credit up to a total of 12 units.
Fall: K. Nelson (Module 1), M. Twardowski (Module 2), T. Swager (Module 3)
Spring: Staff (Modules 1 & 2), T. Swager (Module 3)

5.36 Biochemistry and Organic Laboratory
(Subject meets with 5.36U)
Prereq: See module descriptions under subject 5.36
U (Fall, Spring)
Units arranged
Can be repeated for credit
This 12-unit subject consists of 3 modules, which may be taken during different terms. Instruction and practice in the written and oral presentation of experimental results provided.
Prerequisites and modules are as follows:
—Module 4 Spring (Prereq: 5.07 or 7.05, Module 2 or 5.310, Module 5) Expression and Purification of Enzyme Mutants. Must be taken simultaneously with Module 5.
—Module 5 Spring (Prereq: 5.07 or 7.05, Module 2 or 5.310, Module 4) Kinetics of Enzyme Inhibition. Must be taken simultaneously with
Module 4.
—Module 6 Fall (Prereq: 5.12, Module 2 or 5.310, 5.13) Organic Structure Determination.
   Enrollment limited; preference to Course 5 majors.
Fall: R. L. Danheiser (Module 6)
Spring: B. Pentelute (Modules 4 & 5)

5.36U Biochemistry and Organic Laboratory
(Subject meets with 5.36)
Prereq: See module descriptions under subject 5.36
U (Fall, Spring)
Units arranged
Can be repeated for credit
For students who might not take all modules of 5.36. Consult department when choosing a version of 5.36. See description for 5.36. May be taken for 8 or 4 units and repeated for credit up to a total of 12 units.
Fall: R. L. Danheiser (Module 6)
Spring: B. Pentelute (Modules 4 & 5)

5.37 Organic and Inorganic Laboratory
(Subject meets with 5.37U)
Prereq: See module descriptions
U (Fall, Spring)
Units arranged
Can be repeated for credit
This 12-unit subject consists of 3 modules, which may be taken during different terms. Modules and prerequisites are as follows:
—Module 7 Spring (Prereq: 5.13, Module 6)
   Introduction to Organic Synthesis.
—Module 8 Fall (Prereq: 5.03, Module 6, 5.61)
   Two Electron Bond.
   —Module 9 Fall (Prereq: 5.03, Module 6, 5.61)
   Dinitrogen Cleavage.
   Enrollment limited; preference to Course 5 majors.
Fall: D. Nocera (Module 8), C. C. Cummins (Module 9)
Spring: M. Twardowski (Module 7)

5.37U Organic and Inorganic Laboratory
(Subject meets with 5.37)
Prereq: See module descriptions under subject 5.37
U (Fall, Spring)
Units arranged
Can be repeated for credit
For students who might not take all modules of 5.37. Consult department when choosing a version of 5.37. See description for 5.37. May be taken for 8 or 4 units and repeated for credit up to a total of 12 units.
Fall: D. Nocera (Module 8), C. C. Cummins (Module 9)
Spring: M. Twardowski (Module 7)

5.38 Physical Chemistry Laboratory
Prereq: See module descriptions
U (Spring)
Units arranged
Can be repeated for credit
This 12-unit subject consists of 3 modules, which may be taken during different terms. Instruction and practice in the written and oral presentation of experimental results provided. Modules and prerequisites are as follows:
—Module 10 (Prereq: 5.61, Module 6)
   Quantum Dots.
—Module 11 (Prereq: 5.61, 5.07 or 7.05, Module 5)
   Time Resolved Molecular Spectroscopy.
—Module 12 (Prereq: 5.61, 5.07 or 7.05, Module 6)
   Solid State NMR.
   Enrollment limited; preference to Course 5 majors.
M. G. Bowendt (Module 10), A. Tkamakoff (Module 11), J. Simpson (Module 12)

5.43 Advanced Organic Chemistry
Prereq: 5.13
4-0-8
Credit cannot also be received for 5.56 Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates. Organometallic chemistry, with an emphasis on fundamental reactivity, mechanistic studies, and applications in organic chemistry. Meets with 5.531 second half of term; credit cannot also be received for the sequence of 5.53 and 5.531.
G. Fu

5.44 Organometallic Chemistry
Prereq: 5.43, 5.47, 5.061, or permission of instructor
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Examination of the most important transformations of organotransition-metal species. Emphasizes basic mechanisms of their reactions, structure-reactivity relationships, and applications in synthesis.
S. Buchwald

5.45 Heterocyclic Chemistry
Prereq: 5.43, 5.511, 5.53
Acad Year 2011–2012: G (Spring; second half of term)
Acad Year 2012–2013: Not offered
2-0-4 H-LEVEL Grad Credit
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. L. Buchwald

5.451 Chemistry of Biomolecules and Natural Product Pathways
Prereq: 5.43
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Introduction to chemistry, biology, biochemistry and metabolic engineering of secondary metabolic pathways.
Staff

5.46 NMR Spectroscopy and Organic Structure Determination
Prereq: 5.43
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Applications of 1-D and 2-D ¹H and ¹³C NMR spectroscopy to organic structure determination.
J. H. Simpson

5.47 Tutorial in Organic Chemistry
Prereq: 5.43, permission of instructor
G (Fall; first half of term)
2-0-4 [P/D/F] H-LEVEL Grad Credit
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.
M. Movassaghi

5.48I Protein Folding and Human Disease
(Same subject as 7.88I, 10.543I)
Prereq: 7.51 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Examination of the most important transformations of organotransition-metal species. Emphasizes basic mechanisms of their reactions, structure-reactivity relationships, and applications in synthesis.
S. Lindquist, J. A. King

5.50 Enzymes: Structure and Function
Prereq: 5.07 or 7.05; 5.12, 5.13
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to methods used to elucidate the mechanism of enzyme-catalyzed reactions. Application of steady-state and presteady-state kinetics, isotope effect measurements, site-directed mutagenesis, and mechanism-based inhibitors as tools to investigate the mechanisms
of enzymes that have been well-characterized structurally.

J. Stubbe

5.511 Synthetic Organic Chemistry I
Prereq: 5.43
G (Fall; partial term)
3-0-9 H-LEVEL Grad Credit

Introduction to the design of syntheses of complex organic compounds.

R. L. Danheiser

5.512 Synthetic Organic Chemistry II
Prereq: 5.511
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

General methods and strategies for the synthesis of complex organic compounds.

T. F. Jamison

5.52 Advanced Biological Chemistry
Prereq: Permission of Instructor
G (Fall)
2-2-8 H-LEVEL Grad Credit

Concepts and methods of biochemistry, with emphasis on quantitative aspects of problem analysis and fundamentals of experimental methods. Intended for first-year graduate students with a strong interest in biological chemistry.

A. M. Klibanov

5.53 Molecular Structure and Reactivity I
Prereq: 5.13, 5.60
G (Fall; first half of term)
3-0-3 H-LEVEL Grad Credit

Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates.

J. Johnson

5.531 Organometallic Reaction Mechanisms
Prereq: 5.53
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall; second half of term)
3-0-3 H-LEVEL Grad Credit

Discusses the key elementary steps in organometallic chemistry with an emphasis on studies of reaction mechanism. Credit cannot also be received for 5.43; meets with 5.43 second half of term.

G. Fu

5.541 Frontiers in Chemical Biology
(Same subject as 7.540J, 20.554J)
Prereq: 5.13, 5.07, 7.06, permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit

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, metabolomics, and methods for analyzing signaling network dynamics. Lectures are interspersed with class discussions and student presentations based on current literature.

B. Imperiali

5.55 Chemical Tools for Assessing Biological Function
Prereq: 5.43; 5.07 or 7.05; Coreq: 5.47 or 5.52
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
2-0-4 H-LEVEL Grad Credit

Contemporary bioorganic chemistry and chemical biology, emphasizing the application of chemical approaches to interrogate biochemical function. Selected topics include specific enzyme inhibition as a mechanism for rational drug design; molecular mechanisms of drug resistance; uses of intrinsic and extrinsic reporter functionality to understand biological functions and interactions; chemical methods for probing cellular activities in real time. Meets with 20.485 for second half of term.

B. Imperiali, F. White

5.56 Molecular Structure and Reactivity II
Prereq: Permission of Instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
2-0-4 H-LEVEL Grad Credit

Credit cannot also be received for 5.43. Application of physical principles and methods to contemporary problems of interest in organic chemistry.

Staff

5.561 Chemistry in Industry
Prereq: 5.03; 5.07 or 7.05; 5.13
G (Spring; second half of term)
2-0-4 [P/D/F] H-LEVEL Grad Credit

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), Chemistry (GIR)
U (Fall, Spring)
5-0-7 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.

Fall: A. Tokmakoff, R. J. Silbey
Spring: T. Van Voorhis, R. J. Silbey

5.61 Physical Chemistry
Prereq: Physics II (GIR), Calculus II (GIR), Chemistry (GIR)
U (Fall)
5-0-7 REST

Introductory quantum chemistry; particles and waves; wave mechanics; atomic structure and the Periodic Table; valence and molecular orbital theory; molecular structure; and photochemistry.

R. W. Field, T. Van Voorhis

5.62 Physical Chemistry
Prereq: 5.60, 5.61
U (Spring)
4-0-8

Elementary statistical mechanics; transport properties; kinetic theory; solid state; reaction rate theory; and chemical reaction dynamics.

J. Cao, K. Nelson

5.64 Biophysical Chemistry
Prereq: 5.13, 5.60; 5.07 or 7.05
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

Introduction to the major principles and concepts of biophysical chemistry, with emphasis on the conformational changes and interactions of biological macromolecules, biochemical reaction dynamics, and membranes. Incorporates current experimental methods, thermodynamics, statistical mechanics, and kinetics.

A. Tokmakoff, A. Ting
5.65 Molecular Imaging
Prereq: 5.13, 5.60; 5.07 or 7.05
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
Overview of molecular imaging methods used to study biological systems, ranging from cells to entire organisms. Course begins with micrometer-scale imaging, dominated by visible light microscopy. Students discuss physics and instrumentation, chemical probes, and biological applications. The second unit covers imaging at millimeter scales, focusing on PET and MRI imaging in live organisms. The final unit addresses imaging at the nanometer to micrometer scale: electron microscopy, AFM, and NSOM.

A. Ting

5.68J Kinetics of Chemical Reactions
(Same subject as 10.652J)
Prereq: 5.62, 10.37, or 10.65
G (Spring)
3-0-6 H-LEVEL Grad Credit
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

5.70J Statistical Thermodynamics
(Same subject as 10.546J)
Prereq: 5.60 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.

A. K. Chakraborty, J. M. Deutch

5.72 Statistical Mechanics
(Same subject as 10.546J)
Prereq: 5.70, 5.73, 18.075
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
R. Silbey

5.73 Introductory Quantum Mechanics I
Prereq: 5.61, 8.03, 18.03
G (Fall)
3-0-9 H-LEVEL Grad Credit
Presents the fundamental concepts of quantum mechanics: wave properties, uncertainty principles, Schrodinger 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.
R. G. Griffin

5.74 Introductory Quantum Mechanics II
Prereq: 5.73
G (Spring; first half of term)
3-0-3 H-LEVEL Grad Credit
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.
R. G. Griffin

5.77) Topics in Metabolic Biochemistry
(Same subject as 7.75J)
Prereq: 5.07 or 5.07
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 7.75J.
G. M. Brown

5.78 Biophysical Chemistry Techniques
Prereq: 5.07 or 7.05
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
Credit cannot also be received for 7.71
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
(Same subject as 7.71)
Prereq: 5.61 or 8.04; 18.03
G (Spring)
3-0-9 H-LEVEL Grad Credit
Advanced topics of current special interest.
Staff

5.891 Independent Study in Chemistry for Undergraduates
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Advanced topics of current special interest.
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.
J. Essigmann

5.90 Problems in Chemistry
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Directed research and study of special chemical problems. For Chemistry graduate students only.
J. Essigmann

5.913 Seminar in Organic Chemistry
Prereq: Permission of instructor
G (Fall)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Directed research and study of special chemical problems. For graduate students only.
J. Essigmann
5.914 Seminar in Organic Chemistry
Prereq: Permission of instructor
G (Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discussion of current journal publications in organic chemistry by graduate students and staff members.
R. L. Danheiser

5.92] Projects in Energy
(Same subject as 10.191J)
Prereq: Permission of instructor
U (Spring)
3-2-4
Can be repeated for credit
Explores energy issues in the context of real-world problems. Projects may focus on the MIT campus, local communities, or distant locations. Faculty and staff work with student teams on projects that have potential to affect local energy management. Students participate in multiple phases of project design and implementation, including developing research questions, gathering and analyzing data, articulating conclusions and recommendations, and presenting findings. Emphasis on effective teamwork. Preference to freshmen and sophomores.
Staff

5.921 Seminar in Biological Chemistry
(Same subject as 10.191J)
Prereq: Permission of instructor
G (Fall)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
5.922 Seminar in Biological Chemistry
Prereq: Permission of instructor
G (Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses topics of current interest in biological chemistry by graduate students and staff.
C. Drennan
J. Stubbe

5.931 Seminar in Physical Chemistry
Prereq: 5.60
G (Fall)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
5.932 Seminar in Physical Chemistry
Prereq: Permission of instructor
G (Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses topics of current interest in physical chemistry by staff members and students.
Staff

5.941 Seminar in Inorganic Chemistry
Prereq: 5.03
G (Fall)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses topics of current interest in physical chemistry by staff members and students.
J. Cao
C. Degen

5.942 Seminar in Inorganic Chemistry
Prereq: 5.03
G (Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses current research in inorganic chemistry by graduate students and staff.
M. Dinca

5.95J Teaching College-Level Science and Engineering
(Same subject as 1.95J, 6.982J, 7.59J, 8.395J, 18.094J)
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
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. Subject is appropriate for both novices and those with teaching experience.
J. Rankin

5.CME Study at Cambridge University
(Same subject as 6.982J, 7.59J, 8.395J, 18.094J)
Subject meets with 2.978
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides credit for students studying at Cambridge University under the Cambridge-MIT Exchange program. Credit may be used to satisfy specific SB degree requirements. Consult with department and CME office.
J. Essigmann

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.
J. Essigmann

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.
J. Essigmann

5.UR 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 9 to 12 units per term, not to exceed a cumulative total of 24 units. A 10-page paper summarizing research is required. Restricted to juniors and seniors.
C. C. Cummins
# Bachelor of Science in Chemistry/Course 5

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Description</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement (one subject can be satisfied by 5.111 or 5.112 in the Departmental Program)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (one subject can be satisfied by 5.12, 5.60, or 5.61 in the Departmental Program)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (can be satisfied by completing all three modules in 5.35 in the Departmental Program)</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**: 17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.03 Principles of Inorganic Chemistry I, 12; 5.12</td>
<td>12</td>
</tr>
<tr>
<td>5.07J Biological Chemistry I, 12; REST; 5.12</td>
<td>12</td>
</tr>
<tr>
<td>5.111 or 5.112 Principles of Chemical Science, REST; 5.12</td>
<td>12</td>
</tr>
<tr>
<td>5.12 Organic Chemistry I, 12; REST; Chemistry (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>5.23 Organic Chemistry II, 12; 5.12</td>
<td></td>
</tr>
<tr>
<td>5.35 Introduction to Experimental Chemistry, 12, LAB; Chemistry (GIR)</td>
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<tr>
<td>Module 1 Survey of Spectroscopy, 4</td>
<td>4</td>
</tr>
<tr>
<td>Module 2 Inorganic Synthesis and Kinetics, 4; Module 1</td>
<td></td>
</tr>
<tr>
<td>Module 3 Polymeric Light Emitting Devices, 4; 5.12, Module 2</td>
<td></td>
</tr>
<tr>
<td>5.36 Biochemistry and Organic Laboratory, 12, CI-M</td>
<td></td>
</tr>
<tr>
<td>Module 4 Expression and Purification of Enzyme Mutants, 4; 5.07 or 7.05</td>
<td>Module 2 or 5.310; Module 5</td>
</tr>
<tr>
<td>Module 5 Kinetics of Enzyme Inhibition, 4; 5.07 or 7.05; Module 4</td>
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</tr>
<tr>
<td>Module 6 Organic Structure Determination, 4; 5.12; Module 2 or 5.310; 5.23</td>
<td></td>
</tr>
<tr>
<td>5.37 Organic and Inorganic Laboratory, 12</td>
<td></td>
</tr>
<tr>
<td>Module 7 Introduction to Organic Synthesis, 4; 5.13, Module 6</td>
<td></td>
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<tr>
<td>Module 8 Two-Electron Bond, 4; 5.03; Module 6, 5.61</td>
<td></td>
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<tr>
<td>Module 9 Dinitrogen Cleavage, 4; 5.03; Module 6, 5.61</td>
<td></td>
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<tr>
<td>5.38 Physical Chemistry Laboratory, 12, CI-M</td>
<td></td>
</tr>
<tr>
<td>Module 10 Quantum Dots, 4; 5.61, Module 6</td>
<td></td>
</tr>
<tr>
<td>Module 11 Time Resolved Molecular Spectroscopy, 4; 5.61; 5.07 or 7.05</td>
<td>Module 5</td>
</tr>
<tr>
<td>Module 12 Solid State NMR, 4; 5.61; 5.07 or 7.05; Module 6</td>
<td></td>
</tr>
<tr>
<td>5.43 Advanced Organic Chemistry, 12; 5.13</td>
<td></td>
</tr>
<tr>
<td>5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>5.61 Physical Chemistry, 12, REST; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)</td>
<td></td>
</tr>
</tbody>
</table>

### Restricted Electives

At least two of the following four subjects:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.04 Principles of Inorganic Chemistry II, 12; 5.03</td>
<td></td>
</tr>
<tr>
<td>5.08J Biological Chemistry II, 12; 5.12; 5.07 or 7.05</td>
<td></td>
</tr>
<tr>
<td>5.43 Advanced Organic Chemistry, 12; 5.13</td>
<td></td>
</tr>
<tr>
<td>5.62 Physical Chemistry, 12; 5.60, 5.61</td>
<td></td>
</tr>
</tbody>
</table>

### Departmental Program Units That Also Satisfy the GIRs

(36)\(^{(2)}\)

### Unrestricted Electives

60

**Total Units Beyond the GIRs Required for SB Degree**: 180

*No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

## Notes

\(^{(1)}\)An alternate subject is listed in the GIR description.

\(^{(2)}\)Students who do not take 5.111 or 5.112 to fulfill the General Institute Requirement in Chemistry will have 24 units in the Departmental Program that will also satisfy the General Institute Requirements.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
6.00 Introduction to Computer Science and Programming
Prereq: None
U (Fall, Spring)

An introduction to computer science and programming for students with little or no programming experience. Students learn how to program and how to use computational techniques to solve problems. Topics include algorithms, simulation techniques, and use of software libraries. Assignments are done using the Python programming language.

J. V. Guttag

6.01 Introduction to EECS I
Prereq: None. Coreq: Physics II (GIR)
U (Fall, Spring)

2-4-6 1/2 Institute LAB

An 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. 6 Engineering Design Points.

D. M. Freeman, L. P. Kaelbling, T. Lazano-Perez

6.02 Introduction to EECS II
Prereq: 6.01; 18.03 or 18.06
U (Fall, Spring)

4-4-4 1/2 Institute LAB

Explores communication signals, systems and networks. Substantial laboratory experiments illustrate the role of abstraction and modularity in engineering design. Students gain practical experience in building reliable systems using imperfect components; selecting appropriate design metrics; choosing effective representations for information; and evaluating tradeoffs in complex systems. Topics include physical characterization and modeling of transmission systems in the time and frequency domains; analog and digital signaling; coding; detecting and correcting errors; relating information transmission rate to signal power, bandwidth and noise; and engineering of packet-switched networks. 6 Engineering Design Points.

C. J. Terman, H. Balakrishnan, J. K. White

6.07 Projects in Microscale Engineering for the Life Sciences
(Same subject as HST.410J)
Prereq: None
U (Spring)

2-4-3

See description under subject HST.410J.

D. Freeman, M. Gray, A. Aranyosi

6.002 Circuits and Electronics
Prereq: 18.03; Physics II (GIR) or 6.01
U (Fall, Spring)

4-1-7 REST

Fundamentals of the lumped circuit abstraction. Resistive elements and networks, independent and dependent sources, switches and MOS devices, digital abstraction, amplifiers, and energy storage elements. Dynamics of first- and second-order networks; design in the time and frequency domains; analog and digital circuits and applications. Design exercises. Occasional laboratory. 4 Engineering Design Points.

A. Agarwal, J. del Alamo, J. H. Lang, D. J. Perreault

6.003 Signals and Systems
Prereq: 6.02
U (Fall, Spring)

5-0-7

Presents the fundamentals of signal and system analysis. Topics include discrete-time and continuous-time signals, Fourier series and transforms, Laplace and Z transforms, and analysis of linear, time-invariant systems. Applications drawn broadly from engineering and physics, including audio and image processing, communications, and automatic control. 4 Engineering Design Points.

D. M. Freeman, Q. Hu, J. S. Lim

6.004 Computation Structures
Prereq: Physics II (GIR)
U (Fall, Spring)

4-0-8

Introduces architecture of digital systems, emphasizing structural principles common to a wide range of technologies. Multilevel implementation strategies; definition of new primitives (e.g., gates, instructions, procedures, and processes) and their mechanization using lower-level elements. Analysis of potential concurrency; precedence constraints and performance measures; pipelined and multidimensional systems. Instruction set design issues; architectural support for contemporary software structures. 4 Engineering Design Points.

S. A. Ward, C. J. Terman

6.005 Elements of Software Construction
Prereq: 6.01; Coreq: 6.042
U (Fall, Spring)

4-0-8

Introduction to the fundamental principles and techniques of software development that have greatest impact on practice. Topics include capturing the essence of a problem by recognizing and inventing suitable abstractions; key paradigms, including state machines, functional programming, and object-oriented programming; use of design patterns to bridge gap between models and code; the role of interfaces and specification in achieving modularity and decoupling; reasoning about code using invariants; testing, test-case generation and coverage; essentials of programming with objects, functions, and abstract types. Includes exercises in modeling, design, implementation and reasoning. 12 Engineering Design Points.

D. N. Jackson, R. C. Miller

6.006 Introduction to Algorithms
Prereq: 6.01, 6.042
U (Fall, Spring)

4-0-8

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.

R. L. Rivest, S. Devadas

6.007 Electromagnetic Energy: From Motors to Lasers
Prereq: 6.01 or 8.02; 18.03
U (Fall, Spring)
5-1-6
Discusses applications of electromagnetic and equivalent quantum mechanical principles to classical and modern devices. Covers energy conversion and power flow in both macroscopic and quantum-scale electrical and electromechanical systems, including electric motors and generators, electric circuit elements, quantum tunneling structures and instruments. Studies photons as waves and particles and their interaction with matter in optoelectronic devices, including solar cells, displays, and lasers.

V. Bulovic, R. J. Ram

6.011 Introduction to Communication, Control, and Signal Processing
Prereq: 6.003; 6.041 or 18.440
U (Spring)
4-0-8
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 Microelectronic Devices and Circuits
Prereq: 6.002
U (Fall, Spring)
4-0-8
Microelectronic device modeling, and basic microelectronic circuit analysis and design. Physical electronics of semiconductor junction and MOS devices. Relating terminal behavior to internal physical processes, developing circuit models, and understanding the uses and limitations of different models. Use of incremental and large-signal techniques to analyze and design transistor circuits, with examples chosen from digital circuits, linear amplifiers, and other integrated circuits. Design project. 4 Engineering Design Points.

A. I. Akinwande, D. A. Antoniadis, C. G. Fonstad, Jr., C. G. Sodini

6.013 Electromagnetics and Applications
(Subject meets with 6.630 when offered concurrently)
Prereq: 6.603 or 6.007
U (Fall, Spring)
4-0-8
Credit cannot also be received for 6.630
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 waves; resonance; acoustic analogs; and forces, power, and energy. Students taking graduate version complete different assignments.

D. H. Staelin, E. P. Ippen, M. Zahn

6.021J Cellular Biophysics
(Same subject as 2.791J, 20.370J)
Prereq: 2.794J, 6.521J, 20.470J, HST.541J
Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110, 20.111, or permission of instructor
U (Fall)
5-2-5
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 half of course focuses on mass transport through membranes: diffusion, osmosis, chemically mediated, and active transport. Second half focuses on electrical properties of cells: ion transport to action potentials in electrically excitable cells. Electrical properties interpreted via kinetic and molecular properties of single voltage-gated ion channels. Laboratory and computer exercises illustrate the concepts. Provides instruction in written and oral communication. Students taking graduate version complete different assignments. Preference to juniors and seniors. 4 Engineering Design Points.

D. M. Freeman, J. Han, J. Voldman, M. F. Yanik

6.022J Quantitative Systems Physiology
(Same subject as 2.792J, 20.371J, HST.542J)
Prereq: 2.796J, 6.522J, 20.471J
Prereq: Physics II (GIR), 18.03, or permission of instructor
U (Spring)
4-2-6
Application of the principles of energy and mass flow to major human organ systems. Mechanical properties of regulation and homeostasis. Anatomical, physiological and pathophysiological features of the cardiovascular, respiratory and renal systems. Systems, features and devices that are most illuminated by the methods of physical sciences. Laboratory work includes some animal studies. 2 Engineering Design Points.

R. G. Mark, C. M. Stultz

6.023J Fields, Forces and Flows in Biological Systems
(Same subject as 2.793J, 20.330J)
Prereq: 2.005, 6.021, 20.320 or permission of instructor
U (Spring)
4-0-8
See description under subject 20.330J.
J. Han, S. Manalis, N. Tedford

6.024J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.797J, 3.053J, 20.310J)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Spring)
4-0-8
See description under subject 20.310J.
Fall: R. D. Kamm
Spring: R. D. Kamm, A. J. Grzodzinsky

6.033 Computer System Engineering
Prereq: 6.004
U (Spring)
5-1-6
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. Two design projects. Students engage in extensive written communication exercises. Enrollment may be limited. 4 Engineering Design Points.

M. F. Kaashoek, H. Balakrishnan

6.034 Artificial Intelligence
Prereq: 6.01
U (Fall, Spring)
5-3-4
Introduces representations, techniques, and architectures used to build applied systems and to account for intelligence from a computational point of view. Applications of rule chaining, heuristic search, constraint propagation, con-

Fall: P. H. Winston  
Spring: R. A. Barzilay

6.035 Computer Language Engineering  
Prereq: 6.004 and 6.005  
U (Spring)  
4-4-4  
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. 8 Engineering Design Points.  
S. P. Amarasinghe

6.041 Probabilistic Systems Analysis  
(Subject meets with 6.431)  
Prereq: Calculus II (GIR)  
U (Fall, Spring)  
4-0-8 REST  
Credit cannot also be received for 18.05, 18.440  
D. P. Bertsekas, J. N. Tsitsiklis

6.042J Mathematics for Computer Science  
(Subject same as 18.062J)  
Prereq: Calculus I (GIR)  
U (Fall, Spring)  
5-0-7 REST  
Elementary discrete mathematics for computer science and engineering. Emphasis on mathematical definitions and proofs as well as on applicable methods. Topics: formal logic notation, proof methods; induction, well-ordering; sets, relations; elementary graph theory; integer congruences; asymptotic notation and growth of functions; permutations and combinations, counting principles; discrete probability. Further selected topics such as: recursive definition and structural induction; state machines and invariants; recurrences; generating functions.  
A. R. Meyer, T. Leighton

6.045J Automata, Computability, and Complexity  
(Subject same as 18.400J)  
Prereq: 6.042  
U (Spring)  
4-0-8  
Provides an introduction to some of the central ideas of theoretical computer science, including circuits and decision trees, finite automata, Turing machines and computability, efficient algorithms and reducibility, the P versus NP problem, NP-completeness, the power of randomness, cryptography and one-way functions, computational learning theory, and quantum computing. Examines the classes of problems that can and cannot be solved in various computational models.  
S. Micali

6.046J Design and Analysis of Algorithms  
(Subject same as 18.410J)  
Prereq: 6.006  
U (Fall, Spring)  
4-0-8  
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.  
C. E. Leiserson, M. Goemans

6.047 Computational Biology: Genomes, Networks, Evolution  
(Subject meets with 6.878J, HST.507J)  
Prereq: 6.006, 6.041, Biology (GIR); or permission of instructor  
U (Fall)  
3-0-9  
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

6.048J Computational Evolutionary Biology  
(Subject meets with 6.877J, HST.949J)  
Prereq: 6.047 or permission of instructor  
Acad Year 2011–2012: U (Fall)  
Acad Year 2012–2013: Not offered  
3-3-6  
Explores and illustrates theory underlying computational approaches to solving problems in evolutionary biology. Begins with components of evolutionary theory and inferential logic of evolution by natural selection. Emphasizes development of analytical skills needed to judge the computational and algorithmic implications and requirements of evolutionary models. Examples drawn from current research in evolutionary biology: whole-genome species comparison, phylogenetic tree construction, molecular evolution, homology and development, optimization and evolvability, heritability, disease evolution, detecting selection in human populations, and evolution of language. Extensive laboratory exercises in model-building and analyzing evolutionary data. Graduate version requires a more substantial final project and completion of additional laboratory assignments. 4 Engineering Design Points.  
R. C. Berwick

6.049J Evolutionary Biology: Concepts, Models and Computation  
(Subject same as 7.33J)  
Prereq: 7.03; 6.00, 6.01, or permission of instructor  
U (Spring)  
3-0-9  
See description under subject 7.33J.  
R. Berwick, D. Bartel

6.050J Information, Entropy, and Computation  
(Subject same as 2.110J)  
Prereq: Physics I (GIR)  
U (Spring)  
4-0-5  
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
(Same subject as 2.038J)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-0-9
Simple reasoning techniques for complex phenomena: divide and conquer, dimensional analysis, extreme cases, continuity, scaling, successive approximation, balancing, cheap calculus, and symmetry. Applications from physical and biological sciences, mathematics, and engineering. Examples include bird and machine flight, neuron biophysics, weather, prime numbers, and animal locomotion. Emphasis on low-cost experiments to test ideas and on fostering curiosity about phenomena in the world.
S. Mahajan, R. Abeyaratne

6.061 Introduction to Electric Power Systems
(Subject meets with 6.690)
Prereq: 6.002, 6.013
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
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, induction and DC machinery. Interconnection of generators and motors with electric power transmission and distribution circuits. Power generation, including alternative and sustainable sources. Students taking graduate version complete additional assignments. 6.061 offers 6 Design Points.
J. L. Kirtley, Jr.

Prereq: None
U (Fall, IAP, Spring)
Can be repeated for credit
Basic undergraduate subjects not offered in the regular curriculum.
Consult Department

6.070[J] Electronics Project Laboratory
(Same subject as EC.120J)
Prereq: None
U (Fall, Spring)
2-2-2
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, assembling, and troubleshooting. Students design, build, and keep a small electronics project, such as a simple robot, to put their new knowledge into practice. Intended for students with little or no previous background in electronics. Enrollment may be limited.
J. Bales

6.071[J] Electronics, Signals, and Measurement
(Same subject as 22.071J)
Prereq: 18.03
U (Spring)
3-3-6 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.
J. Hutchinson, A. White

6.072[J] Introduction to Digital Electronics
(Same subject as EC.110J)
Prereq: None
U (Spring)
0-3-3 [P/D/F]
See description under subject EC.110J.
S. Banzaert

6.073[J] Creating Video Games
(Same subject as CMS.611J)
Prereq: One subject in CMS or 6.01
U (Spring)
3-6-6 REST
See description under subject CMS.611J.
P. Tan, S. Verrilli, O. Macindoe, P. Kaelbling

6.076–6.084 Special Subject in Electrical Engineering and Computer Science (6.076–6.084)
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

6.085–6.099 Special Subject in Electrical Engineering and Computer Science (6.085–6.099)
Prereq: Permission of instructor
U (Fall, IAP, 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.
D. M. Freeman

UNDERGRADUATE LABORATORY SUBJECTS

6.100 Electrical Engineering and Computer Science Laboratory
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Individual experimental work related to electrical engineering and computer science not covered by other subjects. 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. If 6.100 is used to satisfy departmental laboratory requirement, student must register for 12 units of laboratory credit in the term the work is done. Consult department undergraduate office early in the term.
C. J. Terman

6.101 Introductory Analog Electronics Laboratory
Prereq: 6.002 or 6.071
U (Fall)
2-9-1 Institute LAB
Introductory experimental laboratory explores the design, construction, and debugging of analog electronic circuits. Lectures and six laboratory projects investigate the performance characteristics of diodes, transistors, JFETs, and op-amps, including the construction of a small audio amplifier and preamplifier. Seven weeks are devoted to the design and implementation, and written and oral presentation of a project in an environment similar to that of engineering
design teams in industry. Provides opportunity to simulate real-world problems and solutions that involve trade-offs and the use of engineering judgment. Engineers from local analog engineering companies come to campus to help students with their design projects. 12 Engineering Design Points.

B. M. Roscoe

6.102 Introductory RF Design Laboratory
Prereq: 6.002 or 6.071
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
2-9-1 Institute LAB
Introductory experimental laboratory focuses on the fundamentals of radio frequency design through the study of radio receiver circuits from 1920 to 1960. Five labs using JFETs (arranged to behave like triodes and pentodes) investigate the behavior of series and parallel tuned circuits, bandwidth control, RF amplifiers, local oscillators, mixers, IF amplifiers, AM and FM detectors, audio stages, and RF measurements. Lecture topics include regenerative receivers and detectors; tuned RF, neodymium, superhel-etrodine and FM receivers; the “All-American 5” AC-DC AM receiver; and common vacuum tube triode and pentode topologies. Five weeks of the term are devoted to the restoration and circuit analysis of an antique radio supplied by the instructor. 12 Engineering Design Points.

B. M. Roscoe

6.111 Introductory Digital Systems Laboratory
Prereq: 6.002, 6.071, or 16.004
U (Fall)
3-7-2 Institute LAB
Lectures and labs on digital logic, flip flops, PALs, FPGAs, counters, timing, synchronization, and finite-state machines prepare 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. Students engage in extensive written and oral communication exercises. 12 Engineering Design Points.

A. P. Chandrakasan, C. J. Terman, A. I. Akinwande

6.115 Microcomputer Project Laboratory
Prereq: 6.002, 6.003, 6.004, or 6.007
U (Spring)
3-6-3 Institute LAB
Introduces the analysis and design of embedded systems. Microcontrollers provide adaptation, flexibility, and real-time control. Emphasis placed on the construction of complete systems, including a five-axis robot arm, a fluorescence lamp ballast, a tomographic imaging station (e.g. a CAT scan), and a simple calculator. Introduces a wide range of basic tools, including software and development tools, 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. Final project may be expanded to satisfy a 6.UAP project. Provides instruction in written and oral communication. 12 Engineering Design Points.

S. B. Leeb

6.123J Bioinstrumentation Project Lab (New)
(Same subject as 20.345J)
Prereq: Biology (GIR), and 2.004 or 6.003; or 20.309; or permission of instructor
U (Spring)
2-7-3
See description under subject 20.345J.

E. Boyden, S. F. Nagle, S. Wasserman, M. F. Yanik

6.131 Power Electronics Laboratory
Prereq: 6.002, 6.003, or 6.007
U (Fall)
3-6-3 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. Final project may be expanded to serve as a 6.UAP project, with instructor permission. Provides instruction in written and oral communication. 12 Engineering Design Points.

S. B. Leeb

6.141J Robotics: Science and Systems I
(Same subject as 16.405J)
Prereq: Permission of instructor
U (Spring)
2-6-4 Institute LAB
Presents concepts, principles, and algorithms for sensing and computation related to the physical world. Topics include motion planning, geometric reasoning, kinematics and dynamics, state estimation, tracking, map building, manipulation, human-robot interaction, fault diagnosis, and embedded system development. Students specify and design a small-scale yet complex robot capable of real-time interaction with the natural world. Students may continue content in 6.142. Prior knowledge of one or more of the following areas would be useful: control (2.004, 6.302, or 16.30); software (1.00, 6.005, or 16.35); electronics (6.002, 6.070, 6.111, or 6.115); mechanical engineering (2.007); or independent experience such as MasLAB, 6.270, or a relevant UROP. Students engage in extensive written and oral communication exercises. Enrollment limited. 12 Engineering Design Points.

N. Roy, D. Rus, S. Teller

6.142J Robotics: Science and Systems II
(Same subject as 16.406J)
Prereq: 6.141 or permission of instructor
U (Fall)
2-6-4
Implementation and operation of the embedded system designed in 6.141. Addresses open research issues such as sustained autonomy, situational awareness, and human interaction. Students carry out experiments to assess their design and deliver a final written report. Prior knowledge of one or more of the following areas would be useful: control (2.004, 6.302, or 16.30), software (1.00, 6.005, or 16.35), electronics (6.002, 6.070, 6.111, or 6.115), mechanical engineering (2.007), independent experience (MasLAB, 6.270, or a UROP). 12 Engineering Design Points.

D. Rus, S. Teller, N. Roy

6.152J Micro/Nano Processing Technology
(Same subject as 3.155J)
Prereq: Permission of instructor
U (Fall, Spring)
3-4-5
Introduces the theory and technology of micro/nano fabrication. Lectures and laboratory sessions on basic processing techniques such as vacuum processes, lithography, diffusion, oxidation, and pattern transfer. Students fabricate MOS capacitors, nanomechanical cantilevers, and microfluidic mixers. Emphasis on the interrelationships between material properties and processing, device structure, and the electrical, mechanical, optical, chemical or biological behavior of devices. Provides background for thesis work in micro/nano fabrication. Students engage in extensive written and oral communication exercises. 6 Engineering Design Points.

M. A. Schmidt, L. A. Kolodziejski, J. Michel, C. A. Ross
6.161 Modern Optics Project Laboratory
(Subject meets with 6.37)
Prereq: 6.003, 6.007 or 8.03 also recommended. 
U (Fall)
3-5-4 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. 12 Engineering Design Points. 
C. Warde

6.163 Strobe Project Laboratory
Prereq: Physics II (GIR) or permission of instructor
U (Fall, Spring)
2-8-2 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, strobscopy, motion analysis, and high-speed videography. Students write five 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. 12 Engineering Design Points. 
J. K. Vandiver, J. W. Bales

6.172 Performance Engineering of Software Systems
Prereq: 6.004, 6.005, 6.006
U (Fall)
3-6-3
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. 12 Engineering Design Points. 
S. Amarasinghe, C. E. Leiserson

6.173 Multicore Systems Laboratory
Prereq: 6.004
U (Fall)
3-8-1 Institute LAB
Lectures and labs illustrate how to architect and build a multicore computer system. Topics include parallelism, load balancing, communication and synchronization primitives, memory hierarchy, on-chip interconnection networks, and cache coherence. Using a field-programmable gate array (FPGA) board, programmed with a simple multicore processor and a minimal software environment, students develop Verilog and software to implement different hardware/software designs for caches, messages, shared memory, and coordination primitives. Labs culminate in a term project which students describe in a design paper and in-class presentation. Provides instruction in written and oral communication. 12 Engineering Design Points. 
A. Agarwal, M. F. Kaashoek, R. T. Morris, C. J. Terman

6.182 Psychoacoustics Project Laboratory
Prereq: None
U (Spring)
3-6-3 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. 12 Engineering Design Points. 
L. D. Braida

6.5183– 6.5192 Special Laboratory Subject in Electrical Engineering and Computer Science (6.183–6.190)
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Lectures and labs illustrate how to architect and build a multicore computer system. Topics include parallelism, load balancing, communication and synchronization primitives, memory hierarchy, on-chip interconnection networks, and cache coherence. Using a field-programmable gate array (FPGA) board, programmed with a simple multicore processor and a minimal software environment, students develop Verilog and software to implement different hardware/software designs for caches, messages, shared memory, and coordination primitives. Labs culminate in a term project which students describe in a design paper and in-class presentation. Provides instruction in written and oral communication. 12 Engineering Design Points. 
D. M. Freeman

SENIOR PROJECTS

6.1AP Undergraduate Advanced Project
Prereq: 6.1AP
U (Fall, Spring, Summer)
0-6-0
Can be repeated for credit
Research project for those students completing the SB degree, 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. 
C. J. Terman

6.1AT Preparation for Undergraduate Advanced Project
Prereq: None
U (Fall, Spring)
3-0-3
Instruction in aspects of effective technical oral presentations through exposure to different workplace communication skills. As preparation for the advanced undergraduate project (UAP), students develop research topics, identify a research supervisor, and prepare a short research proposal for an oral presentation. 
T. L. Eng

ADVANCED UNDERGRADUATE SUBJECTS AND GRADUATE SUBJECTS BY AREA

Systems Science and Control Engineering

6.207J Networks
(Same subject as 14.15J)
Prereq: 6.041 or 14.30
U (Fall)
4-0-8 HASS-S (HASS-E)
See description under subject 14.15J. 
D. Acemoglu, M. Dahleh

6.231 Dynamic Programming and Stochastic Control
Prereq: 6.041 or 18.313; 18.100
G (Fall)
3-0-9 H-LEVEL Grad Credit
Sequential decision-making via dynamic programming. Unified approach to optimal control of stochastic dynamic systems and Markovian decision problems. Applications in linear-quadratic control, inventory control, resource

6.241 Dynamic Systems and Control
(Same subject as 16.338J)
Prereq: 6.003, 18.06
G (Spring)
4-0-8 H-LEVEL Grad Credit

M. A. Dahleh, A. Megretski, E. Frazzoli

6.242 Advanced Linear Control Systems
Prereq: 18.06, 6.241
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

M. A. Dahleh, A. Megretski

6.243 Dynamics of Nonlinear Systems
Prereq: 6.241; Coreq: 18.100
G (Fall)
3-0-9 H-LEVEL Grad Credit

J. L. Wyatt, Jr., A. Megretski, M. Dahleh

6.245 Multivariable Control Systems
Prereq: 6.241 or 16.31
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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 (New)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Advanced study of topics in control. Specific focus varies from year to year.
Consult Department

R. M. Freund, D. P. Bertsekas, G. Perakis

6.248–6.249 Advanced Topics in Numerical Methods (New)
Prereq: Permission on instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Advanced study of topics in numerical methods. Specific focus varies from year to year.
Consult Department

6.251J Introduction to Mathematical Programming
(Same subject as 15.081J)
Prereq: 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit

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, A. Schulz

6.252J Nonlinear Programming
(Same subject as 15.084J)
Prereq: 18.06, 18.100
G (Spring)
3-0-9 H-LEVEL Grad Credit

A unified analytical and computational approach to nonlinear optimization problems. Unconstrained optimization methods include gradient, conjugate direction, Newton, and quasi-Newton methods. Constrained optimization methods include feasible directions, projection, interior point, and Lagrange multiplier methods. Convex analysis, Lagrangian relaxation, nondifferentiable optimization, and applications in integer programming. Comprehensive treatment of optimality conditions, Lagrange multiplier theory, and duality theory. Applications drawn from control, communications, power systems, and resource allocation problems.
R. M. Freund, D. P. Bertsekas, G. Perakis

6.253 Convex Analysis and Optimization
Prereq: 18.06, 18.100
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Core analytical issues of continuous optimization, duality, and saddle point theory, and development using a handful of unifying principles that can be easily visualized and readily understood. Discusses in detail the mathematical theory of convex sets and functions which are the basis for an intuitive, highly visual, geometrical approach to the subject. Convex optimization algorithms focus on large-scale problems, drawn from several types of applications, such as resource allocation and machine learning. Includes batch and incremental subgradient, cutting plane, proximal, and bundle methods.
D. P. Bertsekas

6.254 Game Theory with Engineering Applications
Prereq: 6.041
G (Spring)
4-0-8 H-LEVEL Grad Credit

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

6.255J Optimization Methods
(Same subject as 15.093J)
Prereq: 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.093J.
D. Bertsimas, P. Parrilo

6.256 Algebraic Techniques and Semidefinite Optimization
Prereq: 6.251 or 6.255
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
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 (New)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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: 6.041, 6.431 or 18.313
G (Spring)
3-0-9 H-LEVEL Grad Credit
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, J. L. Wyatt

6.263J Data-Communication Networks
(Same subject as 16.37J)
Prereq: 6.041 or 18.313
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Provides an introduction to data networks with an analytic perspective, using telephone networks, wireless networks, optical networks, the Internet and data centers as primary applications. Presents basic tools for modeling and performance analysis accompanied by elementary, meaningful simulations. Develops insights for large networks by means of simple approximations. Draws upon concepts from queueing theory and optimization.
D. P. Bertsekas, E. Modiano, D. Shah

6.264J Queues: Theory and Applications
(Same subject as 15.072J)
Prereq: 6.262
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.072J.
D. Bertsimas, D. Gamarnik, J. N. Tsitsiklis

6.265J Advanced Stochastic Processes
(Same subject as 15.070J)
Prereq: 6.431, 15.085J, or 18.100
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.070J.
D. Gamarnik, D. Shah

6.266 Network Algorithms
Prereq: 6.436 or 6.262
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit
Modern theory of networks from the algorithmic perspective with emphasis on the foundations in terms of modeling, performance analysis, and design. Topics include algorithmic questions arising in the context of scheduling, routing and congestion control in a communication network; information processing and data fusion in peer-to-peer, sensor and social networks; and efficient data storage/retrieval in a distributed storage network.
D. Shah

6.267 Heterogeneous Networks: Architecture, Transport, Protocols, and Management
Prereq: 6.041 or 6.042
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to modern heterogeneous networks and the provision of heterogeneous network 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, focusing on the architecture and performance analysis of interconnected heterogeneous networks. Provides background and insight to understand current network literature and to perform research on networks. 4 Engineering Design Points.
V. W. S. Chan, R. G. Gallager

6.268 Network Science and Models (New)
Prereq: 6.041, 18.06
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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, and social learning. Applications drawn from social, economic, natural, and infrastructure networks, as well as networked decision systems such as sensor networks.
J. N. Tsitsiklis

6.281J Logistical and Transportation Planning Methods
(Same subject as 1.203J, 15.073J, 16.76J, ESD.216J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.203J.
R. C. Larson, A. R. Odoni, A. I. Barnett
and power amplifiers. One of each student’s designs is presented to the class, and one may be built and evaluated. Associated laboratory emphasizing the use of modern analog building blocks. 12 Engineering Design Points.

J. K. Roberge

6.332–6.333 Advanced Topics in Circuits (New)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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 H-LEVEL Grad Credit

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. 6 Engineering Design Points

J. G. Kassakian, D. Perreault

6.336J Introduction to Numerical Simulation
(Same subject as 2.096J, 16.910J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduction to computational techniques for the simulation of a large variety of engineering and engineered systems. Applications drawn from aerospace, mechanical, electrical, and chemical engineering, biology, and materials science. Topics: mathematical formulations; network problems; sparse direct and iterative matrix solution techniques; Newton methods for nonlinear problems; discretization methods for ordinary, time-periodic and partial differential equations; fast methods for partial differential equations and integral equations, techniques for model order reduction of dynamical systems and approaches for molecular dynamics.

L. Daniel, J. K. White

6.337J Introduction to Numerical Methods
(Same subject as 18.335J)
Prereq: 18.03 or 18.034; 18.06, 18.700, or 18.701
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 18.335J.

S. G. Johnson

6.338J Parallel Computing
(Same subject as 18.337J)
Prereq: 18.06, 18.700, or 18.701
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 18.337J.

A. Edelman

(Same subject as 2.097J, 16.920J)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 16.920J.

A. T. Patera, J. K. White, K. E. Willcox

6.341 Discrete-Time Signal Processing
Prereq: 6.011
G (Fall)
4-0-8 H-LEVEL Grad Credit

Representation, analysis, and design of discrete time signals and systems. Discrete-time processing of continuous-time signals. Decimation, interpolation, and sampling rate conversion. Flowgraph structures for DT systems. Time- and frequency-domain design techniques for recursive (IIR) and non-recursive (FIR) filters. Parametric signal modeling and linear prediction. Discrete Fourier transform, FFT algorithm. Short-time Fourier analysis and filter banks. Multirate techniques. May cover additional applications and topics, such as Hilbert transforms and Cepstral analysis.

A. V. Oppenheim, V. K. Goyal

6.342 Wavelets, Approximation, and Compression
Prereq: 18.06, 6.011
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Hilbert space formulation of continuous-time and discrete-time signals; sampling; orthogonal and biorthogonal signal expansions; uncertainty principles and the time-frequency plane; two-channel filter banks, iterated filter banks, discrete wavelet transforms, multiresolution...
analysis, wavelet bases, regularity, approximation properties, and nonlinear approximation; basics of quantization and source coding; compression, denoising, and other image processing using wavelets. Advanced topics from the current research literature.

V. K. Goyal

6.344 Digital Image Processing
Prereq: 6.003, 6.041
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G(Spring)
3-0-9 H-LEVEL Grad Credit


J. S. Lim

6.345J) Automatic Speech Recognition
(Subject meets with HST.728J)
Prereq: 6.003, 6.041, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-1-8 H-LEVEL Grad Credit

Introduces the rapidly developing fields of automatic speech recognition and spoken language processing. Topics include acoustic theory of speech production and perception, acoustic-phonetics, signal representation, acoustic and language modeling, search, hidden Markov modeling, robustness, adaptation, discriminative and alternative approaches. Lectures interspersed with theory and applications. Assignments include problems, laboratory exercises, and a term project. 4 Engineering Design Points.

V. W. Zue, J. R. Glass

6.347–6.348 Advanced Topics in Signals and Systems (New)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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: 6.012, 6.004
G (Fall)
3-3-6 H-LEVEL Grad Credit

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. 4 Engineering Design Points.

A. P. Chandrakasan

6.375 Complex Digital Systems Design
Prereq: 6.004
G (Spring)
5-5-2 H-LEVEL Grad Credit

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. 12 Engineering Design Points.

Arvind

6.376 Ultra Low Power Bioelectronics
Prereq: 6.301
G (Fall)
4-0-8 H-LEVEL Grad Credit

Comprehensive introduction to analog microelectronic design with an emphasis on ultra-low-power electronics, biomedical electronics, and bio-inspired electronics. Device physics of the MOS transistor, including subthreshold operation and scaling to nanometer processes. Ultra-low-noise, RF, sensor, actuator, and feedback circuits. System examples vary from year to year and include implantable and noninvasive biomedical systems, circuits inspired by neurobiology or cell biology, micromechanical systems (MEMS), and biological sensing and actuating systems. Class project involves a complete design of a VLSI chip, including layout, verification, design-rule checking, and SPICE simulation. 8 Engineering Design Points.

R. Sarpeshkar

Probabilistic Systems and Communication

6.431 Applied Probability
(Subject meets with 6.041)
Prereq: Calculus II (GIR)
G (Fall, Spring)
4-0-8

Meets with undergraduate subject 6.041. Requires the completion of additional advanced home problems.

D. P. Bertsekas, J. N. Tsitsiklis

6.434J Statistics for Engineers and Scientists
(Same subject as 16.391J)
Prereq: Calculus II (GIR), 18.06, 6.431, or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Provides a rigorous introduction to fundamentals of statistics motivated by engineering applications and emphasizing the informed use of modern statistical software. Topics include sufficient statistics, exponential families, estimation, hypothesis testing, measures of performance, and notion of optimality.

M. Win, J. N. Tsitsiklis

6.435 System Identification
Prereq: 6.241, 6.432
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Mathematical models of systems from observations of their behavior. Time series, state-space, and input-output models. Model structures, parametrization, and identifiability. Non-parametric methods. Prediction error methods for parameter estimation, convergence, consistency, and asymptotic distribution. Relations to maximum likelihood estimation. Recursive estimation; relation to Kalman filters; structure determination; order estimation; Akaike criterion; and bounded but unknown noise models. Robustness and practical issues.

M. A. Dahleh, S. K. Mitter
6.436J Fundamentals of Probability
(Same subject as 15.085J)
Prereq: Calculus II (GIR)
G (Fall)
4-0-8 H-LEVEL Grad Credit


J. N. Tsitsiklis, D. Gamarnik

6.437 Inference and Information
Prereq: 6.041 or 6.436
G (Spring)
4-0-8 H-LEVEL Grad Credit

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 deviation theory. Model order estimation; nonparametric statistics. Computational issues and approximation techniques; Monte Carlo methods. Selected special topics such as universal prediction and compression.

P. Golland, A. S. Willsky, G. W. Wornell

6.438 Algorithms for Inference
Prereq: 6.041 or 6.436; 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit

Introduction to statistical inference with probabilistic graphical models. Covers directed and undirected graphical models, factor graphs, and Gaussian models; hidden Markov models, linear dynamical systems; sum product and junction tree algorithms; forward backward algorithm, Kalman filtering and smoothing; and min sum algorithm and Viterbi algorithm. Presents variational methods, mean field theory, and loopy belief propagation; and particle methods and filtering. Includes building graphical models from data; parameter estimation, Baum-Welch algorithm; structure learning; and selected special topics.

P. Golland, G. W. Wornell, W. T. Freeman

6.440 Essential Coding Theory
Prereq: 6.006, 6.045
G (Spring)
3-0-9 H-LEVEL Grad Credit

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.

M. Sudan

6.441 Information Theory
Prereq: 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit

Introduction to the quantitative theory of information and its applications to reliable, efficient communication systems. Mathematical definition and properties of information and its operational meanings. Basics of large deviations and its use in information theory, coding theory, and statistics. Source coding theorem and noisy channel coding theorem; error exponents; the source-channel separation theorem; multiple access channels, broadcast channels. Readings from the literature in these topics.

M. Medard, L. Zheng

6.442 Optical Networks
Prereq: 6.041, 6.042
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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 introduced and characterized as fundamental network building blocks on which optical transmission systems and network architectures are based. In addition to the Physical Layer, the higher network layers (Media Access Control, Network and Transport Layers) are considered 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

6.443J Quantum Information Science
(Same subject as 8.371J, 18.436J)
Prereq: 18.435
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 18.436J.

I. Chuang

6.450 Principles of Digital Communication I
Prereq: 6.011
G (Fall)
3-0-9 H-LEVEL Grad Credit

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.

M. Medard, L. Zheng

6.452 Principles of Wireless Communication
Prereq: 6.450
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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, 18.06
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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 para-
metric 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 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
2-0-4 H-LEVEL Grad Credit
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; 2.687, or 6.011 and 18.06
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-2-7 H-LEVEL Grad Credit

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.

J. Preisig

Bioelectrical Engineering

6.502J Introduction to Molecular Simulations
(Same subject as HST.457J)
(Subject meets with 6.582J, HST.557J)
Prereq: Physics II (GIR); 18.03 or 18.06; 6.041 or 6.042; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9

See description under subject 6.582J.

C. M. Stultz

6.503 Foundations of Algorithms and Computational Techniques in Systems Biology (New)
(Subject meets with 6.581J, 20.482J)
Prereq: 6.021, 6.034, 6.046, 6.336, 18.417, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9

Illustrates computational approaches to solving problems in systems biology. Uses a series of case studies to demonstrate how an effective match between the statement of a biological problem and the selection of an appropriate algorithm or computational technique can lead to fundamental advances. Covers several discrete and numerical algorithms used in simulation, feature extraction, and optimization for molecular, network, and systems models in biology. Students taking graduate version complete additional assignments.

B. Tidor, J. K. White

6.521J Cellular Biophysics
(Same subject as 2.794J, 20.470J, HST.541J)
(Subject meets with 2.791J, 6.021J, 20.370J)
Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110, or permission of instructor
G (Fall)
5-2-5 H-LEVEL Grad Credit

See description under subject 6.021.

D. M. Freeman, J. Han

6.522J Quantitative Physiology: Organ Transport Systems
(Same subject as 2.796J, 20.471J)
(Subject meets with 2.792J, 6.022J, 20.371J, HST.542J)
Prereq: 2.006 or 6.013; 6.021
G (Spring)
4-2-6 H-LEVEL Grad Credit

Meets with undergraduate subject 6.022J. Requires the completion of more advanced home problems and/or an additional project.

R. G. Mark, C. M. Stultz

6.524J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.798J, 3.971J, 10.537J, 20.410J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 20.410J.

R. D. Kamm, K. Van Vliet

6.541J Speech Communication
(Same subject as 24.968J, HST.710J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit

Survey of human speech communication with special emphasis on the sound patterns of natural languages. Acoustic theory of speech production; physiologic and acoustic descriptions of phonetic features, prosody, speech perception, speech respiration, and speech motor control. Applications to recognition and generation of speech by machine and to speech disorders. Recommended prerequisite: mathematical background equivalent to 6.003.

L. D. Braida, R. E. Hillman, S. Shattuck-Hufnagel

6.542J Laboratory on the Physiology, Acoustics, and Perception of Speech
(Same subject as 24.966J, HST.712J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
2-2-8 H-LEVEL Grad Credit

Experimental investigations of speech processes. Topics: measurement of articulatory movements; measurements of pressures and airflows in speech production; computer-aided waveform analysis and spectral analysis of speech; synthesis of speech; perception and discrimination of speechlike sounds; speech prosody; models for speech recognition; speech development;
and other topics. Recommended prerequisites: 6.002 or 18.03. 4 Engineering Design Points. L. D. Braida, S. Shattuck-Hufnagel

6.544–6.545 Advanced Topics in BioEECS (New)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Advanced study of topics in BioEECS. Specific focus varies from year to year. Consult department for details.
Consult Department

6.551J Acoustics of Speech and Hearing
(Same subject as HST.714J)
Prereq: 8.03, 6.003; or permission of instructor
G (Fall)
4-1-7 H-LEVEL Grad Credit
Provides background for understanding how the acoustics and mechanics of the speech production and auditory systems define what sounds we are capable of producing and what sounds we can sense. Particular focus on the acoustic cues used in determining the direction of a sound source; the mechanisms involved in speech production; the mechanisms used by the auditory system to transduce and analyze sounds; and sound perception (absolute detection, discrimination, masking, and auditory frequency selectivity). 4 Engineering Design Points. L. D. Braida, S. S. Ghosh, J. J. Rosowski, C. Shera

6.552J Signal Processing by the Auditory System: Perception
(Same subject as HST.716J)
Prereq: 6.003; 6.041 or 6.431; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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. Braida

6.555J Biomedical Signal and Image Processing
(Same subject as 16.456J, HST.582J)
Prereq: 6.003, 2.004, 16.004, or 18.085
G (Spring)
3-6-3 H-LEVEL Grad Credit
See description under subject HST.582J, J. Greenberg, E. Adalsteinsson, W. Wells, G. Clifford

6.556J Data Acquisition and Image Reconstruction in MRI
(Same subject as HST.580J)
Prereq: 6.011
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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

6.561J Fields, Forces, and Flows in Biological Systems
(Same subject as 2.795J, 10.539J, 20.430J, HST.544J)
Prereq: 6.013, 2.005, 10.302, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.430J, M. Bathe, A. J. Grodzinsky

(Same subject as 20.482J)
Prereq: Physics II (GIR), 18.03 or 18.06; 6.041 or 6.042; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.503. B. Tidor, J. K. White

6.582J Molecular Simulations
(Same subject as HST.557J)
Prereq: Physics II (GIR), 18.03 or 18.06; 6.041 or 6.042; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to the basic concepts underlying dynamical simulations of proteins and nucleic acids. Basic definitions of components that form biological systems used to develop physical models that describe the dynamics of biomolecules. Topics include classical statistical thermodynamics for calculation of macroscopic observables, normal-mode analyses of protein dynamics, and thermodynamic perturbation theory. Emphasizes actual techniques and algorithms used for such calculations. Prior knowledge of biochemistry is not required. Students taking the graduate version complete an additional project. C. M. Stultz

Electrodynamics

6.602 Fundamentals of Photonics
(Subject meets with 6.621)
Prereq: 6.003; 6.007, 6.013, or 8.07
U (Spring)
4-0-8
Fundamentals of optical and opto-electronic phenomena and devices: topics include electromagnetic waves in media and at interfaces, interference, Gaussian beams, resonators, waveguides, and integrated optics. Quantum electronics: topics include thermal radiation, photo detection, quantum mechanics, light-matter interaction, quantum theory of light. Lasers: topics include gas, solid-state and semiconductor lasers, laser dynamics, Q-switching and mode-locking. F. X. Kaertner
6.608J Introduction to Particle Accelerators
(Same subject as 8.277J)
Prereq: 6.013 or 8.07
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9
See description under subject 8.277J.
W. Barletta

6.621 Fundamentals of Photonics
(Subject meets with 6.602)
Prereq: 6.003; 6.007, 6.013, 8.07 or 6.630
G (Spring)
4-0-8 H-LEVEL Grad Credit
Meets with undergraduate subject 6.602, but requires the completion of additional homework assignments. See subject description under 6.602.
F. X. Kaertner

6.630 Electromagnetics
(Subject meets with 6.013 when offered concurrently)
Prereq: 6.003 or 6.007
G (Fall)
4-0-8 H-LEVEL Grad Credit
Credit cannot also be received for 6.013
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. Students taking graduate version complete different assignments.
D. H. Staelin, E. P. Ippen, M. Zahn

6.631 Optics and Photonics
Prereq: 6.013 or 8.07
G (Fall)
3-0-9
J. G. Fujimoto

6.632 Electromagnetic Wave Theory
Prereq: 6.013, 6.630, or 8.07
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

6.634J Nonlinear Optics
(Same subject as 8.431J)
Prereq: 6.013 or 8.07
G (Spring)
3-0-9 H-LEVEL Grad Credit
E. P. Ippen, J. G. Fujimoto

6.637 Optical Signals, Devices, and Systems
(Subject meets with 6.161)
Prereq: 6.003. 6.007 or 8.03 also recommended.
G (Fall)
3-0-9 H-LEVEL Grad Credit
Principles of operation and applications of devices and systems for 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; optical waveguides and fiber-optic communication systems; photodetectors; 2-D and 3-D optical storage technologies; adaptive optical systems; role of optics in next-generation computers. Student research paper on a specific contemporary topic required.
C. Warde

6.638 Ultrafast Optics
Prereq: 6.602, 6.621, 6.630, or 6.631
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Detailed exposition of the principles involved in ultrashort pulse generation, propagation, and characterization. Linear and nonlinear pulse shaping processes are discussed. Optical solitons, pulse compression. Laser principles: Single- and multimode-laser dynamics, Q-switching and mode-locking: active and passive model-locking mechanisms. Noise in mode-locked lasers and its limitations imposed on measurements. Laser amplifiers. Optical parametric amplifiers and oscillators. Applications in research and industry, such as various pump-probe techniques, optical imaging, frequency metrology, high Harmonic Generation, Attosecond pulse generation.
F. X. Kaertner

6.641 Electromagnetic Fields, Forces, and Motion
Prereq: 6.013
G (Spring)
4-0-8 H-LEVEL Grad Credit
Electric and magnetic quasistatic forms of Maxwell’s equations applied to dielectric, conduction, and magnetization boundary value problems. Electromagnetic forces, force densities, and stress tensors, including magnetization and polarization. Thermodynamics of electromagnetic fields, equations of motion, and energy conservation. Applications to synchronous, induction, and commutator machines; sensors and transducers; microelectromechanical systems; propagation and stability of electromagnetic waves; and charge transport phenomena.
M. Zahn, J. H. Lang

6.642 Continuum Electromechanics
Prereq: 6.641 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit
M. Zahn
6.644–6.645 Advanced Topics in Applied Physics (New)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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

6.651| Introduction to Plasma Physics I
(Same subject as 8.613J, 22.611J)
Prereq: 6.013, 8.07, or 22.105; 18.04 or Coreq: 18.075
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.611J.
J. Egedal-Pedersen

6.652| Introduction to Plasma Physics II
(Same subject as 8.614J, 22.612J)
Prereq: 6.651J, 8.613J, or 22.611J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 8.614J.
Staff

6.673 Introduction to Numerical Simulation in Electrical Engineering
Prereq: 6.012 or 6.013
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Selection of a simulation model and physical approximations. Solution of nonlinear coupled PDEs in 1-D through finite difference and finite element methods, Newton’s method, and variants. Finite difference and finite element methods in 2-D and sparse matrix methods emphasizing conjugate gradient algorithms. Semiconductor devices used as primary examples; additional examples drawn from E&M modeling, nonlinear pulse propagation, and laser physics.
R. L. Hagelstein

6.685 Electric Machines
Prereq: 6.061, 6.690, or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
J. L. Kirtley, Jr.

6.690 Introduction to Electric Power Systems
(Subject meets with 6.061)
Prereq: 6.002, 6.013
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.061.
J. L. Kirtley, Jr.

6.691 Seminar in Electric Power Systems
Prereq: 6.061, 6.690, or permission of Instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Planning and operation of modern electric power systems. Content varies with current interests of instructor and class; emphasis on engineering aspects, but economic issues may be examined. Core topics include overview of power system structure and operation; representation of components, including transmission lines, transformers, generating plants, loads; power flow analysis, dynamics and control of multimachine systems, steady-state and transient stability, system protection; economic dispatch; mobil and isolated power systems; computation and simulation.
J. L. Kirtley, Jr.

6.695J Engineering, Economics and Regulation of the Electric Power Sector
(Same subject as 15.032J, ESD.162J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.162J.
J. L. Kirtley, Jr.

6.701| Introduction to Nanoelectronics
(Subject meets with 6.719)
Prereq: 6.003 or 2.003, Physics II (GIR); or permission of instructor
U (Spring)
4-0-8 H-LEVEL Grad Credit
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. 4 Engineering Design Points.
C. Livermore, D. Weinstein

6.719| Nancelectronics
(Subject meets with 6.701)
Prereq: 6.003
G (Spring)
4-0-8 H-LEVEL Grad Credit
Meets with undergraduate subject 6.701, but requires the completion of additional/different homework assignments and or projects. See description under subject 6.701.
M. A. Baldo

6.720| Integrated Microelectronic Devices
(Same subject as 3.43J)
Prereq: 6.012 or 3.42
G (Fall)
4-0-8 H-LEVEL Grad Credit
The physics of microelectronic semiconductor devices for silicon integrated circuit applications. Topics: semiconductor fundamentals, p-n junction, metal-oxide semiconductor structure, metal-semiconductor junction, MOS field-effect transistor, and bipolar junction transistor. Emphasis on physical understanding of device operation through energy band diagrams and short-channel MOSFET device design. Issues in modern device scaling outlined. Includes device characterization projects and device design project. 2 Engineering Design Points.
J. A. del Alamo, H. L. Tuller

Solid-State Materials and Devices

6.701| Introduction to Nanoelectronics
(Subject meets with 6.719)
Prereq: 6.003
U (Spring)
4-0-8
Transistors at the nanoscale. Quantization, wavefunctions, and Schrödinger’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| Design and Fabrication of Microelectromechanical Systems
(Same subject as 2.374J)
(Subject meets with 2.372J, 6.777J)
Prereq: 6.003 or 2.003, Physics II (GIR); or permission of instructor
U (Spring)
3-0-9
Prereq: 6.608J to 6.720J

Prereq: 6.061, 6.690, or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Selection of a simulation model and physical approximations. Solution of nonlinear coupled PDEs in 1-D through finite difference and finite element methods, Newton’s method, and variants. Finite difference and finite element methods in 2-D and sparse matrix methods emphasizing conjugate gradient algorithms. Semiconductor devices used as primary examples; additional examples drawn from E&M modeling, nonlinear pulse propagation, and laser physics.
R. L. Hagelstein

Prereq: 6.012 or 6.013
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Selection of a simulation model and physical approximations. Solution of nonlinear coupled PDEs in 1-D through finite difference and finite element methods, Newton’s method, and variants. Finite difference and finite element methods in 2-D and sparse matrix methods emphasizing conjugate gradient algorithms. Semiconductor devices used as primary examples; additional examples drawn from E&M modeling, nonlinear pulse propagation, and laser physics.
6.728 Applied Quantum and Statistical Physics  
Prereq: 6.003, 18.06  
G (Fall)  
4-0-8 H-LEVEL Grad Credit  
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, thermionic emitters, atomic force microscope, and more.  
P. L. Hagelstein, T. R. Orlando, K. K. Berggren

6.730 Physics for Solid-State Applications  
Prereq: 6.013, 6.728  
G (Spring)  
5-0-7 H-LEVEL Grad Credit  
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, semi-classical 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.  
T. P. Orlando, R. Ram, Q. Hu

6.731 Semiconductor Optoelectronics: Theory and Design  
Prereq: 6.728, 6.012  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
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 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
4-0-8 H-LEVEL Grad Credit  
Continuation of 6.730 emphasizing applications-related physical issues in solids. Topics: electronic structure and energy band diagrams of semiconductors, metals, and insulators; Fermi surfaces; dynamics of electrons; 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; photon-lattice interactions; optical 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 (New)  
Prereq: Permission of instructor  
G (Fall, Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Advanced study of topics in materials, devices, and nanotechnology. Specific focus varies from year to year.  
Consult Department

6.763 Applied Superconductivity  
Prereq: 6.728  
Acad Year 2011–2012: G (Fall)  
Acad Year 2012–2013: Not offered  
3-0-9 H-LEVEL Grad Credit  
T. P. Orlando

6.772 Compound Semiconductor and Heterostructure Devices  
Prereq: 6.012  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
4-0-8 H-LEVEL Grad Credit  
Physics, modeling, and application of compound semiconductors (primarily III-Vs and Si-Ge) in high speed electronic, optoelectronic, and photonic devices and ICs. The materials palette; energy band and effective mass concepts; theory and practice of III-V and Si-Ge heterojunctions, quantum structures, and strained layers; metal-semiconductor diodes and field effect transistors (MESFETs); heterojunction field effect transistors (HFETs) and bipolar transistors (HBTs); dielectric waveguides and photonic lattices; LEDs, laser diodes, photodetectors, and other optoelectronic devices; heterogeneous integration with Si.  
C. G. Fonstad, Jr., T. A. Palacios

6.774 Physics of Microfabrication: Front End Processing  
Prereq: 6.152  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
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, SiGe and fabrication of process-induced strained Si. Studies 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 H-LEVEL Grad Credit  
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.  
4 Engineering Design Points.  
H. S. Lee, C. G. Sodini
6.776 High Speed Communication Circuits
Prereq: 6.301
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-3-6 H-LEVEL Grad Credit
Principles and techniques for integrated circuit design within communication systems such as wireless and broadband data links. Circuit blocks for communication transceivers and phase-locked loops, which include broadband, narrowband, and low-noise amplifiers, mixers, voltage-controlled oscillators, power amplifiers, and high speed frequency dividers. Passive component design of on-chip inductors and capacitors. Analysis of distributed effects using transmission line modeling, S-parameters, Smith chart. Significant laboratory component.
J. L. Dawson, H. S. Lee

6.789 Organic Optoelectronics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-1-7 H-LEVEL Grad Credit
Examines optical and electronic processes in organic molecules and polymers that govern the behavior of practical organic optoelectronic devices. Electronic structure of a single organic molecule is used as a guide to the electronic behavior of organic aggregate structures. Emphasis on use of organic thin films in active organic devices including organic LEDs, solar cells, photodetectors, transistors, chemical sensors, memory cells, electrochromic devices, as well as xerography and organic nonlinear optics. Reaching the ultimate miniaturization limit of molecular electronics and related nanoscale patterning techniques of organic materials are discussed. Laboratory sessions are conducted in a research laboratory environment with the goal of exposing students to material deposition and device testing techniques.
V. Bulovic

Computer Science

6.801 Machine Vision
(Same subject with 6.866)
Prereq: 6.003 or permission of instructor
U (Fall)
3-0-9
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

6.803 The Human Intelligence Enterprise
(Same subject with 6.833)
Prereq: 6.034 or permission of instructor
U (Spring)
3-0-9
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 Computational Cognitive Science
(Same subject with 9.66)
Prereq: 9.07, 18.05, 6.041, or permission of instructor
U (Fall)
3-0-9
See description under subject 9.66.
J. Tenenbaum

6.805 Ethics and the Law on the Electronic Frontier
(Same subject with STS.085, STS.487)
Prereq: Permission of instructor
U (Fall)
3-0-9
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: com-
**6.813 User Interface Design and Implementation**

(Subject meets with 6.831)
Prereq: 6.005 or permission of instructor
U (Spring)
3-0-9

Examines human-computer interaction in the context of graphical user interfaces. Covers human capabilities, design principles, prototyping techniques, evaluation techniques, and the implementation of graphical user interfaces. Includes short programming assignments and a semester-long group project. Students taking the graduate version also have readings from current literature and additional assignments. Enrollment limited. 6 Engineering Design Points.

R. C. Miller

**6.814 Database Systems**

(Subject meets with 6.830)
Prereq: 6.033; 6.046 or 6.006; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9

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 the graduate version complete different assignments. Enrollment may be limited. 4 Engineering Design Points.

S. R. Madden

**6.815 Digital and Computational Photography**

(Subject meets with 6.865)
Prereq: 18.06, 6.003
U (Spring)
3-0-9

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 the graduate version complete additional assignments. 6.815 offers 6 Engineering Design Points.

F. P. Durand, W. T. Freeman

**6.820 Foundations of Program Analysis**

Prereq: 6.035
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Presents major principles and techniques for scalable program analysis. Includes formal semantics, type systems and type-based program analysis, pointer analysis, abstract interpretation and model checking. Applications of these techniques to software quality and security will also be covered. Involves readings from original research papers and a term project and paper.

A. Solar-Lezama

**6.821 Programming Languages**

Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Principles of functional, imperative, and logic programming languages. Meta-circular interpreters, semantics (operational and denotational), type systems (polymorphism, inference, and abstract types), object oriented programming, modules, and multiprocessing. Case studies of contemporary programming languages. Programming experience and background in language implementation required.

D. K. Gifford

**6.823 Computer System Architecture**

Prereq: 6.004
G (Fall)
4-0-8 H-LEVEL Grad Credit

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.

4 Engineering Design Points.

Arvind, J. S. Emer

**6.824 Distributed Computer Systems Engineering**

Prereq: 6.033, permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Abstractions and implementation techniques for engineering distributed systems: remote procedure call, threads and locking, client/server, peer-to-peer, consistency, fault tolerance, and security. Readings from current literature. Individual laboratory assignments culminate in the construction of a fault-tolerant and scalable network file system. Programming experience with C/C++ required. Enrollment limited. 6 Engineering Design Points.

R. T. Morris, M. F. Kaashoek

**6.828 Operating System Engineering**

Prereq: 6.005, 6.033
G (Fall)
3-6-3 H-LEVEL Grad Credit

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. 6 Engineering Design Points.

M. F. Kaashoek

**6.829 Computer Networks**

Prereq: 6.033 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Topics on the engineering and analysis of network protocols and architecture, including architectural principles for designing heterogeneous networks; transport protocols; internet routing, foundations and practice; router design; congestion control and network resource management;
wireless networks; network security; naming; overlay and peer-to-peer networks. Readings from original research papers and Internet RFCs. Semester-long project and paper. Enrollment may be limited. 4 Engineering Design Points.

H. Balakrishnan

6.830 Database Systems
(Subject meets with 6.814)
Prereq: 6.033; 6.046 or 6.006; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.814.
S. R. Madden

6.831 User Interface Design and Implementation
(Subject meets with 6.813)
Prereq: 6.005 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.813.
R. C. Miller

6.832 Underactuated Robotics
Prereq: 6.141, 2.12, 2.165, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers nonlinear dynamics and control of underactuated mechanical systems, with an emphasis on computational methods. Topics include nonlinear dynamics of passive robots (walkers, swimmers, flyers), motion planning, robust and optimal control, reinforcement learning/approximate optimal control, and the influence of mechanical design on control. Includes 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 H-LEVEL Grad Credit
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

6.834J Cognitive Robotics
(Same subject as 16.412J)
Prereq: 6.041, 6.042, or 16.09; 16.410, 16.413, 6.034, or 6.825
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.412J.
B. C. Williams

6.835 Intelligent Multimodal User Interfaces
Prereq: 6.034, 6.005, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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 an interface to illustrate one or more themes of the course. 8 Engineering Design Points.
R. Davis

6.837 Computer Graphics
Prereq: Calculus II (GIR), 6.005; or permission of instructor
U (Fall)
3-0-9
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. 6 Engineering Design Points.
F. P. Durand

6.838 Advanced Topics in Computer Graphics
Prereq: 6.837
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
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.
F. P. Durand

6.839 Advanced Computer Graphics
Prereq: 18.06, 6.005, 6.837, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
F. P. Durand

6.840J Theory of Computation
(Same subject as 18.404J)
Prereq: 18.310 or 18.062J
G (Fall)
4-0-8 H-LEVEL Grad Credit (H except 18)
See description under subject 18.404J.
M. Sipser

6.841J Advanced Complexity Theory
(Same subject as 18.405J)
Prereq: 18.404
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.405J.
Information: M. Sudan, J. Kelner

6.842 Randomness and Computation
Prereq: 6.046, 6.840
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

6.845 Quantum Complexity Theory
Prereq: 6.045, 6.840, 18.435
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to quantum computational complexity, 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
lems in higher dimensions: linear programming, motion planning, pattern matching. Geometric polygon triangulation, Delaunay triangulation, algorithms for geometric problems, in low and high dimensions. 

6.850 Geometric Computing
Prereq: 6.046
G (Spring)
3-0-9 H-LEVEL Grad Credit


P. Indyk

6.852 Advanced Data Structures
Prereq: 6.046
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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

6.854J Advanced Algorithms
(Same subject as 18.415J)
Prereq: 6.041, 6.042, or 18.440; 6.046
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
5-0-7 H-LEVEL Grad Credit

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.

D. R. Karger

6.855J Network Optimization
(Same subject as 15.082J, ESD.78J)
Prereq: 6.046, 15.081, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 15.082J.

J. Orlin

6.856J Randomized Algorithms
(Same subject as 18.416J)
Prereq: 6.854J, 6.041 or 6.042
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
5-0-7 H-LEVEL Grad Credit

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, 6.042
G (Spring)
3-0-9 H-LEVEL Grad Credit

Techniques for achieving security in multi-user computer systems and distributed computer systems. Topics: physical security; discretionary and mandatory access control; biometrics; information-flow models of security; covert channels; elementary cryptography; public-key cryptography; logic of authentication; electronic cash; viruses; firewalls; electronic voting; risk assessment; secure web browsers.

R. L. Rivest

6.858 Computer Systems Security
Prereq: 6.033
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Design and implementation of secure computer systems. Lectures cover threat models, attacks that compromise security, and techniques for achieving security, based on recent research papers. Topics include operating system (OS) security, capabilities, information flow control, language security, network protocols, hardware security, and security in web applications. Assignments include labs that involve implementing and compromising a secure web server and web application, and a group final project. 4 Engineering Design Points.

N. B. Zeldovich

6.859J Integer Programming and Combinatorial Optimization
(Same subject as 15.083J)
Prereq: 15.081J or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 15.083J.

D. J. Bertsimas, A. S. Schulz

6.863J Natural Language and the Computer Representation of Knowledge
(Same subject as 9.611J)
Prereq: 6.034
G (Spring)
3-3-6 H-LEVEL Grad Credit

Relationship between computer representation of knowledge and the structure of natural language. Emphasizes development of the analytical skills necessary to judge the computational implications of grammatical formalisms, and uses concrete examples to illustrate particular computational issues. Efficient parsing algorithms for context-free grammars; augmented transition network grammars. Question answering systems. Extensive laboratory work on building natural language processing systems. 8 Engineering Design Points.

R. C. Berwick

6.864 Advanced Natural Language Processing
Prereq: 6.046J or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Graduate introduction to natural language processing, the study of human language from a computational perspective. Syntactic and discourse processing models. Emphasis on machine learning or corpus-based methods and algorithms. Use of these methods and models in applications including syntactic parsing, information extraction, statistical machine translation, dialogue systems, and summarization.

R. A. Barzilay, M. J. Collins

6.865 Advanced Computational Photography
(Subject meets with 6.815)
Prereq: 6.003, 18.06
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 6.815.

F. P. Durand, W. T. Freeman

6.866 Machine Vision
(Subject meets with 6.801)
Prereq: 6.003 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

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 prepare a paper analyzing research in a selected area.

B. K. P. Horn

6.867 Machine Learning
Prereq: 6.034, 18.06, 6.041 or 18.05
G (Fall)
3-0-9 H-LEVEL Grad Credit

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, hidden Markov models, and Bayesian networks.

T. Jaakkola, L. P. Koelbling, M. J. Collins

6.868J The Society of Mind
(Same subject as MAS.731J)
Prereq: Must have read The Society of Mind and The Emotion Machine; permission of instructor
G (Spring)
2-0-10 H-LEVEL Grad Credit

Introduction to a theory that tries to explain how minds are made from collections of simpler processes. Treats such aspects of thinking as vision, language, learning, reasoning, memory, consciousness, ideals, emotions, and personality. Incorporates ideas from psychology, artificial intelligence, and computer science to resolve theoretical issues such as wholes vs. parts, structural vs. functional descriptions, declarative vs. procedural representations, symbolic vs. connectionist models, and logical vs. common-sense theories of learning. Enrollment limited.

M. Minsky

6.869 Advances in Computer Vision
Prereq: 6.041 or 6.042; 18.06
G (Spring)
3-0-9 H-LEVEL Grad Credit

Advanced topics in computer vision with a focus on the use of machine learning techniques and applications in graphics and human-computer interface. Topics include 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 6.801/6.866; these subjects may be taken in sequence.

W. T. Freeman, A. Torralba

6.870 Advanced Topics in Computer Vision
Prereq: 6.801, 6.869, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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, P. Golland, B. K. P. Horn, A. Torralba
6.872J Biomedical Computing
(Same subject as HST.950J)
Prereq: 6.034
G (Fall)
3-0-9 H-LEVEL Grad Credit
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. Topics: the nature of clinical data; architecture and design of healthcare information systems; privacy and security issues; medical expert systems; introduction to bioinformatics. Case studies and guest lectures describe contemporary systems and research projects. Term project using large clinical and genomic data sets integrates classroom topics. 6 Engineering Design Points.
P. Szolovits, I. Kohane

6.874J Computational Systems Biology
(Same subject as HST.506J)
(Subject meets with 6.802)
Prereq: Biology (GIR); 18.440 or 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.802.
D. K. Gifford, T. S. Jaakkola

6.875J Cryptography and Cryptanalysis
(Same subject as 18.425J)
Prereq: 6.046J
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

6.876J Advanced Topics in Cryptography
(Same subject as 18.426J)
Prereq: 6.875
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Recent results in cryptography, interactive proofs, and cryptographic game theory. Lectures by instructor, invited speakers, and students.
S. Goldwasser, S. Micali

6.877J Computational Evolutionary Biology
(Same subject as HST.949J)
(Subject meets with 6.048)
Prereq: 6.046J, 6.047, 7.36, 6.807, or HST.508; or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-3-6 H-LEVEL Grad Credit
See description under subject 6.048.
R. C. Berwick

6.878J Advanced Computational Biology: Genomes, Networks, Evolution
(Same subject as HST.507J)
(Subject meets with 6.047)
Prereq: 6.006, 6.041, Biology (GIR); or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
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

6.881–6.884 Advanced Topics in Artificial Intelligence
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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 (Fall, IAP, Spring)
3-0-9 H-LEVEL Grad Credit
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)
3-0-9 H-LEVEL Grad Credit
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)
3-0-9 H-LEVEL Grad Credit
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

Thesis, Research and Practice

6.902J Engineering Innovation and Design
(Same subject as ESD.051J)
Prereq: None
U (Fall, Spring)
4-0-5
See description under subject ESD.051J.
B. Kotelly, J. Schindall

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. Projects require prior approval.
C. J. Terman

6.920 Practical Work Experience
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 [P/D/F]
Can be repeated for credit
For Course 6 students participating in curriculum-related off-campus work 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 work 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.

C. J. Terman

6.921 6-A Internship
Prereq: None
U (Summer)
0-12-0 [P/D/F]

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.

M. Zahn

6.922 Advanced 6-A Internship
Prereq: 6.921
U (Spring, Summer)
0-12-0 [P/D/F]

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.

M. Zahn

6.930 Management in Engineering
Engineering School-Wide Elective Subject
(Offered under: 2.96, 10.806, 16.653)
Prereq: None
U (Fall)
3-1-8

See description under subject 2.96.

H. S. Marcus

6.931 Development of Inventions and Creative Ideas
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Role of the engineer as patent expert and as technical witness in court and patent interference and related proceedings. Rights and obligations of engineers in connection with educational institutions, government, and large and small businesses. Various manners of transplanting inventions into business operations, including development of New England and other US electronics and biotech industries and their different types of institutions. American systems of incentive to creativity apart from the patent laws in the atomic energy and space fields. Conducting periodic joint real-time class sessions and discussions by video-audio Internet conferencing, with other universities. For graduate students only; others see 6.901. Enrollment limited.

Staff

6.932J Linked Data Ventures (New)
(Same subject as 15.377J)
Prereq: 6.005, 6.033, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Provides practical experience in the use and development of semantic web technologies. Focuses on gaining practical insight from executives and practitioners who use these technologies in their companies. Working in multidisciplinary teams, students complete a term project to develop a sustainable prototype. Concludes with a professional presentation, judged by a panel of experts, and a technical presentation to faculty.

T. Berners-Lee

6.938 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject ESD.72.

G. Apostolakis

6.945 Large-scale Symbolic Systems
Prereq: 6.001, 6.01, 6.034, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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. Means for decoupling goals from strategy. Mechanisms for implementing additive data-directed invocation. Work with partially-specified entities. Manage multiple viewpoints. Topics include combinators, generic operations, pattern matching, pattern-directed invocation, rule systems, backtracking, dependencies, indeterminacy, memoization, constraint propagation, and incremental refinement. Comparable programming experience required.

G. J. Sussman

6.946J Classical Mechanics: A Computational Approach
(Same subject as 8.351J, 12.620J)
Prereq: Physics I (GIR), 18.03, permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit

See description under subject 12.620.

J. Wisdom, G. J. Sussman

6.951 Graduate 6-A Internship
Prereq: 6.921, 6.922, or 6.923
G (Fall, Spring, Summer)
0-12-0 [P/D/F]

Provides academic credit for a graduate assignment of 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.

M. Zahn

6.952 Graduate 6-A Internship
Prereq: 6.951
G (Fall, Spring, Summer)
0-12-0 [P/D/F]

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.

M. Zahn

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

115  subjects 6.872J to 6.690  C O U R S E  6
6.961 Introduction to Research in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-0-0
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. Kolodziejski

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. Kolodziejski

6.969 Special Studies in Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring, Summer)
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.
L. A. Kolodziejski

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.
D. M. Freeman

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.
D. M. Freeman

6.982J Teaching College-Level Science and Engineering
(Same subject as 1.95J, 5.95J, 7.59J, 8.395J, 18.094J)
Subject meets with 2.978
Prereq: None
G (Fall)
2-0-2 [P/D/F]
See description under subject 5.95J.
J. Rankin

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.
C. J. Terman

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.CME Study at Cambridge University
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides credit for students studying at Cambridge University under the Cambridge-MIT Exchange program. Credit may be used to satisfy specific SB degree requirements by arrangement with the department.
D. S. Boning, T. Akinwande

6.EPE UPOP Summer Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 10.EPE, 16.EPE, 22.EPE)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit
See description under subject 2.EPE.
S. Luperfoy

6.EPR UPOP Reflective Learning Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPR, 2.EPR, 3.EPR, 10.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall)
0-0-3 [P/D/F]
See description under subject 2.EPR.
S. Luperfoy

6.EPW UPOP IAP Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (IAP)
3-0-0 [P/D/F]
See description under subject 2.EPW.
S. Luperfoy

Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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
6.911–6.919 Special Subject in Electrical Engineering and Computer Science (6.911–6.919)
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Covers subject matter not offered in the regular curriculum.
Consult Department

6.976–6.979 Special Subject in Electrical Engineering (6.976–6.979)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 students who have been admitted to the MEng program.
C. J. Terman

6.UR Undergraduate Research in Electrical Engineering and Computer Science
Prereq: None
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Extended participation in the work of a faculty member or research group, including independent study of the literature, direct involvement in the group's research, and project work under an individual faculty member. Research is arranged by mutual agreement between the student and a member of the faculty of the Department of Electrical Engineering and Computer Science, and may continue over several terms. Forms and instructions for the initial letter of intent and final summary report are available in the department undergraduate office.
C. J. Terman
Bachelor of Science in Electrical Science and Engineering/Course 6-1  
Bachelor of Science in Electrical Engineering and Computer Science/Course 6-2  
Bachelor of Science in Computer Science and Engineering/Course 6-3

### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

### Communication Requirement

The program includes a Communication Requirement of 4 subjects:  
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and  
2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program

**Subject names below are followed by credit units and by prerequisites, if any (corequisites in italics).**  

#### Required Subjects

- **6.01** Introduction to EECS I, 12, 1/2 LAB; Physics II (GIR)  
- **6.02** Introduction to EECS II, 12, 1/2 LAB; 6.01, 18.03*  
- **6.UAT and 6.UAP** Undergraduate Advanced Project, 12

#### Restricted Electives

1. Two mathematics subjects (also satisfies REST requirement):  
   - (a) Either 18.03 or 18.06 (alternatively 18.700)  
   - (b) Either 6.041 (alternatively 18.440) or 6.042J. Students in Course 6-1 must select 6.041 (or 18.440); students in Course 6-3 must select 6.042J.

2. One department laboratory:  
   - One subject selected from the undergraduate laboratory subjects 6.100–6.182 or a departmental list of CS laboratory subjects; students in Course 6-3 must select a CS laboratory subject. Students in Course 6-1 or 6-2 who take both 6.021J and 6.022J may use 6.022J to satisfy the department laboratory requirement.

3. Three/four foundation subjects:  
   - (a) Students in Course 6-1 must take three subjects from the EE foundation list: 6.002, 6.003, 6.004, 6.007.  
   - (b) Students in Course 6-3 must take the three subjects in the CS foundation list: 6.004, 6.005, 6.006.  
   - (c) Students in Course 6-2 must take four subjects from the EECS foundation list (6.002–6.007), with two chosen from the EE foundation list and two from the CS foundation list (6.004 may be counted under either EE or CS).

4. Three header subjects:  
   - (a) Students in Course 6-1 must take three subjects from the EE header list: 6.011, 6.012, 6.013, 6.021J.  
   - (b) Students in Course 6-3 must take the three subjects in the CS header list: 6.031, 6.032, 6.046J.  
   - (c) Students in Course 6-2 must take three subjects from the EECS header list (6.011, 6.012, 6.013, 6.021J, 6.033, 6.034, 6.046J), with at least one chosen from the EE header list and at least one from the CS header list.  

5. Two subjects from a departmental list of advanced undergraduate subjects.

To complete the required Communication-Intensive subjects in the major, students must take one of the following CI-M subjects as a restricted elective in categories 2 or 4 above by the end of the third year: 6.021J, 6.033, 6.101, 6.111, 6.115, 6.131, 6.142J, 6.152J, 6.161, 6.163, 6.173, 6.182, or 6.805. 6.UAT/6.UAP constitutes the second CI-M.

### Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Subject</th>
<th>(36)</th>
</tr>
</thead>
</table>

### Unrestricted Electives

<table>
<thead>
<tr>
<th>Subject</th>
<th>48</th>
</tr>
</thead>
</table>

### Total Units Beyond the GIRs Required for SB Degree

No subject can be counted both as part of the 17-subject GIRs and as part of the 180–192 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

*Alternate prerequisites are listed in the subject descriptions.  
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Master of Engineering in Electrical Engineering and Computer Science/Course 6-P

See Notes on Master of Engineering and Bachelor’s Degree Programs

General Institute Requirements (GIRs) | Subjects | Units
--- | --- | ---
Science Requirement | 6 | 6
Humanities, Arts, and Social Sciences Requirement | 8 | 8
Restricted Electives in Science and Technology (REST) Requirement [satisfied by the mathematics requirement in the Departmental Program] | 2 | 2
Laboratory Requirement [satisfied by 6.01 and 6.02 together in the Departmental Program] | 1 | 1

Total GIR Subjects Required for the SB and MEng Degrees | 17 | 17

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

Required Subjects

6.01 Introduction to ECE I, 12, 1/2 LAB; Physics II (GIR)
6.02 Introduction to ECE II, 12, 1/2 LAB; 6.01, 18.03*
6.IAT and 6.UAP Undergraduate Advanced Project, 12
6.TH.M MEng Program Thesis, 24**

Restricted Electives

1. Two mathematics subjects (also satisfies REST requirement):
   (a) Either 18.03 or 18.06 (alternatively 18.700) and
   (b) Either 6.041 (alternatively 18.440) or 6.042 or both. Students in Course 6-1 for their bachelor’s degree must select 6.041 (or 18.440); students in Course 6-3 for their bachelor’s degree must select 6.042.

2. One department laboratory:
   One subject selected from the undergraduate laboratory subjects 6.100-6.182 or a departmental list of CS laboratory subjects; students in Course 6-3 must select a CS laboratory subject. Students in Course 6-1 or 6-2 who take both 6.021J and 6.022J may use 6.022J to satisfy the department laboratory requirement.

3. Three/four foundation subjects:
   (a) Students in Course 6-1 must take three subjects from the EE foundation list: 6.002, 6.003, 6.004, 6.007.
   (b) Students in Course 6-2 must take the three subjects in the CS foundation list: 6.004, 6.005, 6.006.
   (c) Students in Course 6-2 must take four subjects from the ECEs foundation list (6.002-6.007), with two chosen from the EE foundation list and two from the CS foundation list (6.004 may be counted under either EE or CS).

4. Three header subjects:
   (a) Students in Course 6-1 must take three subjects from the EE header list: 6.011, 6.012, 6.013, 6.021.
   (b) Students in Course 6-3 must take the three subjects in the CS header list: 6.033, 6.034, 6.046.
   (c) Students in Course 6-2 must take three subjects from the ECEs header list: 6.011, 6.012, 6.013, 6.033, 6.034, 6.046, with at least one chosen from the EE header list and at least one from the CS header list.

5. Two subjects from a departmental list of advanced undergraduate subjects.
6. Four H-level graduate subjects totaling at least 42 units, of which at least 36 units must come from subjects taken within the department.
7. Two subjects from a restricted departmental list of mathematics, science, and engineering electives.

To complete the required Communication-Intensive subjects in the major, students must take one of the following CI-M subjects as a restricted elective in categories 2 or 4 above by the end of the third year: 6.021J, 6.033, 6.041, 6.111, 6.115, 6.115, 6.141, 6.152, 6.161, 6.163, 6.173, 6.182, or 6.809. 6.IAT / 6.UAP constitutes the second CI-M.

Departmental Program Units That Also Satisfy the GIRs

(36)

Unrestricted Electives

48

Total Units Beyond the GIRs Required for Simultaneous Award of the MEng and SB Degrees

270–282

No subject can be counted both as part of the 17-subject GIRs and as part of the 270–282 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes

*Alternate prerequisites are listed in the subject description.
**6-PA Program requires performance of thesis at company location.

Notes on Master of Engineering and Bachelor’s Degree Programs
The Master of Engineering program builds on the bachelor’s degree program selected by the student (6-1, 6-2, or 6-3), with restricted elective categories 6 and 7 and the MEng thesis (6.TH.M).

The subjects required under restricted elective category 6 are selected with departmental review and approval to ensure that the combination of these with the two advanced undergraduate subjects under restricted elective category 5 includes at least 36 units in a distinct and appropriate area of graduate concentration.

The Master of Engineering in Electrical Engineering and Computer Science is only awarded to students who have received, or are simultaneously receiving, one of the three bachelor’s degrees. Students who receive the Master of Engineering degree after having obtained one of the three bachelor’s degrees must fulfill the requirements for Course 6-P as described above.

For further details on all EECS programs, visit http://www.eecs.mit.edu/acad.html.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
# Bachelor of Science in Computer Science and Molecular Biology/Course 6-7

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 6.042, 18.03, or 18.06 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 7.02 in the Departmental Program]</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**

17

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics). Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics and Introductory</td>
<td>162</td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td>or 18.06 Linear Algebra, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>6.03 Introduction to EECS I, 12, 1/2 LAB; Physics II (GIR)</td>
<td>6.042J Mathematics for Computer Science, 12, REST; Calculus I (GIR)</td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
</tr>
<tr>
<td>5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)</td>
<td>5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>or 7.10 Physical Chemistry of Biomolecular Systems, 12; Calculus II (GIR), Chemistry (GIR), Physics I (GIR), Physics II (GIR)</td>
<td>or 20.110J Thermodynamics of Biomolecular Systems, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>Introductory Laboratory</td>
<td></td>
</tr>
<tr>
<td>7.02 Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)</td>
<td></td>
</tr>
<tr>
<td>Foundational Subjects</td>
<td></td>
</tr>
<tr>
<td>Three Computer Science subjects:</td>
<td>6.005 Elements of Software Construction, 12; 6.01, 6.042J 6.006 Introduction to Algorithms, 12; 6.01, 6.042J 6.046J Design and Analysis of Algorithms, 12; 6.006*</td>
</tr>
<tr>
<td>Three Biological Science subjects:</td>
<td>7.03 Genetics, 12, REST; Biology (GIR) 7.06 Cell Biology, 12; 7.03, 7.05 7.05 General Biochemistry, 12, REST; 5.12*</td>
</tr>
<tr>
<td>or 5.07 Biological Chemistry I, 12, REST; 5.12</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>24</td>
</tr>
<tr>
<td>One subject in Computational Biology:</td>
<td>6.047 Computational Biology: Genomes, Networks, Evolution, 12; 6.006, 6.042, Biology (GIR)* 6.048 Computational Evolutionary Biology, 12; 6.042*</td>
</tr>
<tr>
<td>or 6.049 Foundations of Algorithms and Computational Techniques in Systems Biology, 12; 6.046J*</td>
<td>6.802 Computational Functional Genomics, 12; Biology (GIR), 6.041*</td>
</tr>
<tr>
<td>7.36 Foundations of Computational and Systems Biology, 12; Biology (GIR)*</td>
<td></td>
</tr>
<tr>
<td>One subject in Biology:</td>
<td>7.20 Human Physiology, 12; 7.05 7.23 Immunology, 12; 7.01* 7.27 Principles of Human Disease, 12; 7.03, 7.04, 7.06 7.28 Molecular Biology, 12; 7.03, 7.05 7.33 Evolutionary Biology: Concepts, Models, and Computation, 12; 7.03, 6.00*</td>
</tr>
<tr>
<td>Advanced Undergraduate Project</td>
<td></td>
</tr>
<tr>
<td>6.UAP and 6.UAT Undergraduate Advanced Project, 12; CI-M</td>
<td></td>
</tr>
<tr>
<td>Departmental Program Units That Also Satisfy the GIRs</td>
<td>(36)</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>198</td>
</tr>
</tbody>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 198 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

*Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
COURSE 7

BIOLOGY

UNDERGRADUATE SUBJECTS

7.012 Introductory Biology
U (Fall)
5-0-7 BIOLOGY
Credit cannot also be received for 7.013, 7.014, ES.7013

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

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

All three subjects cover the same core material, which includes the fundamental principles of biochemistry, genetics, molecular biology, and cell biology. In addition, each version of the subject has its own distinctive material, described below. The core material focuses on function at a molecular level: the structure and regulation of genes, and the structure and synthesis of proteins; how these molecules are integrated into cells; how cells are integrated into multicellular systems and organisms; and computational and genomic approaches to biology. 7.012 and 7.013 are similar, as both emphasize current issues in human biology. 7.012 focuses slightly more on genetic approaches, 7.013 on development and neurobiology. Fall Term: 7.012. Exploration into areas of current research in cell biology, immunology, neurobiology, human genetics, developmental biology, and evolution. Spring Term: 7.013. Application of the fundamental principles toward an understanding of human biology. Topics include genetics, cell biology, molecular biology, disease (infectious agents, inherited diseases and cancer), developmental biology, neurobiology and evolution. Spring Term: 7.014. Application of the fundamental principles toward an understanding of microorganisms as geochemical agents responsible for the evolution and renewal of the biosphere and of their role in human health and disease. Topics include biogeochemical cycles; population growth; ecosystem ecology; microbial diversity.

Fall: 7.012: E. Lander, R. Weinberg
Spring: 7.013: T. Jacks, H. Sive;
7.014: G. C. Walker, S. W. Chisholm

7.02J Introduction to Experimental Biology and Communication
(Same subject as 10.702J)
Prereq: Biology (GIR)
U (Fall, Spring)
4-8-6 Institute LAB

Introduction to the experimental concepts and methods of molecular biology, biochemistry, and genetic analysis. Emphasis on experimental design, critical data analysis, and the development of written communications skills. 12 units may be applied to the General Institute Laboratory Requirement. Concurrent registration with 7.03 strongly recommended. Enrollment limited.

Fall: L. Boyer, W. Gilbert, D. Wittrup
Spring: P. Chang, T. Schwartz, D. Wittrup

7.03 Genetics
Prereq: Biology (GIR)
U (Fall, Spring)
4-0-8 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.

Fall: G. Fink, P. Reddien
Spring: C. Kaiser

7.05 General Biochemistry
Prereq: 5.12, Biology (GIR), or permission of instructor
U (Spring)
5-0-7 REST
Credit cannot also be received for 5.07

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. General metabolism of carbohydrates, fats, and nitrogen-containing materials such as amino acids, proteins, and related compounds.

G. M. Brown, M. Vander Heiden, U. RajBhandary

7.06 Cell Biology
Prereq: 7.03, 7.05
U (Fall, Spring)
4-0-8

Presents the biology of cells of higher organisms. Studies the structure, function, and bio-synthesis 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.

Fall: A. Amon, H. Lodish
Spring: I. Cheeseman, T. Orr-Weaver

7.08J Biological Chemistry II
(Same subject as 5.08J)
(Subject meets with 7.80)
Prereq: 5.12; 5.07 or 7.05
U (Spring)
4-0-8

See description under subject 7.80.

A. Y. Ting, E. Nolan

7.10J Physical Chemistry of Biomolecular Systems
(Same subject as 20.111J)
Prereq: Calculus II (GIR), Chemistry (GIR), Physics I (GIR); Coreq: Physics II (GIR)
U (Spring)
5-0-7

Credit cannot also be received for 20.110

Provides a quantitative approach to understanding the physical and chemical laws that govern the behavior of biological macromolecules. Basic thermodynamics, state of a system, state variables. Work, heat, first, second, and third laws of thermodynamics. Entropy and its statistical basis, free energy representations, Legendre transforms, Maxwell relations, Gibbs function, Boltzmann distribution and partition functions. Equilibrium properties of macroscopic and microscopic systems; macromolecular structure and interactions in solution. Driving forces for molecular self-assembly. Binding, cooperativity, solvation, and titration of macromolecules. Applications of introductory quantum mechanics to spectroscopy.

E. Alm, M. Bathe
7.11 Biology Teaching
Prereq: None
U (Fall, IAP, 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

7.13 Experimental Microbial Genetics
Prereq: 7.02, 7.03, 7.05
U (Fall)
4-16-10
Molecular genetics used to examine the biology of the bacteria Pseudomonas aeruginosa and Caulobacter crescentus. Students engage in independent research projects to probe various aspects of bacterial physiology including the response to DNA damage, survival in stationary phase, antibiotic resistance and phase variation. Students may also explore aspects of pathogenesis and virulence in the context of a simple nematode host organism, Caenorhabditis elegans. Projects aim to discover the molecular basis for these processes using both classical and cutting-edge techniques. These include plasmid manipulation, genetic complementation, mutagenesis, PCR, DNA sequencing, enzyme assays, and gene expression studies. Instruction and practice in written and oral communication are also emphasized Enrollment limited. D. Kim, M. Laub

7.16 Experimental Molecular Biology: Biotechnology II
Prereq: 7.02, 7.03, 7.05
U (Spring)
4-16-10
Applies emerging high-throughput genetic approaches to study the response of mammalian cells to cytotoxic or infectious stimuli. RNA interference (RNAi) screening, microarray expression analysis, and massively parallel sequencing will be used to examine the genetics of cellular pro-survival and pro-death pathways. Teams of two or three students design and carry out experiments to address questions regarding the mechanisms that govern the regulation and execution of cellular responses. Some projects involve the use of DNA damaging agents or other cytotoxic drugs to help understand the pathways that control a cell’s response to chemotherapy. Other projects examine the genes that underlie the cellular response to pathogens. Instruction and practice in written and oral communication provided. M. Hemann, J. Saeij

7.18 Topics in Experimental Biology
(Subject meets with 7.19)
Prereq: 7.02, 7.03, 7.05
U (Fall, Spring)
4-16-10
Independent experimental study under the direction of a member of the Biology Department faculty. Allows students with a strong interest in independent research to fulfill the project laboratory requirement for the Biology 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. Written and oral presentation of the research results is required. Journal club discussions are used to help students evaluate and write scientific papers. Instruction and practice in written and oral communication is provided. Permission of the faculty research supervisor and the Biology Education Office must be obtained in advance. Fall: M. L. Pardue, A. J. Sinskey Spring: S. Lindquist, N. Hopkins

7.19 Communication in Experimental Biology
(Subject meets with 7.18)
Prereq: 7.02, 7.03, 7.05
U (Fall, Spring)
4-4-4
Students carry out independent literature research. Meets with the seminar and writing tutorial portions of 7.18. Journal club discussions are used to help students evaluate and write scientific papers. Instruction and practice in written and oral communication is provided. Permission of instructor and the Biology Education Office must be obtained in advance. Fall: M. L. Pardue, A. J. Sinskey Spring: S. Lindquist, N. Hopkins

7.20] Human Physiology
(Same subject as HST.540)
Prereq: 7.05
U (Fall)
5-0-7
Comprehensive subject in 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. M. Krieger, D. Sabatini

7.21 Microbial Physiology
(Subject meets with 7.62)
Prereq: 7.03, 7.05
U (Fall)
4-0-8
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

7.22 Development and Evolution
Prereq: 7.03, 7.06
U (Fall)
5-0-7
Covers experimental approaches to problems of development and evolution, such as the study of vertebrate (mouse, chick, frog, fish) and invertebrate (fly, worm) models. Topics include development of animal body plans, tissue patterning, cell type determination, organogenesis, morphogenesis, stem cells, and the evolution of developmental diversity and processes. R. O. Hynes, R. Reddien

7.23 Immunology
(Subject meets with 7.63)
Prereq: 7.03, 7.05, 7.06, or permission of instructor
U (Spring)
5-0-7
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; immunoglobin, 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 the graduate version are expected to explore the subject in greater depth. H. Ploegh, L. Steiner
7.25 Biological Regulatory Mechanisms
Prereq: 7.02, 7.03, 7.05
Acad Year 2011−2012: Not offered
Acad Year 2012−2013: U (Spring)
4-0-8

Cells utilize a variety of mechanisms to regulate gene expression, growth, development, and behavior in response to both external and internal conditions. Examines basic principles of biological regulation, focusing on several well-studied examples, usually drawn from microbial species. Reading includes primary literature and review articles with emphasis on how we know what we know, and how to think experimentally.
Staff

7.26 Molecular Basis of Infectious Disease
(Subject meets with 7.66)
Prereq: 7.03, 7.05, 7.06
U (Spring)
4-0-8

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.
D. Housman, L. Guarente

7.27 Principles of Human Disease
Prereq: 7.03, 7.05, 7.06
U (Spring)
4-0-8

Covers current understanding of and modern approaches to human disease, emphasizing the molecular and cellular basis of both genetic disease and cancer. Topics include the genetics of simple and complex traits; karyotypic analysis and positional cloning; genetic diagnosis; the roles of oncogenes and tumor suppressors in tumor initiation, progression, and treatment; the interaction between genetics and environment; animal models of human disease; cancer; aging and disease; and conventional and gene therapy treatment strategies.
D. Housman, L. Guarente

7.28 Molecular Biology
(Subject meets with 7.58)
Prereq: 7.03; Coreq: 7.05
U (Spring)
5-0-7

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.
T. Baker, S. Bell

7.29J Cellular Neurobiology
(Same subject as 9.09J)
Prereq: 7.05
U (Spring)
4-0-8

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.
W. G. Quinn, J. T. Littleton

7.30J Ecology I: The Earth System
(Same subject as 1.018J)
Prereq: None
U (Fall)
3-1-8 REST

See description under subject 1.018J.
S. W. Chisholm, E. DeLong

7.31 Current Topics in Mammalian Biology: Medical Implications
Prereq: 7.05, 7.06, or permission of instructor
Acad Year 2011−2012: Not offered
Acad Year 2012−2013: U (Fall)
4-0-8

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 7.81J, 8.591J)
Prereq: Permission of instructor
U (Fall)
4-0-8

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

7.33J Evolutionary Biology: Concepts, Models and Computation
(Same subject as 6.049J)
Prereq: 7.03; 6.00, 6.01, or permission of instructor
U (Spring)
3-0-9

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

7.340−7.349 Advanced Undergraduate Seminars
Prereq: 7.03, 7.05, 7.06, or 7.28
U (Fall, Spring)
2-0-4 [P/D/F]
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 done. Contact Biology Education Office for topics.
H. R. Horvitz
7.35 Topics in Metabolic Biochemistry (Subject meets with 5.77, 7.75J)
Prereq: 7.05 or 5.07
U (Fall)
4-0-8

Topics include major metabolic pathways for the biosynthesis of certain cellular constituents and oxidative metabolism. Emphasizes enzymology and methods used to understand metabolism and enzymatic processes.

G. M. Brown

7.36 Foundations of Computational and Systems Biology (Subject meets with 7.91J, 20.490J)
Prereq: Biology (GIR); 7.05 or 5.07; 1.00, 1.001, or 6.00; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9

Provides an introduction to computational and systems biology. Includes units on the analysis of protein and nucleic acid sequences, protein structures, and biological networks. Presents principles and methods used for sequence alignment, motif finding, expression array analysis, structural modeling, structure design and prediction, and network analysis and modeling. Techniques include dynamic programming, Markov and hidden Markov models, Bayesian networks, clustering methods, and energy minimization approaches. Exposes students to emerging research areas. Designed for students with strong backgrounds in either molecular biology or computer science. Some foundational material covering basic programming skills, probability and statistics is provided for students with less quantitative backgrounds. Students taking graduate version complete additional assignments.

C. Burge, A. Keating, E. Fraenkel

7.37 Molecular and Engineering Aspects of Biotechnology (Same subject as 10.441J, 20.361J)
Prereq: 2.005, 3.012, 5.60, 20.110, or 20.111; 7.06; or permission of instructor
U (Spring)
4-0-8

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.

H. Lodish, D. Lauffenburger

7.391 Independent Study in Biology for Undergraduates
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

7.392 Independent Study in Biology for Undergraduates
Prereq: None
U (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

7.539 Special Subject in Biology for Undergraduates (7.39)
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

Covers material in various fields of biology not offered by the regular subjects of instruction.

Staff

7.40 Biotechnology: Engineering of Macromolecules
Prereq: 7.05
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-6

Fundamentals of genetics and biochemical principles for the synthesis, design, engineering, and application of biopolymers such as polymers and polysaccharides. Principles underlying structure-function properties of biopolymers. Topics include conformation, image, and nanostructure analysis; behavior of polymers in solution; structure, topography, and functional performance of biopolymers; and biopolymer complexes and assemblies.

C. K. Rha, A. J. Sinskey

7.UR Undergraduate Research
Prereq: Permission of department
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

7.URG Undergraduate Research
Prereq: Permission of department
U (Fall, Spring)
Units arranged
Can be repeated for credit

Undergraduate research opportunities in the Department of Biology. For further information, consult departmental coordinator, Gene Brown.

Staff

MIT-WHOI Joint Program in Oceanography

7.410 Applied Statistics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Applied statistics covers probability and distributions (normal binomial, poisson, exponential, lognormal, and uniform), estimation and hypothesis testing, parametric and nonparametric one-sample and two-sample tests of means, analysis of variance for crossed and nested designs, linear and multiple regression with residual analysis, correlation and discrete data analysis using chi-squared tests. Discussion of experimental and sampling designs are included. Examples use data from biological studies.

V. Starczak (WHOI)

7.411–7.A19 Seminars in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Selected topics in biological oceanography.

Information: J. Waterbury (WHOI)

7.421 Problems in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Advanced problems in biological oceanography with assigned reading and consultation.

Information: J. Waterbury (WHOI)
7.430 Topics in Quantitative Marine Science
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on quantitative marine ecology. Topics vary from year to year.
A. Solow, M. Neubert (WHOI)

7.431 Topics in Marine Ecology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on the biology of marine communities, and ecosystems. Topics vary from year to year.
H. Caswell, R. Harbison (WHOI)

7.432 Topics in Marine Physiology and Biochemistry
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on physiological and biochemical processes in marine organisms. Topics vary from year to year.
M. Hahn, J. McDowell, J. Stegeman (WHOI)

7.433 Topics in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on biological oceanography. Topics vary from year to year.
R. Gast (WHOI)

7.434 Topics in Zooplankton Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on the biology of marine zooplankton. Topics vary from year to year.
L. Madin, R. Harbison (WHOI)

7.435 Topics in Benthic Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussions on the biology of marine benthos. Topics vary from year to year.
L. Mullineaux, R. Scheltema, T. Shank (WHOI)

7.436 Topics in Phytoplankton Biology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussion on the biology of marine phytoplankton. Topics vary from year to year.
R. Olson, H. Sosik, D. Anderson, S. Dyhrman (WHOI)

7.437 Topics in Molecular Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussion on molecular biological oceanography. Topics vary from year to year.
M. Hahn, T. Shank, R. Gast, D. Anderson, S. Sievert (WHOI)

7.438 Topics in the Behavior of Marine Animals
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussion on the behavioral biology of marine animals. Topics vary from year to year.
P. Tyack, M. Moore (WHOI)

7.439 Topics in Marine Microbiology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Lectures and discussion on the biology of marine prokaryotes. Topics vary from year to year.
J. Waterbury, S. Sievert, E. Webb (WHOI)

7.440 An Introduction to Mathematical Ecology
Prereq: Calculus I (GIR), 1.018J, or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit
Covers the basic models of population growth, demographic, 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, H. Caswell (WHOI)

7.441 Biological Oceanography
Prereq: Advanced training in biology
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
L. Mullineaux, H. Sosik, J. Pineda, S. Dyhrman, E. Webb (WHOI)

7.491 Research in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Directed research in biological oceanography not leading to graduate thesis and generally done before the qualifying examination. Possible areas include population dynamics, physiology, and cytology of marine microorganisms; population interaction (competition, predation, mutualism); food webs, and the flow of energy within different marine habitats.
J. Waterbury, S. Sievert, E. Webb (WHOI)

Microbiology (MICRO)

7.492J Methods and Problems in Microbiology
(Same subject as 1.86J, 20.445J)
Prereq: Permission of instructor or Coreq: 7.493
G (Fall)
3-0-9 H-LEVEL Grad Credit
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. Limited to students in the Microbiology program.
L. Samson, M. Polz
7.493J Microbial Genetics and Evolution
(Same subject as 1.87J, 20.446J)
Prereq: 7.03, 7.05, 7.28 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Covers aspects of microbial genetic and genomic analyses, central dogma, horizontal gene transfer, and evolution.
A. D. Grossman, M. Polz, E. Alm

7.494 Research Problems in Microbiology (New)
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Directed research in the fields of microbial science and engineering.
Staff

7.495 Microbiology Graduate Thesis (New)
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad 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

7.498 Teaching Experience in Microbiology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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: Permission of instructor; Coreq: 7.492, or 7.493
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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

7.50 Method and Logic in Molecular Biology
Prereq: Permission of instructor or Coreq: 7.51 and 7.52
G (Fall)
4-0-8 H-LEVEL Grad Credit
Logic and experimental design: an in-depth discussion and assessment of biochemical, physical, genetic, and cell biological methods employed in testing hypotheses. Limited to Course 7 graduate students.
W. Gilbert, M. Hemmann, J. Lees, D. Sabatini, F. Solomon

7.51 Principles of Biochemical Analysis
Prereq: Permission of instructor
G (Fall)
6-0-6 H-LEVEL Grad Credit
Fundamental principles of biochemistry. Analysis of the structure and mechanism of catalytic and regulatory macromolecules.
R. T. Sauer, F. Solomon, I. Cheeseman

7.52 Genetics for Graduate Students
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Principles and approaches of genetic analysis, including Mendelian inheritance and prokaryotic genetics, developmental genetics, neurogenetics, and epigenetics. Recitations and problem sets supplement lectures.
H. R. Horvitz, D. Housman, A. Amon

7.540J Frontiers in Chemical Biology
(Same subject as 5.54J, 10.54J)
Prereq: 5.13, 5.07, 7.06, permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: 6 (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 5.54J.
B. Imperiali

7.549J Case Studies and Strategies in Drug Discovery and Development
(Same subject as 15.137J, 20.486J, HST.916J)
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
See description under subject 20.486J.
S. R. Tannenbaum, A. J. Sinskey, A. Wood

7.55 Case Studies in Modern Experimental Design
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
Designed to help students increase their command of experimental design using contemporary tools. Students read and discuss papers that developed or utilized modern experimental techniques (e.g., quantitative microscopy and biophysical- and molecular genetic approaches applied to problems in areas such as cell cycle control, structural biopolymers, and cell polarity). In-class discussions and short written exercises emphasize conceptualizing experimental approaches, designing experiments, and choosing appropriate controls.
P. Chang, F. Solomon

7.57 Quantitative Biology for Graduate Students
Prereq: Permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
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, cellular biology, genomics, and systems biology.
M. Laub, P. Gupta

7.58 Molecular Biology
(Same subject as 15.136J)
Prereq: 7.03; 7.05
G (Spring)
5-0-7 H-LEVEL Grad Credit
See description under subject 7.28
T. Baker, S. Bell
7.59] Teaching College-Level Science and Engineering
(Same subject as 1.95J, 5.95J, 6.982J, 8.395J, 18.094J)
Prereq: None
G (Fall)
2-0-2 [P/D/F]
See description under subject 5.95J.

J. Rankin

7.60 Cell Biology: Structure and Functions of the Nucleus
Prereq: 7.06
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit

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.

P. Sharp, R. Young

7.61 Eukaryotic Cell Biology: Principles and Practice
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Emphasizes methods and logic used to analyze eukaryotic cells in diverse systems (e.g., yeast, fly, worm, mouse, human; development, neurons). Subject combines lectures and in-depth roundtable discussions of literature readings with active participation of faculty experts.

Focuses on membranes, organelles, the cell surface, cytoskeleton and extracellular matrix. Topics include membrane protein structure, cell surface receptors and transporters; signal transduction pathways; membrane trafficking/sorting/secretion; adhesion and its effects on organization, migration and polarity of cells; stem cells; integration of cells into tissues and organs. Ranges from basic studies to applications to human disease, while emphasizing critical analysis of experimental approaches. Enrollment limited.

R. O. Hynes, M. Krieger

7.62 Microbial Physiology
(Subject meets with 7.21)
Prereq: 7.03, 7.05
G (Fall)
4-0-8 H-LEVEL Grad Credit

See description under subject 7.21.

G. C. Walker, A. J. Sinskey

7.63 Immunology
(Subject meets with 7.23)
Prereq: Permission of instructor
G (Spring)
5-0-7 H-LEVEL Grad Credit

See description under subject 7.23.

H. Ploegh, L. Steiner

7.65] Molecular and Cellular Neuroscience Core I
(Subject meets with 9.015J)
Prereq: None
G (Fall)
3-0-9

See description under subject 9.015J.

J. T. Littleton, W. Xu, G. Feng, H. Sive

7.66 Molecular Basis of Infectious Disease
(Subject meets with 7.26)
Prereq: 7.03, 7.05, 7.06
G (Spring)
4-0-8 H-LEVEL Grad Credit

See description under subject 7.26.

J. Kim, J. Saeij

7.67] Genetic Methods in Neurobiology
(Subject meets with 9.322J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

See description under subject 9.322J.

W. G. Quinn

7.68] Molecular and Cellular Neuroscience Core II
(Subject meets with 9.013J)
Prereq: Permission of instructor
G (Spring)
3-0-9

See description under subject 9.013J.

M. Constantine-Paton, Y. Lin, L.-H. Tsai

7.69] Developmental Neurobiology
(Subject meets with 9.181J)
Prereq: 9.011 or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
4-0-8 H-LEVEL Grad Credit

See description under subject 9.181J.

E. Nedivi

7.70] Regulation of Gene Expression
Prereq: Permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

Cells utilize a variety of mechanisms to regulate gene expression, growth, development, and behavior in response to both external and internal conditions. Seminar examines basic principles of biological regulation and focuses on examples that underpin the principles, as well as those that challenge certain long-held views. Limited to 40.

L. Boyer, M. Gehring

7.71 Biophysical Chemistry Techniques
Prereq: 5.13, 5.60; 5.07 or 7.05
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
5-0-7 H-LEVEL Grad Credit

Credit cannot also be received for 5.78

For students who want to understand the benefits and caveats of biophysical techniques used to ascertain the structure of macromolecules, especially on the 3-D level. The first half of the course focuses on x-ray crystallography, the single most important technique used in determining the 3-D structure of macromolecules. Discussion of crystallographic theory is complemented with exercises such as crystalization, data processing, and model building. In the second half of the course, biophysical techniques are covered that supplement the 3-D characterization of biological macromolecules. Topics include CD spectroscopy, isothermal calorimetry, analytical ultracentrifugation, dynamic light scattering, and surface plasmon resonance (BIAcore). Theoretical principles behind the techniques are covered, applications are discussed, and students are performing practical exercises using instrumentation available at MIT. Meets with 5.78 when offered concurrently.

C. Drennan, T. Schwartz

7.72] Principles of Development and Evolution
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Lectures and literature discussion cover animal development and evolution. Focuses on molecular mechanisms, experimental approaches, and relevant disorders. Compares vertebrate (mouse, chick, frog, fish) and invertebrate (fly, worm) models. Topics include the early body plan, cell type determination and diversity, organogenesis, morphogenesis, maternal control, organismal growth, stem cells, and issues in human development.

H. Sive, T. Orr-Weaver
7.74j Evaluating Current Research in Molecular and Cellular Biophysics
(Same subject as 20.416j)
Prereq: None
G (Fall)
2-0-4
See description under subject 20.416j.
*M. Bathe, J. Gore*

7.75j Topics in Metabolic Biochemistry
(Same subject as 5.77j)
(Subject meets with 7.35)
Prereq: 7.05 or 5.07
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 7.35.
*G. M. Brown*

7.76 Topics in Protein Biochemistry
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
In-depth analysis and discussion of classic and current literature, with an emphasis on protein structure and function. Topics include binding specificity; cooperativity and allosteroy; protein folding and misfolding; macromolecular assembly; sequence homology and prediction of structure; and protein engineering and design. Undergraduates should have taken 7.71 or 5.64.
*R. T. Sauer*

7.77 Nucleic Acids, Structure, Function, Evolution and Their Interactions with Proteins
Prereq: 7.05 or 7.51
G (Spring)
3-0-9 H-LEVEL Grad Credit
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 5.08j, 7.08j)
Prereq: 5.12; 5.07 or 7.05
G (Spring)
4-0-8 H-LEVEL Grad Credit
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. Students taking the graduate version are expected to explore the subject in greater depth.
*A. Y. Ting, E. Nolan*

7.81j Systems Biology
(Subject meets with 8.591j)
Prereq: None
4-0-8
See description under subject 8.591j.
*J. Gore*

7.82 Topics of Mammalian Development and Genetics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 [P/D/F] H-LEVEL Grad Credit
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, D. Page*

7.88j Protein Folding and Human Disease
(Same subject as 5.48j, 10.543j)
Prereq: 7.51 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Addresses the multifaceted biochemical problem of protein folding and the surprising ways it affects biological systems. Considers underlying chemistry and cellular biology, folding intermediates and off-pathway reactions, and the roles of chaperones and other folding assistants. Covers the amyloid fold, beneficial amyloid functions, major protein folding diseases (such as Alzheimer’s and Prion diseases) and the effects of protein folding on the evolution of novel functions.
*S. Lindquist, J. A. King*

7.89j Topics in Computational and Systems Biology
(Same subject as CSB.100j)
Prereq: Permission of instructor
G (Fall)
2-0-10 H-LEVEL Grad Credit
See description under subject CSB.100j.
*C. Burge*

7.91j Foundations of Computational and Systems Biology
(Same subject as 20.490j)
(Subject meets with 7.36)
Prereq: Biology (GIR); 7.05 or 5.07; 1.00, 1.001, or 6.00; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 7.36.
*C. Burge, A. Keating, E. Fraenkel*

7.931 Independent Study in Biology for Graduate Students
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

7.932 Independent Study in Biology for Graduate Students
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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] H-LEVEL Grad Credit
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, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
For qualified graduate students in the Biology graduate program interested in teaching. Classroom or laboratory teaching under the supervision of a faculty member.
Staff

7.941 Research Problems
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
7.942 Research Problems
Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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: 7.03, 7.06
G (Spring)
3-0-9 H-LEVEL Grad Credit
Intensive analysis of historical and current developments in cancer biology. Topics include principles of transformation, viral and cellular oncogenes, tumor suppressor genes, tumor-cell growth, apoptosis, principles of cancer biology, and cancer genetics. Detailed analyses of the current research literature including important research reports published in recent years. Enrollment limited.
J. Lees, M. Hemann, M. Vander Heiden, R. Weinberg

7.98J Neural Plasticity in Learning and Memory
(Same subject as 9.301J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 9.301J.
S. Tonegawa, W. Quinn

7.93 Special Subject in Biology for Graduate Students (7.93)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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, Spring)
Units arranged H-LEVEL Grad Credit
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.
Staff
## Bachelor of Science in Biology/Course 7

### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement (two subjects can be satisfied by 5.111, 5.112, or 3.091, and 7.012, 7.013, or 7.014 in the Departmental Program)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (can be satisfied from among 5.12, 5.60(1) and 7.03 or 7.05 in the Departmental Program)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (can be satisfied by 7.02J in the Departmental Program)</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**: 17

### Communication Requirement

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

#### Required Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.111 or 5.112 Principles of Chemical Science</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>or 3.091 Introduction to Solid-State Chemistry</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>5.12 Organic Chemistry I</td>
<td>12</td>
<td>REST; Chemistry (GIR)</td>
</tr>
<tr>
<td>20.110J Thermodynamics of Biomolecular Systems, (1)</td>
<td>12</td>
<td>REST; Calculus II (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>or 7.10J Physical Chemistry of Biomolecular Systems, (2)</td>
<td>12</td>
<td>Calculus II (GIR), Chemistry (GIR), Physics I (GIR), Physics II (GIR)</td>
</tr>
<tr>
<td>or 5.60 Thermodynamics and Kinetics, (3)</td>
<td>12</td>
<td>REST; Calculus II (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>7.012 or 7.013 or 7.014 Introductory Biology</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>7.02J Introduction to Experimental Biology and Communication</td>
<td>18</td>
<td>LAB, CI-M; Biology (GIR)</td>
</tr>
<tr>
<td>or 7.10J Laboratory Fundamentals in Biological Engineering</td>
<td>15</td>
<td>LAB, CI-M; Biology (GIR), Chemistry (GIR), 6.00, 18.03, 20.110J*</td>
</tr>
<tr>
<td>7.03 Genetics</td>
<td>12</td>
<td>REST; Biology (GIR)</td>
</tr>
<tr>
<td>7.05 General Biochemistry</td>
<td>12</td>
<td>REST; 5.12*</td>
</tr>
<tr>
<td>or 5.07 Biological Chemistry I</td>
<td>12</td>
<td>5.12</td>
</tr>
<tr>
<td>7.06 Cell Biology</td>
<td>12</td>
<td>7.03, 7.05</td>
</tr>
</tbody>
</table>

#### Restricted Electives

Three undergraduate-level 12-unit subjects offered by the Department of Biology for which 7.03 and/or 7.05 are prerequisites. Exceptions: 7.30J is eligible as a restricted elective; 7.19 cannot be used as a restricted elective. Graduate-level subjects may not be used as restricted electives. Subjects that count as restricted electives are the following: 7.08J, 7.20J, 7.21, 7.22, 7.23, 7.24, 7.25, 7.26, 7.27, 7.28, 7.29J, 7.30J, 7.31J, 7.32, 7.33, 7.35, 7.36, and 7.37J.

One of the 30-unit project laboratory subjects in the department curriculum. Those currently offered are: 7.13 Experimental Microbial Genetics, 30, CI-M; 7.02, 7.03, 7.05
7.14 Experimental Molecular Biology: Biotechnology II, 30, CI-M; 7.02, 7.03, 7.05
7.15 Topics in Experimental Biology, 30, CI-M; 7.02, 7.03, 7.05

#### Departmental Program Units That Also Satisfy the GIRs

(66)

### Unrestricted Electives

78

#### Total Units Beyond the GIRs Required for SB Degree

180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

* Alternate prerequisites are listed in the subject description.

(1) The department recommends 20.110J, 7.10J, or 5.60 to fulfill the biology requirements, but will also accept 2.005, 3.012, 8.044, or 10.213 as a substitution.

(2) Either 7.02J or 5.311J satisfies the Institute Laboratory Requirement. However, both or their equivalent are required in order to satisfy medical school entrance requirements.

(3) 7.012, 7.013, 7.014 are intended to be first biology subjects and are not to be taken after other biology subjects.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi)
Bachelor of Science in Computer Science and Molecular Biology/Course 6-7

General Institute Requirements (GIRs)  
Subjects

Science Requirement  6
Humanities, Arts, and Social Sciences Requirement  8
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 6.042, 18.03, or 18.06 in the Departmental Program]  2
Laboratory Requirement [can be satisfied by 7.02 in the Departmental Program]  1

Total GIR Subjects Required for SB Degree  17

Communication Requirement  
The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program  
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

Required Subjects  162

Mathematics and Introductory  
18.03 Differential Equations, 12, REST; Calculus II (GIR)
or  
18.06 Linear Algebra, 12, REST; Calculus II (GIR)

6.01 Introduction to EECS I, 12, 1/2 LAB; Physics II (GIR)
6.042 Mathematics for Computer Science, 12, REST; Calculus I (GIR)
6.01  

Chemistry  
5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)

5.07 Biological Chemistry I, 12, REST; 5.12*

5.07 Biological Chemistry I, 12, REST; 5.12*
or  
5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)
5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)
or  
7.10 Physical Chemistry of Biomolecular Systems, 12; Calculus II (GIR), Chemistry (GIR), Physics I (GIR), Physics II (GIR)
or  
20.110 Thermodynamics of Biomolecular Systems, 12, REST; Calculus II (GIR), Chemistry (GIR)

Introductory Laboratory  
7.02 Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)

Foundational Subjects  
Three Computer Science subjects:
6.005 Elements of Software Construction, 12; 6.01, 6.042
6.006 Introduction to Algorithms, 12; 6.01, 6.042*
6.046 Design and Analysis of Algorithms, 12; 6.006*

Three Biological Science subjects:
7.03 Genetics, 12, REST; Biology (GIR)
7.06 Cell Biology, 12; 7.03, 7.05
7.05 General Biochemistry, 12, REST, 5.12*
or  
5.07 Biological Chemistry I, 12, REST; 5.12

Restricted Electives  24
One subject in Computational Biology:
6.047 Computational Biology: Genomes, Networks, Evolution, 12; 6.006, 6.041, Biology (GIR)*
6.048 Computational Evolutionary Biology, 12; 6.047*
6.504 Foundations of Algorithms and Computational Techniques in Systems Biology, 12; 6.046*
6.802 Computational Functional Genomics, 12; Biology (GIR), 6.041*
7.36 Foundations of Computational and Systems Biology, 12; Biology (GIR)*

One subject in Biology:
7.20 Human Physiology, 12; 7.05
7.23 Immunology, 12; 7.03*
7.27 Principles of Human Disease, 12; 7.03, 7.05, 7.06
7.28 Molecular Biology, 12; 7.03, 7.05
7.33 Evolutionary Biology: Concepts, Models, and Computation, 12; 7.03, 6.00*

Advanced Undergraduate Project  
6.UAP and 6.UAT Undergraduate Advanced Project, 12; CI-M

Departmental Program Units That Also Satisfy the GIRs  (36)

Unrestricted Electives  48

Total Units Beyond the GIRs Required for SB Degree  198

No subject can be counted both as part of the 17-subject GIRs and as part of the 198 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes

*Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
UNDERGRADUATE SUBJECTS

8.01 Physics I
Prereq: None
U (Fall)
3-2-7 PHYSICS I
Credit cannot also be received for 8.011, 8.012, 8.01L, CC.801, CC.8012, ES.801, ES.8012
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.
D. Chakrabarty, P. Dourmashkin

8.011 Physics I
Prereq: None
U (Spring)
5-0-7 PHYSICS I
Credit cannot also be received for 8.01, 8.012, 8.01L, CC.801, CC.8012, ES.801, ES.8012
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.
Staff

8.012 Physics I
Prereq: None
U (Fall)
5-0-7 PHYSICS I
Credit cannot also be received for 8.01, 8.011, 8.01L, CC.801, CC.8012, ES.801, ES.8012
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. Zwierlein

8.01 Physics I
Prereq: None
U (Fall)
3-2-7 PHYSICS I
Credit cannot also be received for 8.01, 8.011, 8.012, CC.801, CC.8012, ES.801, ES.8012
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. Limited to 100 students via lottery.
Y. Lee

8.02 Physics II
Prereq: Physics I (GIR), Calculus I (GIR)
U (Fall, Spring)
3-2-7 PHYSICS II
Credit cannot also be received for 8.021, 8.022, CC.802, 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.

8.021 Physics II
Prereq: Physics I (GIR), Calculus I (GIR), permission of instructor
U (Fall)
5-0-7 PHYSICS II
Credit cannot also be received for 8.02, 8.022, CC.802, 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.
Fall: R. Redwine, J. Conrad
Spring: Staff

8.022 Physics II
Prereq: Physics I (GIR), Calculus II (GIR)
U (Fall, Spring)
5-0-7 PHYSICS II
Credit cannot also be received for 8.02, 8.021, CC.802, 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.
Fall: J. Winn
Spring: Staff
**8.03 Physics III**  
Prereq: Calculus II (GIR), Physics II (GIR)  
U (Fall, Spring)  
5-0-7 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.  
*Fall: A. van Oudenaarden  
Spring: Staff*

**8.033 Relativity**  
Prereq: Physics I (GIR), Calculus II (GIR)  
U (Fall)  
5-0-7

Normally taken by Physics majors in their sophomore year. 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.  
*K. Rajagopal*

**8.04 Quantum Physics I**  
Prereq: 8.03 or 6.014; 18.03 or 18.034  
U (Fall, Spring)  
5-0-7 REST

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: Schrödinger’s equation, wave functions, wave packets, probability amplitudes, stationary states, the Heisenberg uncertainty principle, and zero-point energies. Solutions to Schrödinger’s equation in one dimension: transmission and reflection at a barrier, barrier penetration, potential wells, the simple harmonic oscillator. Schrödinger’s equation in three dimensions: central potentials and introduction to hydrogenic systems.  
*Fall: V. Vuletic  
Spring: Staff*

**8.044 Statistical Physics I**  
Prereq: 8.03, 18.03  
U (Spring)  
5-0-7

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.  
*K. Rajagopal*

**8.05 Quantum Physics II**  
Prereq: 8.04  
U (Fall)  
5-0-7

*B. Zwiebach*

**8.06 Quantum Physics III**  
Prereq: 8.05  
U (Spring)  
5-0-7

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-dimensional, 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.  
*Staff*

**8.07 Electromagnetism II**  
Prereq: 8.03, 18.03  
U (Fall)  
4-0-8

*J. Belcher*

**8.08 Statistical Physics II**  
Prereq: 8.044, 8.05  
U (Spring)  
4-0-8

*Staff*

**8.09 Classical Mechanics III**  
Prereq: Physics I (GIR)  
U (Fall)  
4-0-8

Formal introduction to classical mechanics, Euler-Lagrange equations, Hamilton’s equations of motion used to describe central force motion, scattering, perturbation theory and Noether’s theorem. Extension to continuous and relativistic systems and classical electrodynamics.  
*B. Surrow*
PHYSICS

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1.04: PHYSICS

1.04 Laboratory and Special Project Subjects

8.13 Experimental Physics I
Prereq: 8.04
U (Fall)
0-6-12 Institute LAB

8.14 Experimental Physics II
Prereq: 8.05, 8.13
U (Spring)
0-6-12 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. 8.14 requires knowledge of quantum mechanics at the 8.05 level.

G. Roland

8.18 Special Problems in Undergraduate Physics
Prereq: None
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: Physics I (GIR), Calculus I (GIR)
U (IAP)
2-0-7 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.

J. Formaggio

8.21 Physics of Energy
Prereq: Physics II (GIR), Calculus II (GIR), Chemistry (GIR)
U (Fall)
4-0-8 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.

W. Taylor

8.22 Interactive Introduction to Nuclear Magnetic Resonance
(Same subject as 22.920J)
Prereq: Calculus II (GIR)
G (IAP)
1-2-0 H-LEVEL Grad Credit

See description under subject STS.042J.

D. G. Cory

8.223 Classical Mechanics II
Prereq: Physics I (GIR), Calculus II (GIR)
U (IAP)
2-0-4

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.

P. Fisher

8.224 Exploring Black Holes: General Relativity and Astrophysics
Prereq: 8.033 or 8.20
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9

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 Einstein, Oppenheimer, Feynman: Physics in the 20th Century
(Same subject as STS.042J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

See description under subject STS.042J.

D. I. Kaiser

8.226 Forty-three Orders of Magnitude
Prereq: 8.04, 8.044; or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9

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

Acad Year 2012–2013: Not offered
Acad Year 2012–2013: Not offered
8.231 Physics of Solids I
Prereq: 8.044, Coreq: 8.05
U (Fall)
4-0-8
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.
P. Jarillo-Herrero

8.251 String Theory for Undergraduates
Prereq: 8.033, 8.044, 8.05
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8
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.
B. Zwiebach

8.261J Introduction to Computational Neuroscience
(Same subject as 9.29J)
Prereq: 18.03, Physics II (GIR) or permission of instructor
U (Fall)
3-0-9
See description under subject 9.29J.
M. Fee

8.276 Nuclear and Particle Physics
Prereq: 8.033, 8.04
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8
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.
J. Conrad

8.277J Introduction to Particle Accelerators
(Same subject as 6.608J)
Prereq: 6.013 or 8.07
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9
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.
W. Barletta

8.282J Introduction to Astronomy
(Same subject as 12.402J)
Prereq: Physics I (GIR)
U (Spring)
3-0-6 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.
Staff

8.284 Modern Astrophysics
Prereq: 8.04, Coreq: 8.05
U (Spring)
3-0-9
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, the interstellar medium, galaxies, and as time permits, active galaxies, quasars, and cosmology. Observational data discussed. No prior knowledge of astronomy is required.
Staff

8.286 The Early Universe
Prereq: 18.03, Physics II (GIR)
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 REST
Introduction to modern cosmology. First half deals with the development of the big bang theory from 1915 to 1980, and latter half with 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, 12.402J, 12.409, or other introductory astronomy course; Coreq: 8.03
U (Fall)
3-4-8 Institute LAB
See description under subject 12.410J.
R. Binzel, A. Bosh

8.292J Fluid Physics
(Same subject as 12.330J)
Prereq: 8.044, 5.60, or permission of instructor
U (Spring)
3-0-9
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.
P. Joss

8.297 Physics of the 21st Century
Prereq: 8.033, 8.044, 8.05, 8.13
U (Spring)
4-0-8
Students study four topics in depth from themes of current interest over the course of the term. Topic examples include Bose-Einstein con-
denses, dark energy, neutrino interactions, superconductivity, photonics, semiconductor nanostructures, exoplanets, and space plasmas.

P. Fisher

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 S. Todadri

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.UR Undergraduate Research
Prereq: None
U (Fall, 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, 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. Information: N. Mavalvala

GRADUATE SUBJECTS

8.311 Electromagnetic Theory I
Prereq: 8.07
G (Spring)
4-0-8 H-LEVEL Grad Credit
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. Staff

8.312 Quantum Theory I
Prereq: 8.05
G (Fall)
4-0-8 H-LEVEL Grad Credit

8.313 Statistical Mechanics I
Prereq: None
G (Fall)
4-0-8 H-LEVEL Grad Credit

8.323 Selected Topics in Physics
Prereq: 8.298
G (Spring)
4-0-8 H-LEVEL Grad Credit
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. Staff

8.324 Statistical Mechanics II
Prereq: 8.333
G (Spring)
4-0-8 H-LEVEL Grad Credit

8.325 Relativistic Quantum Field Theory III
Prereq: 8.324
G (Spring)
4-0-8 H-LEVEL Grad Credit
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. Staff

8.333 Statistical Mechanics I
Prereq: 8.044, 8.05
G (Fall)
4-0-8 H-LEVEL Grad Credit

8.351 Classical Mechanics: A Computational Approach
(Same subject as 6.946J, 12.620J)
(Subject meets with 12.008)
Prereq: Physics I (GR), 18.03, permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
See description under subject 12.620J. J. Wisdom, G. J. Sussman
8.361 Quantum Theory of Many-Particle Systems
Prereq: 8.322, 8.333
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
T. W. Donnelly

8.371J Quantum Information Science
(Same subject as 6.443J, 18.436J)
Prereq: 18.435
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.436J.
I. Chuang

8.381, 8.382 Selected Topics in Theoretical Physics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Topics of current interest in theoretical physics, varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult P. A. Lee

8.391 Pre-Thesis Research
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

8.392 Pre-Thesis Research
Prereq: Permission of instructor
G (Spring, Summer)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Advanced problems in any area of experimental or theoretical physics, with assigned reading and consultations.
Consult S. Todadri

8.395J Teaching College-Level Science and Engineering
(Same subject as 1.95J, 5.95J, 6.982J, 7.59J, 18.094J)
Prereq: None
G (Fall)
2-0-2 [P/D/F]
See description under subject 5.95J.
J. Rankin

8.398 Selected Topics in Graduate Physics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Presentation of topics of current interest with content varying from year to year.
Consult K. Rajagopal

8.399 Physics Teaching
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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 S. P. Robinson

Physics of Atoms, Radiation, Solids, Fluids, and Plasmas

8.411J Quantum Computation
(Same subject as 2.111J, 18.435J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.435J.
I. Chuang, E. Farhi, S. Lloyd, P. Shor

8.421 Atomic and Optical Physics I
Prereq: 8.05
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
The first 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

8.422 Atomic and Optical Physics II
Prereq: 8.05
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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

8.431J Nonlinear Optics
(Same subject as 6.634J)
Prereq: 6.013 or 8.07
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.634J.
E. P. Ippen, J. G. Fujimoto

8.481, 8.482 Selected Topics in Physics of Atoms and Radiation
Prereq: 8.321
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Presentation of topics of current interest, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult P. A. Lee

8.511 Theory of Solids I
Prereq: 8.231
G (Fall)
3-0-9 H-LEVEL Grad Credit
P. A. Lee
8.512 Theory of Solids II
Prereq: 8.511
G (Spring)
3-0-9 H-LEVEL Grad Credit


Staff

8.513 Many-Body Theory for Condensed Matter Systems
Prereq: 8.05, 8.08, 8.033, 8.231J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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.

L. Levitov

8.514 Strongly Correlated Systems in Condensed Matter Physics
Prereq: 8.322, 8.333
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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)
3-0-9
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.

Consult P. A. Lee

8.591J Systems Biology
(Same subject as 7.81J)
Prereq: None
G (Fall)
4-0-8
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

8.592J Statistical Physics in Biology
(Same subject as HST.452J)
Prereq: None
G (Spring)
3-0-9
Can be repeated for credit
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

8.594J Introduction to Neural Networks
(Same subject as 9.641J)
Prereq: 9.29 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 9.641J.

H. Seung

8.613J Introduction to Plasma Physics I
(Same subject as 6.651J, 22.611J)
Prereq: 6.013, 8.07, or 22.105; 18.04 or Coreq: 18.075
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 22.611J.

J. Egedal-Pedersen

8.614J Introduction to Plasma Physics II
(Same subject as 6.652J, 22.612J)
Prereq: 6.651J, 8.613J, or 22.611J
G (Spring)
3-0-9 H-LEVEL Grad Credit

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: 8.613J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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 (ECH), 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: 8.613J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

8.642 Physics of High-Energy Plasmas II
Prereq: 8.613J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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-\(j'\)” (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.

B. Coppi

8.681, 8.682 Selected Topics in Fluid and Plasma Physics
Prereq: 8.613J
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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 H-LEVEL Grad Credit

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.

S. Nahn

8.711 Nuclear Physics
Prereq: 8.321, 8.701
G (Spring)
4-0-8 H-LEVEL Grad Credit


J. Matthews

8.712 Advanced Topics in Nuclear Physics
Prereq: 8.711 or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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.

Consult P. Fisher

8.781, 8.782 Selected Topics in Nuclear Theory
Prereq: 8.323
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit

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 H-LEVEL Grad Credit


M. Klute

8.812 Graduate Experimental Physics
Prereq: 8.701
G (IAP)
1-8-3 H-LEVEL Grad Credit

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,
**Physics**

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**8.821 String Theory**
Prereq: 8.324
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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.

J. McGreevy

**8.831J Supersymmetric Quantum Field Theories**
(Same subject as 18.396)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Can be repeated for credit

See description under subject 18.396).

D. Z. Freedman

**8.841 Electroweak Interactions**
(Same subject as 18.396)
Prereq: 8.324
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Can be repeated for credit

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

**8.851 Strong Interactions**
Prereq: 8.324
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

The strong force which bind quarks together is described by a relativistic quantum field theory called quantum chromodynamics (QCD). Subject surveys: The QCD Langrangian, asymptotic freedom and deep inelastic scattering, jets, the QCD vacuum, instantons and the U(1) problem, lattice gauge theory, and other phases of QCD.

i. Stewart

**8.861 Advanced Topics in Superfluidity**
Prereq: 8.324
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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.

F. Wilczek

**8.871, 8.872 Selected Topics in Theoretical Particle Physics**
Prereq: 8.323
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit

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.

Consult E. Farhi

**8.881, 8.882 Selected Topics in Experimental Particle Physics**
Prereq: 8.811
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit

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.

Consult P. Fisher

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**Space Physics and Astrophysics**

**8.901 Astrophysics I**
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit


Staff

**8.902 Astrophysics II**
Prereq: 8.901
G (Fall)
3-0-9 H-LEVEL Grad Credit


R. Simcoe

**8.913 Plasma Astrophysics I**
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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

8.921 Stellar Structure and Evolution
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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.

M. Tegmark

8.952 Particle Physics of the Early Universe
Prereq: 8.323, Coreq: 8.324
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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: 18.03, 18.06, 8.07
G (Spring)
4-0-8 H-LEVEL Grad Credit

The basic principles of Einstein’s general theory of relativity, differential geometry, experimental tests of general relativity, black holes, and cosmology.

Staff

8.971, 8.972 Astrophysics Seminar
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
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
G (Fall, Spring)
3-0-9 [P/D/F] H-LEVEL Grad Credit
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.THG Graduate Physics Thesis
Prereq: None
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 S. Todadri
# Bachelor of Science in Physics/Course 8

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
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<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 8.03 or 8.04, and 18.03 or 18.034 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [satisfied by 8.13 or equivalent in the Departmental Program]</td>
<td>1</td>
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</table>

**Total GIR Subjects Required for SB Degree**: 17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

**Subject names below are followed by credit units, and by prerequisites, if any (corequisites are indicated in italics).**

### Required Subjects

- **8.03** Physics III, 12, REST; Physics II (GIR), Calculus II (GIR)
- **18.03** Differential Equations, 12, REST; Calculus II (GIR) or **18.034** Differential Equations, 12, REST; Calculus II (GIR)
- **8.04** Quantum Physics I, 12, REST; 8.03*, 18.03*
- **8.044** Statistical Physics I, 12; 8.03, 18.03

### Physics: Flexible Option

- **8.21** Physics of Energy, 12; Physics II (GIR), Calculus II (GIR)
- **8.223** Classical Mechanics II, 6; Physics I (GIR), Calculus II (GIR)

### Physics: Focused Option

- **8.21** Physics of Energy, 12; Physics II (GIR), Calculus II (GIR)
- **8.223** Classical Mechanics II, 6; Physics I (GIR), Calculus II (GIR)

### Restricted Electives

- **8.07** Relativity, 12; Physics I (GIR), Calculus II (GIR)
- **8.08** Quantum Physics II, 12; 8.05
- **8.09** Quantum Physics III, 12; 8.05, 8.13
- **8.13** Experimental Physics I, 18, LAB, CI-M; 8.04
- **8.14** Experimental Physics II, 18, LAB; 8.05, 8.13
- **8.223** Classical Mechanics II, 6; Physics I (GIR), Calculus II (GIR)
- **8.09** Quantum Physics III, 12; 8.05, 8.13
- **8.044** Statistical Physics I, 12; 8.03, 18.03

### Departmental Program Units That Also Satisfy the GIRs

- **(24–36)**

### Unrestricted Electives

- **48–87**

**Total Units Beyond the GIRs Required for SB Degree**: 180–186

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### Notes

*Alternate prerequisites and corequisites are listed in the subject description.

**A thesis of 12 units is required. Not more than 30 units of thesis credit may be included in the minimum of 180 units beyond the General Institute Requirements required for the SB degree.

**Subject descriptions identify subjects that cannot be used for this purpose.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
9.00 Introduction to Psychology
Prereq: None
U (Spring)
4-0-8 HASS-S (HASS-E)
Credit cannot also be received for SP.318
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: Physics II (GIR) or permission of instructor
U (Fall)
4-0-8 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. Linden, M. Bear, H. S. Seung

9.011 Systems Neuroscience
Prereq: Permission of instructor
G (Fall)
6-0-12
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.
E. K. Miller, M. Wilson

9.012 Cognitive Science
Prereq: Permission of instructor
G (Spring)
6-0-12
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

9.013J Molecular and Cellular Neuroscience Core II
(Same subject as 7.68J)
Prereq: Permission of instructor
G (Spring)
3-0-9
Survey and primary literature review of major areas in molecular and cellular neurobiology. Covers neurotrophin signaling and cell survival, neuronal and homeostatic plasticity, basic circuit formation and molecular features of sensory processing, and neurological/psychiatric disease mechanisms. Includes lectures and exams, and involves presentation and discussion of primary literature. 9.015 recommended, though the core subjects can be taken in any sequence.
M. Constantine-Paton, Y. Lin, L.-H. Tsai

9.015J Molecular and Cellular Neuroscience Core I
(Same subject as 7.65J)
Prereq: None
G (Fall)
3-0-9
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 exam, together with presentation and discussion of primary literature.
J. T. Littleton, W. Xu, G. Feng, H. Sive

9.02 Systems Neuroscience Laboratory
Prereq: 9.01
U (Spring)
2-4-6 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 ways these techniques are used to study nervous system function. Training provided in the art of scientific writing with feedback designed to improve writing skills. Assignments include weekly preparation for lab sessions, two major lab reports and a series of basic computer programming tutorials (MATLAB). Involves the use of experimental animals. Enrollment limited.
J. J. DiCarlo

9.03 Neural Basis of Learning and Memory
Prereq: 9.01
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9
Highlights the interplay between cellular and molecular storage mechanisms and the cognitive neuroscience of memory. Emphasis on human and animal models of hippocampal mechanisms and function. Lectures and discussion of papers.
M. Wilson, S. Corkin

9.036 The Visual System
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6
Studies the organization of the mammalian visual system and the manner in which shape, color, texture, motion, and depth are processed.
P. H. Schiller

9.04 Neural Basis of Vision and Audition
Prereq: 9.01 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9
Examines the neural bases of visual and auditory processing for perception and sensorimotor
control. Focuses on physiological and anatomical studies of the mammalian nervous system as well as behavioral studies of animals and humans. Studies visual pattern, color and depth perception, auditory responses and speech coding, and spatial localization.

P. H. Schiller, M. C. Brown

9.044J Brain Mechanisms for Hearing and Speech
(Same subject as HST.722J)
Prereq: HST.723 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject HST.722J.
M. C. Brown, B. Delgutte, F. Guenther, J. Melcher

9.05 Neural Basis of Movement
Prereq: 9.01 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
Surveys general principles and specific examples of motor control in biological systems. Emphasizes the neural mechanisms underlying different aspects of movement and movement planning. Covers sensory reception, reflex arcs, spinal cord organization, pattern generators, muscle function, locomotion, eye movement, and cognitive aspects of motor control. Functions of central motor structures, including cerebellum, basal ganglia, and cerebral cortex. Cortical plasticity, motor learning and computational approaches to motor control, and motor disorders are discussed.

Staff

9.07 Statistics for Brain and Cognitive Science
Prereq: Calculus II (GIR) or permission of instructor
U (Fall)
4-0-8
Provides students with the basic tools for analyzing experimental data, properly interpreting statistical reports in the literature, and reasoning under uncertain situations. Topics cover three 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

9.073J Statistics for Neuroscience Research
(Same subject as HST.460J)
Prereq: 9.07 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9
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

9.09J Cellular Neurobiology
(Same subject as 7.29J)
Prereq: 7.05
U (Spring)
4-0-8
See description under subject 7.29J.
W. G. Quinn, J. T. Littleton

9.10 Behavioral Neuroscience
Prereq: 9.01
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9
Explores the cognitive and neural processes that support attention, vision, language, motor control, navigation, and memory. Introduces basic neuroanatomy, functional imaging techniques, and behavioral measures of cognition. Discusses methods by which inferences about the brain bases of cognition are made. Considers evidence from human and animal models. Students prepare presentations summarizing journal articles.

R. Desimone, E. K. Miller

9.12 Experimental Molecular Neurobiology
Prereq: 9.01, Biology (GIR)
U (Fall)
2-4-6 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 tissue culture of neuronal cell lines, dissection and culture of brain cells, DNA manipulation, synaptic protein analysis, immunocyto-
9.161 Cellular Neurophysiology  
Prereq: 9.011 or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  

Surveys the mechanisms of neuronal communication. Covers ion channels in excitable membrane, single cell computation, synaptic transmission, and synaptic plasticity. Correlates the properties of ion channels and synaptic transmission with their physiological function. Discusses the organizational principles for the formation of functional neural networks at synaptic and cellular levels. Involves discussion of primary literature. Juniors and seniors require instructor's permission.  

Staff  

9.173J Noninvasive Imaging in Biology and Medicine  
(Same subject as 20.483J, 22.56J, HST.561J)  
Prereq: 18.03, 8.03, or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 22.56J.  
A. Jasanoff  

9.18 Developmental Neurobiology  
(Subject meets with 7.69, 9.181J)  
Prereq: 9.01, 7.03, 7.05, or permission of instructor  
Acad Year 2011–2012: U (Spring)  
Acad Year 2012–2013: Not offered  
4-0-8  

9.181J Developmental Neurobiology  
(Subject meets as 7.69)  
(Subject meets with 9.18)  
Prereq: 9.011 or permission of instructor  
Acad Year 2011–2012: G (Spring)  
Acad Year 2012–2013: Not offered  
4-0-8 H-LEVEL Grad Credit  

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 graduate credit. Additional readings required for graduate credit.  
E. Nedivi  

9.20 Animal Behavior  
Prereq: 9.00 or permission of instructor  
U (Fall)  
3-0-9 HASS-S (HASS-E)  

Evolution of behavior, the driver of nervous system evolution, is reviewed emphasizing concepts developed in ethology and sociobiology. Examines foraging and feeding, defensive and aggressive behavior, courtship and reproduction, migration and navigation, and various social activities and communication. Students consider the contributions of inherited patterns and cognitive abilities as well as the roles of various types of plasticity. Both field and laboratory studies are reviewed; human behavior is considered in the context of primate studies.  
G. E. Schneider  

9.210 Advanced Topics in Neurochemistry and Neuropharmacology (New)  
Prereq: 9.150 or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-6  

Analyzes in detail developing topics in neurochemistry and neuropharmacology; focus varies by term. Students must be familiar with amino acid neurotransmitters, the loci, syntheses, modes of inactivation, receptors, and physiologic actions of the main monoamine. Open to juniors and seniors with permission of instructor.  
R. J. Wurtman  

9.22J A Clinical Approach to the Human Brain  
(Same subject as HST.422J)  
Prereq: None  
Acad Year 2011–2012: U (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9  

Introduction to normal and abnormal human brain functioning, including the cellular basis of activity-dependent development, critical periods, and plasticity of the brain through learning; neurotransmitters and emotional disorders; fMRI studies of vision, language, dyslexia, motor function, pain, placebo effects, and emotional states. Implications for education, prevention of dementia and dyslexia. Limited to 25.  
T. N. Byrne  

9.24J Diseases of the Nervous System  
(Same subject as HST.424J)  
Prereq: 9.01  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Spring)  
3-0-9  

Topics examined include regional functional anatomy of the CNS through imaging and stroke; degenerative diseases such as Parkinson's and Alzheimer's; immunological disorders such as multiple sclerosis and paraneoplastic syndromes; epilepsy; and gliomas. Emphasis on diseases for which a molecular mechanism is understood. Clinical and pathological findings, differential diagnosis, genetics, pathophysiology, and treatment are discussed for individual diseases. Limited to 25.  
T. N. Byrne  

9.272J Topics in Neural Signal Processing  
(Same subject as HST.576J)  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9  

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. Alternate years.  
E. N. Brown  

9.285J Neural Coding and Perception of Sound  
(Same subject as HST.723J)  
Prereq: Permission of instructor  
G (Spring)  
3-1-8 H-LEVEL Grad Credit  
See description under subject HST.723J.  

9.29J Introduction to Computational Neuroscience  
(Same subject as 8.261J)  
Prereq: 18.03, Physics II (GIR); or permission of instructor  
U (Fall)  
3-0-9  

Mathematical introduction to the biophysics and circuits underlying neural computation. Topics include neuronal excitability, dendrites and cable theory, models of synaptic transmission, single-neuron dynamics, oscillators and sequence generation, and computation and dynamics in simple neuronal networks. Concepts applied to simple computing circuits in the behaving animal.  
M. Fee
9.301J Neural Plasticity in Learning and Memory
(Same subject as 7.98J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
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, W. Quinn

9.31 Cell and Systems Neurophysiology
Prereq: 9.01
U (Fall)
4-0-8
Surveys the mechanisms supporting plasticity in neurons, focusing on how it contributes to learning in several systems. Examines cellular forms of associative plasticity, including long-term potentiation and depression, metaplasticity, homeostatic plasticity, and depotentiation. Relates these phenomena to associative memory in animal systems and humans. Completion of 9.09 recommended.
K. Goosens

9.322J Genetic Methods in Neurobiology
(Same subject as 7.67J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Presents selected topics in which genetic analysis informs neurobiological issues, including action potential conduction and synaptic release in Drosophila, axon guidance in nematodes and Drosophila, olfaction and orienting behavior in nematodes. Studies hippocampal and cortical circuitry and function in mice, as well as genetically-determined and genetically-influenced human traits and diseases. Reviews methods such as mutagenesis, gene knockouts and transgene constructs, tissue-specific expression vectors, optically, chemically and thermally-inducible gene activation and inactivation.
W. G. Quinn

9.34 Sensory and Social Orders
(Same subject as MAS.234J)
Prereq: 9.00 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-6
Explores how sensory and social systems engage in a variety of similar decision-making processes. Examines the use of partial orderings of alternative choices (or models) in interpreting available data, and how both use constraints to relate and narrow the choice options. Examples show how maximum likelihood equilibria depend upon context. Coverage includes important aspects of perception and cognition, decision-making in social systems, and elementary game theory.
W. A. Richards

9.35 Sensation and Perception
Prereq: Physics II (GIR), Calculus II (GIR); or permission of instructor
U (Spring)
4-0-8
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 determine what’s out there in the world. Discusses all the senses, with emphasis on vision. Topics include perception of color, motion, form, and depth. Homework problems involve MATLAB.
P. Sinha

9.37J Anigrafs
(Same subject as MAS.881J)
Prereq: 9.34 or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-6
Many complex systems can be represented as a society of agents who aggregate information to reach a collective decision. An Anigraf makes explicit how one agent’s knowledge is related to another’s, and how the form of these relationships affects the social choice. Simulations are used to discover emergent properties of different Anigraf models. Topics include elementary graph theory, network designs, partial orders, voting strategies, coordination games, and dynamics of choice. Applied examples taken from insect societies, neural networks, studies of co-evolution, cognition, and group decision-making.
W. A. Richards

9.41 Research and Communication in Neuroscience and Cognitive Science
Prereq: 9.URG, permission of instructor
U (Fall)
2-12-4
Emphasizes research and scientific communication. Instruction and practice in written and oral communication provided. Based on 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 course. Other assignments include reading and 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.
S. Jhaveri, P. Sinha

9.422J Principles of Neuroengineering
(Same subject as 20.452J, MAS.881J)
Prereq: 8.03, 6.003, 9.01; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.881J.
E. S. Boyden, Ill

9.455J Neurotechnology Ventures
(Same subject as 15.128J, 20.454J, MAS.883J)
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
See description under subject MAS.883J.
E. S. Boyden, R. Ellis-Behnke, J. Bonsen
9.472J Neuroimaging Cells and Circuits
(Same subject as 20.472J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9
Offers an introduction to imaging methods at the forefront of modern neurobiology. Emphasis is placed on in vivo imaging in the context of neural systems research. Specific topics covered include classical optics, fluorescence and fluorescent dyes, multiphoton microscopy, reflectance-based imaging methods, functional and anatomical magnetic resonance imaging, and molecular neuroimaging. Both applications and underlying principles are discussed, and lectures are supplemented by demonstrations of imaging techniques in the laboratory. Limited to 15.
A. Jasnooff, P. T. So

9.48J Philosophical Issues in Brain Science
(Same subject as 24.08J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-D 2); CI-H
See description under subject 24.08J.
A. Byrne, P. Sinha

9.50 Research in Brain and Cognitive Sciences
(Same subject as 24.08J)
Prereq: 9.00 or permission of instructor
U (Fall, Spring)
0-12-0 Institute LAB
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 director of the Undergraduate Program. Written presentation of results is required.
Consult P. Sinha

9.520 Statistical Learning Theory and Applications
Prereq: 6.867, 6.041J, 18.06, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Focuses on the problem of supervised and unsupervised learning from the perspective of modern statistical learning theory, starting with the theory of multivariate function approxima-

9.56J Abnormal Language
(Same subject as 24.907J)
Prereq: 24.900 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
Can be repeated for credit
Introduction to the linguistic study of language pathology, concentrating on experimental approaches and theoretical explanations. Discussion of Specific Language Impairment, Down syndrome, William’s syndrome, autism, normal aging, Parkinson’s disease, Alzheimer’s disease, hemispherectomy, and aphasia. Focuses on the comparison of linguistic abilities among these syndromes, while drawing clear comparisons with first- and second-language acquisition. Topics include the lexicon, morphology, syntax, semantics, and pragmatics. Relates the lost linguistic abilities in these syndromes to properties of the brain.
K. Wexler

9.57J Language Acquisition
(Same subject as 24.904J)
Prereq: 24.900 or permission of instructor
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)
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.
K. Wexler

9.59] Psycholinguistics
(Same subject as 24.905J)
Prereq: 24.900 or permission of instructor or Coreq: 9.00
U (Spring)
3-0-9 HASS-S (HASS-E)
Examines central topics in language processing, such as the structure and processing of language at multiple levels of analysis, including phonetics, words, sentences, intonation and discourse. Also discusses language acquisition and the relationship between language and thought. Emphasis on quantitative methods to investigate language, including reading and listening paradigms, neural imaging and computational modeling.
E. Gibson

9.59J Language Processing
(Same subject as 24.945J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6
Seminar in real-time language comprehension focusing on models of sentence and discourse comprehension from linguistic, psychology and artificial intelligence literature, including symbolic and connectionist models. Topics include ambiguity resolution; linguistic complexity; the use of lexical, syntactic, semantic, pragmatic, contextual, and prosodic information in language comprehension; the relationship between the computational resources available in working memory and the language processing mechanism; and the psychological reality of linguistic representations.
E. Gibson

9.60J Language Acquisition I
(Same subject as 24.949J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
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.
K. Wexler
9.611J Natural Language and the Computer Representation of Knowledge
(Same subject as 6.863J)
Prereq: 6.034; Coreq: 9.00
G (Spring)
3-3-6 H-LEVEL Grad Credit
See description under subject 6.863J.
R. C. Berwick

9.63 Laboratory in Visual Cognition
(Same subject as 24.945J)
Prereq: 9.07; 9.00, 9.01, or permission of instructor
U (Fall)
3-2-7 Institute LAB
Teaches principles of experimental methods in human visual perception and attention, including how to design, conduct, analyze, and present experiments in visual cognition. Combines lectures and hands-on experimental exercises. Requires two experimental projects, at least one of which is conducted independently; the other may be done as part of a team. To foster improved writing and presentation skills in conducting and critiquing research in cognitive science, students are required to provide several individual reports on experimental designs, as well as to write articles and give oral presentations critiquing three team experiments observed in class. Experience with MATLAB is recommended. Limited to 16.
A. Oliva

9.641J Introduction to Neural Networks
(Same subject as 8.594J)
Prereq: 9.29 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
H. S. Seung

9.65 Cognitive Processes
Prereq: None. Coreq: 9.00
U (Spring)
3-0-9 HASS-S (HASS-E)
Introduction to human information processing and learning. Topics include the nature of mental representation and processing, memory and learning, pattern recognition, attention, imagery and mental codes, concepts and prototypes, and reasoning and problem-solving.
M. C. Potter

9.66 Computational Cognitive Science
(Same subject as 6.804J)
Prereq: 9.07, 18.05, 6.041, or permission of instructor
U (Fall)
3-0-9
9.660 Computational Cognitive Science
(Same subject meets with 6.804J, 9.66J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to computational theories of human cognition. Focuses on principles of inductive learning and inference, and the representation of knowledge. Computational frameworks include Bayesian and hierarchical Bayesian models, probabilistic graphical models, non-parametric 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 influence. Graduate students complete a final project.
J. Tenenbaum

9.675 The Development of Object and Face Recognition
(Same subject as 8.594J)
Prereq: 9.012 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Considers the developmental processes that potentially lead to the organization of ‘blooming, buzzing confusions’ into coherent visual objects. Examines key experimental results and computational proposals pertinent to the discovery of objects in complex visual inputs. Includes in-depth discussion of research articles. Limited to 15.
P. Sinha

9.68 Affect: Biological, Psychological, and Social Aspects of “Feelings”
Prereq: 9.00; Coreq: 9.00
U (Spring)
2-2-8 HASS-S (HASS-E)
Affect is to cognition and behavior as feeling is to thinking and acting or as values are to beliefs and practices. Considers these relations, both at the psychological level of organization and in terms of their neurobiological and sociocultural counterparts. In addition to attending weekly class sessions and doing regular homework assignments, students are required to participate in small study groups that meet for two hours per week.
S. L. Chorover

9.691 Introduction to Connectomics
(Same subject meets with 9.660)
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-6
Covers the emerging field of connectomics, with an emphasis on tools for high-throughput generation of data about neural connectivity. Topics include nanoscale imaging, including electron microscopy and sub-diffraction-limit fluorescence microscopy; nanoscale and microscale cutting; fluorescent and electron-dense staining; and image analysis algorithms. Case studies cover areas such as C. elegans, neuromuscular junction, retina, and cortex.
H. S. Seung

9.70 Social Psychology
(Same subject with 6.804J, 9.66J)
Prereq: None
U (Spring)
3-2-7 HASS-S (HASS-E)
Examines interpersonal and group dynamics, considers how the thoughts, feelings, and actions of individuals are influenced by (and influence) the beliefs, values, and practices of large and small groups. Learning occurs through a combination of in-class activities complemented by participation in small study groups and completion of regular homework assignments. Also involves occasional lectures and demonstrations.
S. L. Chorover

9.71 Functional MRI Investigations of the Human Brain
Prereq: 9.07; 9.34, 9.35, 9.65, 9.66, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
Covers design and interpretation of fMRI experiments, and the relationship between fMRI and other techniques. Focuses on localization of cognitive function in the human brain. Students write papers and give presentations, explain and critique published papers, and design but do not conduct their own fMRI experiments. Upon completion, students should be able to...
understand and critique published fMRI papers and have a good grasp of what is known about localization of cognitive function from fMRI. Limited to 12.

N. G. Kanwisher

7.75 Psychology of Gender and Race
(Same subject as WGS.228J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
Examines evidence (and lack thereof) regarding when and how an individual’s thoughts, feelings, and actions are affected by gender and race. Topics include gender and racial factors in identity development, cognition and emotion, achievement, stereotypes, physical and mental health, sexuality, close relationships, work, and violence. Limited to 20.

E. Adelson, A. Oliva

9.77 Computational Perception
(Subject meets with 9.777)
Prereq: 9.01, 9.00, 9.07; 9.65 or 9.35; or permission of instructor
U (Spring)
3-0-9
9.777 Computational Perception
(Subject meets with 9.77)
Prereq: Permission of instructor
G (Spring)
3-0-6
Begins with a review of the experimental paradigms, findings and theories used to evaluate the capabilities and limits of the human brain. Assesses how knowledge of human perception may be used to guide machine vision systems. Second part of the subject focuses on models in computational perception. Describes how computer vision systems, inspired by the human brain, can perform image analysis and synthesis; face, object and scene perception; texture synthesis, segmentation, and navigation. Introduces various simulation methods. A MATLAB-based project in computational perception is required. Students taking graduate version complete additional assignments. Enrollment in each subject limited to 8.

E. Adelson, A. Oliva

9.85 Infant and Early Childhood Cognition
Prereq: 9.00
U (Fall)
3-0-9 HASS-S (HASS-E)
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

9.91 Independent Study in Brain and Cognitive Sciences
Prereq: 9.00 and any other two subjects in Brain and Cognitive Sciences; 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
(Same subject as SP.650J)
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)
0-0-6 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Students submit written proposals for thesis according to stated deadlines.
Staff

9.551 Special Subject in Brain and Cognitive Sciences (9.51)
Prereq: 9.00 and any other two subjects in Brain and Cognitive Sciences
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

9.552 Special Subject in Brain and Cognitive Sciences (9.52)
Prereq: 9.00 and any other two subjects in Brain and Cognitive Sciences
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

9.5911 Special Subject in Brain and Cognitive Sciences (9.911)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Staff

9.5916 Special Subject in Brain and Cognitive Sciences (9.916)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Consult E. K. Miller or N. Kanwisher
9.5917 Special Subject in Brain and Cognitive Sciences (9.917)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Advanced graduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Staff

9.592 Special Subject in Brain and Cognitive Sciences (9.92)
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

9.593–9.598 Special Subject in Brain and Cognitive Sciences (9.93–9.98)
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit
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

9.599 Special Subject in Brain and Cognitive Sciences (9.99)
Prereq: None
U (IAP)
Units arranged [P/D/F]
Can be repeated for credit
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

9.79 Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.
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.
Consult 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
# Bachelor of Science in Brain and Cognitive Sciences

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by 9.00 and two other HASS subjects in the Departmental Program]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [one subject can be satisfied by 9.01 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by a laboratory in the Departmental Program]</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**

17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

*Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).*

### Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.00 Introduction to Psychology</td>
<td>126–132</td>
</tr>
<tr>
<td>9.01 Introduction to Neuroscience</td>
<td></td>
</tr>
<tr>
<td>9.07 Statistics for Brain and Cognitive Science</td>
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</tbody>
</table>

### Core Subjects

Choose six subjects from three areas: cognitive science, cognitive neuroscience, and neuroscience. Any combination of subjects is permitted, but at least one subject must be chosen in a second area.

#### Cognitive Science

- 9.34 Sensory and Social Orders, 9; 9.00*
- 9.37 Anigrafs, 9; 9.34*
- 9.56 Abnormal Language, 12; 24.900*
- 9.57 Language Acquisition, 12, HASS-S; 24.900*
- 9.59 Psycholinguistics, 12, HASS-S; 24.900* or 9.00
- 9.61 Cognitive Processes, 12, HASS-S; 9.00
- 9.63 Computational Cognitive Science, 12; 9.07*
- 9.85 Infant and Early Childhood Cognition, 12, HASS-S, CI-M; 9.00
- 24.900 Introduction to Linguistics, 12, HASS-S†, CI-H

#### Cognitive Neuroscience

- 9.10 Behavioral Neuroscience, 12; 9.01
- 9.20 Animal Behavior, 12, HASS-S; 9.00*
- 9.23 A Clinical Approach to the Human Brain, 12
- 9.35 Sensation and Perception, 12; Physics II (GIR), Calculus II (GIR); or permission of instructor
- 9.71 Functional MRI Investigations of the Human Brain, 12, CI-M; 9.07; 9.34*

#### Neuroscience

- 9.03 Neural Basis of Learning and Memory, 12; 9.01
- 9.04 Neural Basis of Vision and Audition, 12; 9.01*
- 9.05 Neural Basis of Movement, 12; 9.01*
- 9.09 Cellular Neurobiology, 12; 7.05
- 9.14 Brain Structure and Its Origins, 12, 9.01
- 9.15 Biochemistry and Pharmacology of Synaptic Transmission, 12; 9.01*
- 9.18 Developmental Neurobiology, 12, CI-M; 9.01*
- 9.22 Diseases of the Nervous System, 12; 9.01
- 9.29 Introduction to Computational Neuroscience, 12; 18.03, Physics II (GIR); or permission of instructor
- 9.31 Cell and Systems Neurophysiology, 12; 9.01

### Laboratory

One of the following is required:

- 9.02 Systems Neuroscience Laboratory, 12, LAB, CI-M; 9.01
- 9.12 Experimental Molecular Neurobiology, 12, LAB, CI-M; 9.01, Biology (GIR)
- 9.63 Laboratory in Visual Cognition, 12, LAB, CI-M; 9.07; 9.00*

**plus one of the following:**

- 9.URG Undergraduate Research, 12
- 9.02 Systems Neuroscience Laboratory, 12, LAB, CI-M; 9.01
- 9.12 Experimental Molecular Neurobiology, 12, LAB, CI-M; 9.01, Biology (GIR)
- 9.41 Research and Communication in Neuroscience and Cognitive Science, 18, CI-M; 9.URG, permission of instructor
- 9.50 Research in Brain and Cognitive Sciences, 12, LAB; 9.00*
- 9.63 Laboratory in Visual Cognition, 12, LAB, CI-M; 9.07; 9.00*
<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th>21–24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two relevant subjects to be arranged with the student’s advisor.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(36–45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives (1)</td>
<td>60–69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Units Beyond the GIRs Required for SB Degree</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td>No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.</td>
<td></td>
</tr>
</tbody>
</table>

Notes

*Alternate prerequisites are listed in the subject description
† Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.

(i) Additional elective units may be available to the extent the General Institute Requirements are fulfilled by subjects taken in the department program.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
10.04J A Philosophical History of Energy
(Same subject as 24.114J, CC.114J)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E); CI-H
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, L. D. Perlman

10.10 Introduction to Chemical Engineering
Prereq: Chemistry (GIR), Physics I (GIR), Calculus I (GIR)
U (Fall, Spring)
4-0-8
The diverse applications of chemical engineering are explored through example problems. Solutions require application of fundamental concepts of mass and energy conservation to batch and continuous systems, involving chemical and biological processes. Computer skills and the elements of engineering design are taught in the context of these example problems. The objective is to acquaint the student with the field of chemical engineering and to enable use of computer methods to solve chemical and biological engineering problems.

10.191J Projects in Energy
(Same subject as 5.92J)
Prereq: Permission of instructor
U (Spring)
3-2-4
See description under subject 5.92J.
Staff

10.213 Chemical and Biological Engineering Thermodynamics
Prereq: 5.60, 10.10
U (Spring)
4-0-8
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, N. Maheshri, A. S. Myerson

10.22 Molecular Engineering
Prereq: 5.60, 10.213
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
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, 10.37
G (Fall)
3-0-6 H-LEVEL Grad Credit
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: 2.671, 3.014, 5.310, 7.02, 12.335, or 1.106 and 1.107; 10.302; or permission of instructor
U (Spring)
3-8-4
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 research planning and project management, execution of experimental work, data analysis, oral presentation skills and individual report writing, and team-building.

10.27 Energy Engineering Projects Laboratory
(Subject meets with 10.26, 10.29)
Prereq: 2.671, 3.014, 5.310, 7.02, 12.335, or 1.106 and 1.107; 10.302; or permission of instructor
U (Spring)
3-8-4
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 research planning and project management, execution of experimental work, data analysis, oral presentation skills and technical report writing, and team-building. Projects consider social science issues in addition to technical issues. Intended for students with diverse technical backgrounds. Preference to Energy Studies minors.

10.28 Chemical-Biological Engineering Laboratory
Prereq: 5.310, 7.02, or 10.702; 7.05 or 5.07; or permission of instructor
U (Fall)
2-8-5
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 mod-
ules 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. Enrollment limited.

J.-F. Hamel and K. J. Prather

10.29 Biological Engineering Projects Laboratory
(Subject meets with 10.26, 10.27)
Prereq: 2.671, 3.014, 5.310, 7.02, 12.335, or 1.106 and 1.107; 10.302; or permission of instructor
U (Spring)
3-8-4
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 research planning and project management, execution of experimental work, data analysis, oral presentation skills and report writing, and team-building.


10.291J Introduction to Sustainable Energy
Prereq: Permission of instructor
U (Fall)
3-1-8
See description under subject 22.081J.

M. W. Golay

10.301 Fluid Mechanics
Prereq: 18.03, 10.10
U (Spring)
4-0-8 REST

W. M. Deen, A. K. Chakraborty

10.302 Transport Processes
Prereq: 5.60, 10.301, 10.213; or permission of instructor
U (Fall)
4-0-8
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.

W. H. Dalzell, T. A. Hatton

10.32 Separation Processes
Prereq: 10.213, 10.302
U (Spring)
2-0-4
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.

W. H. Dalzell

10.33 Introduction to Modeling and Simulation Engineering School-Wide Elective Subject
(Offered under: 1.021, 3.021, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 REST
See description under subject 3.021.

M. Buehler, J. Grossman

10.34 Numerical Methods Applied to Chemical Engineering
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
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, P. I. Barton

10.37 Chemical Kinetics and Reactor Design
Prereq: 5.60, 10.301
U (Spring)
3-0-6
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, K. D. Wittrup, W. H. Green

10.391J Sustainable Energy
(Same subject as 1.818J, 2.651J, 11.371J, 22.811J, ESD.166J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 22.811J.

M. W. Golay

10.392J Fundamentals of Advanced Energy Conversion
(Same subject as 2.621J, 3.641J, 22.401J)
Prereq: 2.006, 3.044, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 2.621J.

A. F. Ghoniem, M. Kazimi, Y. Chiang

10.40 Chemical Engineering Thermodynamics
Prereq: 5.60, 10.213
G (Fall)
4-0-8 H-LEVEL Grad Credit
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. Blankshtein, A. K. Chakraborty, B. D. Olsen
10.420 Molecular Aspects of Chemical Engineering
(Subject meets with 10.520)
Prereq: 5.13, 10.213
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-6
Molecular-level engineering and analysis of chemical processes. Use of chemical bonding, reactivity, and other key concepts in the design and tailoring of organic systems. Application and development of structure-property relationships. Descriptions of the chemical forces and structural factors that govern supramolecular and interfacial phenomena for molecular and polymeric systems. Students taking the graduate version complete different assignments.

P. T. Hammond

10.424 Pharmaceutical Engineering (New)
(Subject meets with 10.524)
Prereq: 10.213
U (Fall)
3-0-6
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 (New)
(Subject meets with 10.626)
Prereq: 10.302 or permission of instructor
U (Spring)
3-0-9
Introduces principles and mathematical models of electrochemical energy conversion and storage. Studies equivalent circuits, thermodynamics, reaction kinetics, transport phenomena, electrostatics, porous media, and phase transformations. Includes applications to batteries, fuel cells, supercapacitors, and electrokinetics. Students taking graduate version complete additional assignments.

M. Z. Bazant

10.43 Introduction to Interfacial Phenomena
Prereq: 10.213 or introductory subject in thermodynamics or physical chemistry
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: 6 (Spring)
3-0-6 H-LEVEL Grad Credit

D. Blankschtein

10.441J Molecular and Engineering Aspects of Biotechnology
(Same subject as 7.37J, 20.361J)
Prereq: 2.005, 3.012, 5.60, 20.110, or 20.111; 7.06; or permission of instructor
U (Spring)
4-0-8
See description under subject 7.37J.

H. Lodish, D. Lauffenburger

10.444 Frontiers in Therapeutics and Drug Delivery (New)
(Subject meets with 10.644)
Prereq: 7.05 or permission of instructor
U (Fall)
3-0-6
Provides an introduction to pharmaceutics and conventional oral, injected, transdermal and inhalated 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

10.450 Process Dynamics, Operations, and Control
Prereq: 10.302, 18.03
U (Spring)
3-0-6
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

10.467 Polymer Science Laboratory
Prereq: 5.12, 5.310
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
2-7-6 Institute LAB
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.

P. T. Hammond, G. C. Rutledge, J. C. Love

10.490 Integrated Chemical Engineering I
Prereq: 10.37
U (Fall; first half of term)
3-0-5
10.491 Integrated Chemical Engineering II
Prereq: 10.490
U (Spring; first half of term)
3-0-5
Presents and solves chemical engineering problems in an industrial context, with applications varying by term. Emphasis on the integration of fundamental concepts with approaches of process design. Emphasis on problems that demand synthesis, economic analysis, and process design.

P. I. Barton, B. S. Johnston
10.492 Integrated Chemical Engineering Topics I
Prereq: 10.301 and permission of instructor
U (Fall; second half of term)
2-0-2

10.493 Integrated Chemical Engineering Topics II
Prereq: 10.301 and permission of instructor
U (IAP)
2-0-2

10.494 Integrated Chemical Engineering Topics III
Prereq: 10.301 and permission of instructor
U (Spring; second half of term)
2-0-2

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.


10.495 Molecular Design and Bioprocess Development of Immunotherapies
(Subject meets with 10.595)
Prereq: 7.06 or permission of instructor
U (Spring)
3-0-6

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

10.499J Tissue Engineering for Analysis, Prevention, and Treatment of Human Disease
(Same subject as 20.360J)
Prereq: 5.07 or 7.05; 7.03; 18.03; 20.110 or 5.60
U (Spring)
3-0-6

See description under subject 20.360J.

Staff

10.50 Analysis of Transport Phenomena
Prereq: 10.301, 10.302
G (Fall)
4-0-8 H-LEVEL Grad Credit

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, P. S. Doyle, M. Z. Bazant

10.52 Mechanics of Fluids
Prereq: 10.50
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6 H-LEVEL Grad Credit

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

10.520 Molecular Aspects of Chemical Engineering
(Subject meets with 10.420)
Prereq: 5.13, 10.213
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 10.420.

P. T. Hammond

10.524 Pharmaceutical Engineering (New)
(Subject meets with 10.424)
Prereq: None
G (Fall)
3-0-6

See description under subject 10.424.

A. S. Myerson

10.531J Macromolecular Hydrodynamics
(Same subject as 2.341J)
Prereq: 2.25, 10.301, or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit


R. C. Armstrong, G. H. McKinley

10.536J Thermal Hydraulics in Power Technology
(Same subject as 2.59J, 22.313J)
Prereq: 2.006, 10.302, 22.312, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-2-7 H-LEVEL Grad Credit

See description under subject 22.313J.

N. E. Todreas, M. Podowski

10.537J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.798J, 3.971J, 6.524J, 20.410J)
Prereq: Biology (GR): 2.002, 2.006, 6.013, 10.301, or 10.302
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 20.410J.

R. D. Kamm, K. Van Vliet

10.538J Biomolecular Kinetics and Cellular Dynamics
(Same subject as 20.420)
Prereq: 7.05, 7.06, 18.03
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 20.420J.

K. D. Wittrup, B. Tidor
10.539J Fields, Forces, and Flows in Biological Systems
(Same subject as 2.795S, 6.561J, 20.430J, HST.544J)
Prereq: 6.013, 2.005, 10.302, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.430J.
M. Bathe, A. J. Grodzinski

10.540 Intracellular Dynamics
Prereq: 18.03, 7.06, 10.302, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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

10.541 Kinetics of Biological and Chemical Systems
Prereq: 10.37 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
6-0-6 H-LEVEL Grad Credit
Comprehensive treatment of the kinetics of basic chemical reactions and biological processes. Subject begins with a fundamental analysis of reaction order in homogeneous reactions and proceeds with the kinetics of heterogeneous systems and catalytic reactions. Methods of measuring and calculating reaction rate constants included. After a basic stoichiometric analysis of biological reaction networks, the subject discusses kinetics of enzymatic reactions and extensions to kinetic characteristics of reaction pathways and bioreaction networks. Similarities and differences between chemical and biological kinetics discussed along with concepts of rate-limiting steps and distribution of control among several reactions in a pathway. Subject concludes with applications to the kinetic analysis of chemical and biological reaction systems in the chemical and bioprocess industries.
B. L. Trout, G. Stephanopoulos

10.542 Biochemical Engineering
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit
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

10.543J Protein Folding and Human Disease
(Same subject as 5.48J, 7.88J)
Prereq: 7.51 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 7.88J.
S. Lindquist, J. A. King

10.544 Metabolic and Cell Engineering
Prereq: 5.60, 7.05, 10.302, 18.03
G (Fall)
3-0-6 H-LEVEL Grad Credit
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

10.546J Statistical Thermodynamics
(Same subject as 5.70J)
Prereq: 5.60 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 5.70J.
A. K. Chakraborty, J. M. Deutch

10.547J Principles and Practice of Drug Development
(Same subject as 7.547J, 15.136J, ESD.691J, HST.920J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

10.548J Tumor Pathophysiology and Transport Phenomena: A Systems Biology Approach
(Same subject as HST.525J)
Prereq: 18.03; 10.301
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
2-0-4 H-LEVEL Grad Credit
See description under subject HST.525J.
R. K. Jain

10.55 Colloid and Surfactant Science
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit
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, 10.37
G (Spring)
3-0-6 H-LEVEL Grad Credit
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.
Geo. Stephanopoulos, P. I. Barton
10.552 Advanced Systems Engineering (New)  
Prereq: None  
G (Fall)  
3-0-6  
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. Limited to 30.  
R. D. Braatz

10.555J Bioinformatics: Principles, Methods and Applications (New)  
(Same subject as HST.940J)  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
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, 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 H-LEVEL Grad Credit  
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

10.560 Structure and Properties of Polymers  
Prereq: 10.213 or permission of instructor  
G (Spring)  
3-0-6 H-LEVEL Grad Credit  
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

10.568 Physical Chemistry of Polymers  
Prereq: 5.60, 10.213, or 10.40  
G (Fall)  
3-0-6 H-LEVEL Grad Credit  
Chain macromolecules as random coils (unperturbed, expanded) and as other shapes. Statistical thermodynamics of interpenetrating random coiling polymers in solution with application to phase separations, swelling of networks, depression of melting point. The isolated chain molecule in dilute solutions analyzed for mass or size by static methods (osmometry, light scattering, neutron scattering) and by dynamic methods (intrinsic viscosity, size exclusion chromatography, sedimentation). Introduction to chain dynamics and to rubber elasticity.  
R. E. Cohen

10.569 Synthesis of Polymers  
Prereq: 5.12  
G (Spring)  
3-0-6 H-LEVEL Grad Credit  
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

10.571J Atmospheric Physics and Chemistry  
(Same subject as 12.806J)  
(Subject meets with 12.306)  
Prereq: 5.61, 18.075, or permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 12.806J.  
R. G. Prinn

10.579 Applications of Technology in Energy and the Environment  
Engineering School-Wide Elective Subject  
(Offered under: 1.149, 2.63, 5.00, 22.813, ESD.174)  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 22.813.  
J. Deutch, R. Lester

10.580 Solid-State Surface Science  
Prereq: 10.213  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-6 H-LEVEL Grad Credit  
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: 10.302, 10.213, or permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
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
10.591 Case Studies in Bioengineering
Prereq: Biology (GIR) or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6 H-LEVEL Grad Credit
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)
3-0-6 H-LEVEL Grad Credit
See description under subject 10.495.
J. C. Love

10.625J Electrochemical Energy Conversion and Storage: Fundamentals, Materials and Applications
(Same subject as 2.625J)
Prereq: 3.53, 2.005, 3.046, 10.40, or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 2.625J.
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 H-LEVEL Grad Credit
See description under subject 10.426.
M. Z. Bazant

10.631 Structural Theories of Polymer Fluid Mechanics
Prereq: 10.301
G (Spring)
3-0-6 H-LEVEL Grad Credit
R. C. Armstrong

10.644 Frontiers in Therapeutics and Drug Delivery (New)
(Subject meets with 10.444)
Prereq: 7.05 or permission of instructor
G (Fall)
3-0-6
See description under subject 10.444.
D. G. Anderson

10.65 Chemical Reactor Engineering
Prereq: 10.37 or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
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 biochemical 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, H. D. Sikes

10.652J Kinetics of Chemical Reactions
(Same subject as 5.68J)
Prereq: 5.62, 10.37, or 10.65
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 5.68J.
W. H. Green

10.668J Statistical Mechanics of Polymers
(Same subject as 3.941)
Prereq: 10.568 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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, P. S. Doyle

10.702J Introduction to Experimental Biology and Communication
(Same subject as 7.02J)
Prereq: Biology (GIR)
U (Fall, Spring)
4-8-6 Institute LAB
See description under subject 7.02J.
Fall: L. Boyer, W. Gilbert, D. Wittrup
Spring: P. Chang, T. Schwartz, D. Wittrup

10.74J Radiative Transfer
(Same subject as 2.58J)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
See description under subject 2.58J.
G. Chen

10.792J Global Operations Leadership Seminar
(Same subject as 2.890J, 15.792J, 16.985J)
Prereq: None
Fall: L. Boyer, W. Gilbert, D. Wittrup
Spring: P. Chang, T. Schwartz, D. Wittrup
Can be repeated for credit
Units arranged [P/D/F]
See description under subject 2.890J, 15.792J, 16.985J

10.805J Technology, Law, and the Working Environment
(Same subject as ESD.136J)
(Subject meets with 1.802J, 1.812J, 11.022J, 11.631J, ESD.134J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
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. Caltab
10.806 Management in Engineering  
Engineering School-Wide Elective Subject  
(Offered under: 2.96, 6.930, 16.653)  
Prereq: None  
U (Fall)  
3-1-8  
See description under subject 2.96.  
H. S. Marcus

10.807J Innovation Teams  
(Same subject as 15.371J)  
Prereq: 15.911 or permission of instructor  
G (Fall, Spring)  
4-4-4  
Students work in teams to develop commercialization strategies for innovative research projects generated in MIT laboratories. Projects cover critical aspects of commercialization, from selecting the target application and market for the technology to developing an intellectual property strategy and performing a competitive analysis. Instruction provided in communication and teamwork skills, as well as analysis of the challenges and benefits of technology transfer. Includes lectures, guest speakers, and extensive team coaching. Designed primarily for students in engineering, science, and management. Applications, resumes, and a brief statement of interest are required prior to registration.  
F. Murray, L. Perez-Breva

10.808 (10.82, 10.84, 10.86) School of Chemical Engineering Practice—Technical Accomplishment  
Prereq: Permission of instructor, 10.81 (10.83)  
G (Fall, Spring, Summer)  
0-6-0 H-LEVEL Grad Credit  
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

10.816 Engineering Risk-Benefit Analysis  
Engineering School-Wide Elective Subject  
(Offered under: 1.155, 2.963, 6.938, 16.862, ESD.72)  
Prereq: Calculus II (GIR)  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject ESD.72.  
G. Apostolakis

10.817J Atmospheric Chemistry  
(Same subject as 1.84J, 12.807J)  
Prereq: 5.60  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 1.84J.  
J. H. Kroll

SCHOOL OF CHEMICAL ENGINEERING PRACTICE

10.810 (10.83, 10.85, 10.87) School of Chemical Engineering Practice—Communication Skills and Human Relations  
Prereq: Permission of instructor, 10.80  
G (Fall, Spring, Summer)  
0-6-0 H-LEVEL Grad Credit  
Conducted at industrial field stations of the School of Chemical Engineering Practice. Group problem assignments include communication skills and human relations in group assignments. 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

10.910 Independent Research Problem  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit

10.911 Independent Research Problem  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit  
For undergraduates who wish to do a special investigation or special topic in a particular field. Topic and hours arranged.  
B. S. Johnston

10.953 Seminar in Heterogeneous Catalysis  
Prereq: None  
G (Fall, Spring)  
2-0-4 [P/D/F]  
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

10.960J Student Seminar in Polymer Science and Technology  
(Same subject as 3.903J)  
Prereq: None  
G (Fall, Spring)  
2-0-0 [P/D/F]  
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.  

10.961 Seminar in Advanced Air Pollution Research  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 [P/D/F]  
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

GENERAL

10.90 Independent Research Problem  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
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.  
W. M. Deen
10.962 Seminar in Molecular Cell Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
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 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

10.963 Research, Technology and Business Development in the Chemical Processing Industries
Prereq: None
G (Spring)
2-0-4 [P/D/F]
Structure of CPI; mission, structure and management of R&D organizations; basic research-technology platforms-business creation; measuring R&D effectiveness; road-mapping: linking business and R&D strategies and plans; integrating R&D with marketing: the product-centered companies; IP strategies and portfolio of R&D projects; stage-gate processes: planning, implementing, monitoring, assessing, and controlling R&D projects; Six-Sigma for Research; R&D proposals and projects; the engineering approach to the execution of R&D projects; R&D and the globalization of CPI; creating and leveraging knowledge-assets; from discovery to the creation of business value; R&D in various segments of the CPI.
Geo. Stephanopoulos

10.964 Seminar on Transport Theory
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
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
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 [P/D/F]
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 therapies for diabetes.
D. G. Olsen

10.967 Seminar in Protein-Polymer Materials Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
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: None
G (Fall, Spring)
2-0-4 [P/D/F]
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 [P/D/F]
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 [P/D/F]
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 [P/D/F]
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

10.972 Biochemical Engineering Research Seminar
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
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 [P/D/F]  
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, W. M. Deen

**10.974 Seminar in Chemical Engineering Nanotechnology**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 [P/D/F]  
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 [P/D/F]  
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 [P/D/F]  
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

**10.981 Seminar in Colloid and Interface Science**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 [P/D/F]  
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 [P/D/F]  
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 [P/D/F]  
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 [P/D/F]  
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 Seminar in Materials Systems Engineering**  
Prereq: Permission of instructor  
G (Fall, Spring)  
2-0-4 [P/D/F]  
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 micro-structured 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 [P/D/F]  
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 [P/D/F]  
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 [P/D/F]  
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.  
K. F. Jensen, W. M. Deen

**10.995 Introduction to Research in Biotechnology**  
Prereq: None  
G (Fall)  
2-4-0 [P/D/F]  
Introduction to research in biotechnology by faculty of biotechnology department. Focus is on recent developments and research projects available to new graduate students.  
K. F. Jensen, W. M. Deen
10.991 Seminar in Chemical Engineering
Prereq: Permission of instructor
G (Fall)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

10.992 Seminar in Chemical Engineering
Prereq: Permission of instructor
G (Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
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 [P/D/F]
Can be repeated for credit
Presentations and discussion by graduate students, postdoctoral fellows, and visiting scientists on 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 [P/D/F]
Can be repeated for credit
Graduate students, postdoctoral fellows, and visiting scientists 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, N. Maheshri

10.996 Seminar in Cellular Engineering
Prereq: Permission of Instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Presentations and discussion by graduate students, postdoctoral fellows and visiting scientists on current literature and topics in the field of cellular engineering. Topics include the modeling and experimental validation of cell signaling and transcriptional regulation processes, the evolution of such processes, and engineering these processes in single cells for bioprocess applications.
N. Maheshri

10.997 Theoretical and Computational Immunology Seminar
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
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 [P/D/F]
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.CME Study at Cambridge University
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides credit for students studying at Cambridge University under the Cambridge-MIT Exchange program. Credit may be used to satisfy specific SB degree requirements by arrangement with the department.
B. S. Johnston

10.EPE UPOP Summer Practice Experience
Engineering School-Wide Elective Subject (Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 16.EPE, 22.EPE)
Prereq: 2.EPE or permission of instructor
U (Fall)
0-0-3 [P/D/F]
See description under subject 2.EPE.
S. Luperfoy

10.EPR UPOP Reflective Learning Experience
Engineering School-Wide Elective Subject (Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall)
3-0-0 [P/D/F]
See description under subject 2.EPR.
S. Luperfoy

10.594 Special Problems in Chemical Engineering (New)
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

10.595 Special Problems in Chemical Engineering (New)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit

10.S94 Special Problems in Chemical Engineering (New)
Prereq: Permission of instructor
U (IAP)
0-0-3 [P/D/F]
See description under subject 2.EPR.
S. Luperfoy

10.THU Undergraduate Thesis
Prereq: None
U (Fall, 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.
W. M. Deen

10.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.
W. M. Deen

10.THU Undergraduate Thesis
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Program of research leading to the writing of an SB thesis; topic arranged between student and MIT faculty member.
B. S. Johnston
Bachelor of Science in Chemical Engineering/Course 10

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>can be satisfied from among 5.12; 5.07 or 7.05; 5.60; 10.301; and 18.03 or 18.034 in the Departmental Program</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>can be satisfied by 5.310</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

**Communication Requirement**
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

<table>
<thead>
<tr>
<th>PLUS Departmental Program</th>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Subjects</td>
<td></td>
</tr>
<tr>
<td>5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)</td>
<td>162</td>
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<tr>
<td>5.07 Biological Chemistry I, 12, REST; 5.12</td>
<td>or</td>
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<tr>
<td>7.05 General Biochemistry, 12, REST; 5.12*</td>
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<tr>
<td>5.310 Laboratory Chemistry, 12, LAB; 5.12*</td>
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<tr>
<td>5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
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<tr>
<td>10.10 Introduction to Chemical Engineering, 12; Physics I (GIR), Calculus I (GIR), Chemistry (GIR)</td>
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</tr>
<tr>
<td>10.213 Chemical and Biological Engineering Thermodynamics, 12; 5.60; 10.10</td>
<td></td>
</tr>
<tr>
<td>10.28 Chemical-Biological Engineering Laboratory, 15, CI-M; 7.05*; 10.702J*; or permission of instructor</td>
<td></td>
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<tr>
<td>or one of the following three subjects:</td>
<td></td>
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<tr>
<td>10.26 Chemical Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor</td>
<td></td>
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<tr>
<td>10.27 Energy Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor</td>
<td></td>
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<tr>
<td>10.29 Biological Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor</td>
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<td>plus</td>
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<tr>
<td>10.301 Fluid Mechanics, 12; REST; 18.03, 10.10</td>
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<tr>
<td>10.302 Transport Processes, 12; 5.60, 10.301, 10.213; or permission of instructor</td>
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<tr>
<td>10.32 Separation Processes, 6; 10.213, 10.302</td>
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<tr>
<td>10.37 Chemical Kinetics and Reactor Design, 9; 5.60, 10.301</td>
<td></td>
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<tr>
<td>10.499 Integrated Chemical Engineering I, 8; 10.37</td>
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<tr>
<td>10.491 Integrated Chemical Engineering II, 8; 10.490</td>
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</tbody>
</table>

Two of the following three subjects:
- 10.492 Integrated Chemical Engineering Topics I, 4; 10.301 and permission of instructor | 22–24 |
- 10.493 Integrated Chemical Engineering Topics II, 4; 10.301 and permission of instructor | |
- 10.494 Integrated Chemical Engineering Topics III, 4; 10.301 and permission of instructor | |

or
- 18.03 Differential Equations, 12, REST; Calculus II (GIR) |
- 18.034 Differential Equations, 12, REST; Calculus II (GIR) | |

**Restricted Electives**
One subject in Chemical Engineering, except 10.UR, 10.URG, 10.THU, 10.04, 10.792J, 10.801, 10.90–10.999

plus one laboratory subject from the following list:
- 3.014 Materials Laboratory, 12, LAB; CI-M |
- 5.36 Biochemistry and Organic Laboratory, 12, CI-M |
- Module 4 Expression and Purification of Enzyme Mutants, 4; 5.07 or 7.05; Module 2 or 5.310; Module 5 |
- Module 5 Kinetics of Enzyme Inhibition, 4; 5.07 or 7.05; Module 2 or 5.310; Module 4 |
- Module 6 Organic Structure Determination, 4; 5.12; Module 2 or 5.310; 5.13 |
- 6.152J Micro/Nano Processing Technology, 12, CI-M; permission of instructor |
- 10.28 Chemical-Biological Engineering Laboratory, 15, CI-M; 7.05*; 10.702J*; or permission of instructor |
- 10.467 Polymer Science Laboratory, 15, LAB; CI-M; 5.12; 5.310* |
- 10.702J Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR) |
| or one of the following: | |
| 10.26 Chemical Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor | |
| 10.27 Energy Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor | |
| 10.29 Biological Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor | |

**Departmental Program Units That Also Satisfy the GIRs** |
| 48 |

**Unrestricted Electives** |
| 198 |

**Total Units Beyond the GIRs Required for SB Degree** |
| 198 |

**Notes**
- Alternate prerequisites are listed in the subject description.
- Either 10.28, or one of 10.26, 10.27, or 10.29 must be taken as a Departmental Requirement and cannot also be used to satisfy the Laboratory Requirement within Restricted Electives.
- For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Bachelor of Science in Chemical-Biological Engineering/Course 10-B

General Institute Requirements (GIRs) Subjects
Science Requirement 6
Humanities, Arts, and Social Sciences Requirement 8
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 5.07, 5.12, 5.60, 7.03, 7.05, 10.301, and 18.03 or 18.034 in the Departmental Program] 2
Laboratory Requirement [can be satisfied by 7.02 or 10.702] 1
Total GIR Subjects Required for SB Degree 17

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program Units
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics)

Required Subjects 186
5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)
5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)
10.702J Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)
7.03 Genetics, 12, REST; Biology (GIR)
7.05 General Biochemistry, 12, REST; 5.12*
or
5.07 Biological Chemistry I, 12, REST; 5.12
7.06 Cell Biology, 12; 7.03, 7.05
10.10 Introduction to Chemical Engineering, 12; Physics I (GIR), Calculus I (GIR), Chemistry (GIR)
10.213 Chemical and Biological Engineering Thermodynamics, 12; 5.60, 10.10
10.218 Chemical-Biological Engineering Laboratory, 15, CI-M; 7.05; 7.02; or permission of instructor
or one of the following three subjects:
10.26 Chemical Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor
10.27 Energy Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor
10.29 Biological Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor
10.301 Fluid Mechanics, 12, REST; 18.03, 10.10
10.302 Transport Processes, 12; 5.60, 10.301, 10.213; or permission of instructor
plus
10.37 Chemical Kinetics and Reactor Design, 9; 5.60, 10.301
10.491 Integrated Chemical Engineering II, 8; 10.490
plus two of the following three subjects:
10.492 Integrated Chemical Engineering Topics I, 4; 10.301 and permission of instructor
10.493 Integrated Chemical Engineering Topics II, 4; 10.301 and permission of instructor
10.494 Integrated Chemical Engineering Topics III, 4; 10.301 and permission of instructor
18.03 Differential Equations, 12, REST; Calculus II (GIR)
or
18.034 Differential Equations, 12, REST; Calculus II (GIR)

Departmental Program Units That Also Satisfy the GIRs (36)
Unrestricted Electives 48

Total Units Beyond the GIRs Required for SB Degree 198

No subject can be counted both as part of the 17-subject GIRs and as part of the 198 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes
*Alternate prerequisites are listed in the subject description.
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
Bachelor of Science in Engineering as Recommended by the Department of Chemical Engineering/Course 10-ENG

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>6</th>
</tr>
</thead>
</table>

Science Requirement

Humanities, Arts, and Social Sciences Requirement

Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 5.60, 10.301, or 18.03 or in the Departmental Program]

Laboratory Requirement [can be satisfied by 1.106 and 1.107, or 2.671, 3.014, 5.310, 10.467, 10.702, or 12.335 in the Departmental Program]

**Total GIR Subjects Required for SB Degree**

| 17 |

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:

2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and

2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics)</th>
</tr>
</thead>
</table>

**Required Subjects**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
</table>

5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)  
18.03 Differential Equations, 12, REST; Calculus II (GIR)  
10.10 Introduction to Chemical Engineering, 12; Physics I (GIR), Calculus I (GIR), Chemistry (GIR)  
10.213 Chemical and Biological Engineering Thermodynamics, 12; 5.60, 10.10  
10.301 Fluid Mechanics, 12, REST; 18.03, 10.10  
10.302 Transport Processes, 12; 5.60, 10.301, 10.213; or permission of instructor  
10.37 Chemical Kinetics and Reactor Design, 9; 5.60, 10.301

**Foundational Concepts**

<table>
<thead>
<tr>
<th>Units</th>
<th>39–45</th>
</tr>
</thead>
</table>

All subjects are suitable for any concentration within the program. In consultation with the advisor, students select one subject from each of the three groups. Students may not exceed the 45-unit cap except by petition.

**Group I. Choose one of the following Course 10 CI-M subjects:**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
</table>

10.26 Chemical Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor  
10.27 Energy Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor  
10.28 Chemical-Biological Engineering Laboratory, 15, CI-M; 7.05*; 10.702J; or permission of instructor  
10.29 Biological Engineering Projects Laboratory, 15, CI-M; 5.310*; 10.302; or permission of instructor  
10.467 Polymer Science Laboratory, 15, LAB, CI-M; 5.12; 5.310*

**Group II. Choose one of the following Institute Laboratory subjects:**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
</table>

1.106 Environmental Fluid Transport Processes and Hydrology Laboratory, 6, LAB; 1.061, 1.070 and 1.107  
2.671 Measurement and Instrumentation, 12, LAB, CI-M; 2.001, 2.003J, Physics II (GIR)  
3.014 Materials Laboratory, 12, LAB, CI-M  
5.310 Laboratory Chemistry, 12, LAB, CI-M; 5.12  
5.35 Introduction to Experimental Chemistry, 12, LAB; Chemistry (GIR)  
—Module 1 Survey of Spectroscopy, 4  
—Module 2 Inorganic Synthesis and Kinetics, 4; Module 3  
10.702 Introduction to Experimental Biology and Communication, 18, CI-M, LAB; 9.12; Biology (GIR)  
12.335 Experimental Atmospheric Chemistry, 12, LAB, CI-M; Chemistry (GIR)  
20.109 Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; Biology (GIR), Chemistry (GIR), 6.00, 18.03; 20.110*

**Group III. Choose one of the following:**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
</table>

1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)  
1.018 Ecology I: The Earth System, 12, REST, CI-M  
1.080 Environmental Chemistry, 12; Chemistry (GIR)  
3.012 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*  
3.553J Micro/Nano Processing Technology, 12, CI-M; permission of instructor  
5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)  
5.61 Physical Chemistry, 12, REST; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)  
6.00 Introduction to Computer Science and Programming, 12, REST  
7.09 Genetics, 12, REST; Biology (GIR)  
8.21 Physics of Energy, 12, REST; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)

**Engineering Concentration**

These four electives define a concentrated area of study in one of the following designated concentrations: biomedical engineering, energy, environmental studies, or materials process and design. In all cases, the electives must be chosen with the approval of the student’s advisor and the department. Lists of recommended subjects for each concentration are available from the department. Note that subjects that have been used to satisfy the foundational concepts may not also be counted toward the engineering concentration.
Capstone

Choose one of the following options to obtain 12 units of capstone experience: Senior Thesis, Integrated Chemical Engineering or Integrated Chemical Engineering Topics modules, or Senior Project.

**Option 1**

10.ThU Undergraduate Thesis, 12

**Option 2. Any combination of the following:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.490</td>
<td>Integrated Chemical Engineering I</td>
<td>8; 10.37</td>
</tr>
<tr>
<td>10.491</td>
<td>Integrated Chemical Engineering II</td>
<td>8; 10.490</td>
</tr>
<tr>
<td>10.492</td>
<td>Integrated Chemical Engineering Topics I</td>
<td>4; 10.301 and permission of instructor</td>
</tr>
<tr>
<td>10.493</td>
<td>Integrated Chemical Engineering Topics II</td>
<td>4; 10.301 and permission of instructor</td>
</tr>
<tr>
<td>10.494</td>
<td>Integrated Chemical Engineering Topics III</td>
<td>4; 10.301 and permission of instructor</td>
</tr>
</tbody>
</table>

**Option 3**

10.910 Independent Research Problems, units arranged and any combination of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.492</td>
<td>Integrated Chemical Engineering Topics I</td>
<td>4; 10.301 and permission of instructor</td>
</tr>
<tr>
<td>10.493</td>
<td>Integrated Chemical Engineering Topics II</td>
<td>4; 10.301 and permission of instructor</td>
</tr>
<tr>
<td>10.494</td>
<td>Integrated Chemical Engineering Topics III</td>
<td>4; 10.301 and permission of instructor</td>
</tr>
</tbody>
</table>

Departmental Program Units That Also Satisfy the GIRs (36)

Unrestricted Electives (48)

**Total Units Beyond the GIRs Required for SB Degree**

183–198

No subject can be counted both as part of the 17-subject GIRs and as part of the 183–198 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

*Alternate prerequisites are listed in the subject description.

(1) Subject may be of particular interest for energy concentration.

(2) Subject may be of particular interest for biomedical engineering concentration.

(3) Subject may be of particular interest for materials process and design concentration.

(4) Subject may be of particular interest for environmental studies concentration.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
UNDERGRADUATE SUBJECTS

Introductory Subjects

11.001J Introduction to Urban Design and Development
(Same subject as 4.250J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
Examines the evolving structure of cities and the way that cities, suburbs, and metropolitan areas can be designed and developed. Boston and other cities are studied to see how physical, social, political and economic forces interact to shape and reshape cities over time.
L. Vale

11.002J Making Public Policy
(Same subject as 17.30J)
Prereq: None
U (Fall)
4-0-8 HASS-S (HASS-D 4); 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.
J. Layzer, A. Campbell

11.003J Methods of Policy Analysis
(Same subject as 17.303J)
Prereq: 11.002J, 17.30J, Coreq: 14.01
U (Spring)
3-0-9 HASS-S (HASS-E)
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

11.004J CityScope
(Same subject as 4.001J)
Prereq: None
U (Spring)
3-0-9 HASS-E (HASS-E)
Project-based introduction to the contemporary city as a complex system within a context of limited resources and competing interests. Learn to assess scenarios for the purpose of formulating social, economic and design strategies that provide optimized solutions that are humane and sustainable. Group projects develop and advocate visions for housing, urban planning, regeneration of natural ecologies and other sectors of the city. Travel may be involved that will be funded, but not required. Includes exercises in written and oral communication and team building. Limited to 15 participants. Preference to freshmen.
J. Fernandez, P. Thompson

11.005 Introduction to International Development
Prereq: None
U (Spring)
2-0-7 HASS-H (HASS-E)
Introduction to ideas and institutions in international development using a quantitative approach. Explores why some poor countries are able to develop faster than others. Topics include planning challenges and models, foreign constraints on policy rights, stakeholders, and building sustainability into planning.
A. Amsden

11.011 The Art and Science of Negotiation
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
Introduction to negotiation theory and practice. Applications in public, business, and legal settings are examined. Combines a “hands-on” personal skill-building orientation with a look at pertinent social 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.
L. Susskind

11.012J The Ancient City
(Same subject as 21H.233J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
See description under subject 21H.233J.
W. Broadhead

11.013J American Urban History I
(Same subject as 21H.217J)
Prereq: None
U (Spring)
2-0-7 HASS-H (HASS-E)
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

11.014J American Urban History II
(Same subject as 21H.218J)
Prereq: None
U (Fall)
2-0-7 HASS-H (HASS-E)
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. Focuses on readings and discussions.
R. M. Fogelson

11.015J Riots, Strikes, and Conspiracies in American History
(Same subject as 21H.226J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 5); CI-H
See description under subject 21H.226J.
P. Maier, R. M. Fogelson
11.016| The Once and Future City
(Same subject as 4.211J)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E); 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

11.019| Migration and Immigration in US History
(Same subject as 21H.310J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 21H.310J.
N. Ashford, C. Caldart

11.021| Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.801J, 17.393J)
(Subject meets with 1.811J, 11.630J, ESD.133J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 1.801J.
N. Ashford, C. Caldart

11.022| Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 1.802J)
(Subject meets with 1.812J, 10.805J, 11.631J, ESD.134J, ESD.136J)
Prereq: Permission of instructor
U (Spring)
3-0-9
See description under subject 1.802J.
N. Ashford, C. Caldart

11.025| D-Lab: Development
(Same subject as EC.701J)
(Subject meets with 11.472J, EC.781J)
Prereq: None
U (Fall)
3-2-7 HASS-S (HASS-E)
See description under subject EC.701J.
A. B. Smith, B. Sanyal

11.026| Downtown
(Same subject as 21H.321J)
(Subject meets with 11.339)
Prereq: None
U (Spring)
2-0-7 HASS-H (HASS-E)
See description under subject 21H.321J.
R. M. Fogelson

11.027| City to City: Comparing, Researching and Writing about Cities
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
Introduction to research in urban planning. Study a domestic and a foreign city, focussing on a planning issue common to both. Develop a research question; create a research strategy; interview faculty and other field experts; write and present findings to US and international audiences. Students encouraged to visit one of the study cities for research.
C. Abbanat

**Specialized Subjects**

11.122| Society and Environment
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
Examines environmental policy and planning from a societal perspective, with a focus on the sociopolitical contexts through which individuals and organizations influence environmental decision making. Topics include environmental values, environmental movements and mobilization, environmental justice, risk perception and communication, and collaborative environmental planning.
J. Carmin

11.123| Big Plans and Mega-Urban Landscapes
Prereq: None
U (Spring)
3-0-6 HASS-S (HASS-E)
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| Introduction to Education: Looking Forward and Looking Back on Education
Prereq: None
U (Fall)
3-6-3 HASS-S (HASS-E); 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.
E. Klopf er

11.125| Introduction to Education: Understanding and Evaluating Education
Prereq: None
U (Spring)
3-6-3 HASS-S (HASS-E); 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.
E. Klopf er

11.126| Economics of Education
(Same subject as 14.48J)
(Subject meets with 11.249)
Prereq: 14.01
U (Spring)
4-0-8 HASS-S (HASS-E)
Discusses the economic aspects of current issues in education, using both economic theory and econometric and institutional readings. Topics include discussion of basic human capital theory; the growing impact of education on earnings and earnings inequality; statistical issues in determining the true rate of return to education; the labor market for teachers, implications of the impact of computers on the demand for worker skills; the effectiveness of mid-career training...
11.127J Computer Games and Simulations for Investigation and Education
(Same subject as CMS.590J)
(Subject meets with 11.252J, CMS.863J)
Prereq: None
U (Spring)
3-6-3 HASS-H (HASS-E)
Explores how we learn from computer games and simulations, and delves into the process of building and testing interactive educational media. First, students investigate the design and use of games and simulations in the classroom (including commercial off-the-shelf games), as well as the research and development issues associated with desktop computer-based, mobile, and non-computer based media. Students then develop their own simulations and games, study what and how others learn from them (including field testing of products), and how games and simulations can be implemented in educational settings. All levels of computer experience welcome. Graduate students are expected to complete additional assignments.
E. Klopfer

11.128 Information Technology and the US Labor Market
(Subject meets with 11.248, 14.49)
Prereq: 14.01
U (Spring)
4-0-8 HASS-S (HASS-E)
Combines economic theory, econometric studies, workplace case studies, and pieces of cognitive psychology to examine the impact of computerization on U.S. employment and wages. Topics include computers’ impact on demands for particular labor force skills, globalization and trade, the organization of work within firms and industries productivity, and the extent to which computers are useful in education.
F. Levy

11.129 Educational Theory and Practice I
Prereq: None. Coreq: 11.124
U (Fall)
3-0-9
Concentrates on core set of skills and knowledge necessary for teaching in secondary schools. Topics include educational reform, student behavior and motivation, curriculum design, and the teaching profession. Classroom observation is a key component. Assignments include readings from the educational literature, written reflections on classroom observations, and practice teaching and constructing curriculum. First of a three-course sequence necessary to complete the Teacher Education Program.
R. Gibb

11.130 Educational Theory and Practice II
Prereq: 11.129
U (IAP)
3-0-9
Concentrates on the theory and psychology associated with student learning. Topics include educational theory, educational psychology, and theories of learning. Student teaching is a key component. Assignments include readings from educational literature, written reflections on classroom observations, presentations on class topics, and practice teaching. Second of a three-course sequence necessary to complete the Teacher Education Program.
R. Gibb

11.131 Education Theory and Practice III
Prereq: 11.130
U (Spring)
3-0-9
Concentrates on the theory and psychology associated with student learning. Topics include educational theory, educational psychology, and theories of learning. Assignments include readings from educational literature, written reflections on classroom observations, presentations on class topics, and practice teaching. Classroom observation is a key component of 11.131, third of the three-course sequence.
R. Gibb

11.140 Urbanization and Development (New)
(Subject meets with 11.480)
Prereq: None
U (Fall)
3-0-9 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.
D. Davis

11.147 Urban Public Finance in Developing Countries (New)
(Subject meets with 11.487)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-S
Addresses how cities grapple with providing urban services to some of the fastest growing populations in the developing world, with limited fiscal and institutional capacity. Explores ways to choose and pay for urban public services. Surveys both public finance theory and applied policy debates. Studies public finance analysis, various sources of public finance and their tradeoffs, and provides a general theoretical framework with which to approach urban financing problems. Examines the political economy of cities and the structural forces behind the urban physical environment. Students taking graduate version complete a final term paper.
A. M. Kim

11.150J Metropolis: A Comparative History of New York City
(Same subject as 21H.220J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
See description under subject 21H.220J.
C. Wilder

11.152J The Ghetto: From Venice to Harlem
(Same subject as 21H.385J)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
2-0-10 HASS-S (HASS-E)
See description under subject 21H.385J.
C. Wilder

11.153J Shanghai and China’s Modernization (New)
(Same subject as 21H.351J)
Prereq: None
U (Spring)
2-0-10 HASS-H (HASS-E)
See description under subject 21H.351J.
C. Leighton

(Same subject as 14.43J, 15.031J, 21A.341J)
Prereq: 14.01 or permission of instructor
U (Spring)
4-0-8 HASS-S (HASS-E)
See description under subject 15.031J.
D. Lessard, R. Schmalensee
11.162 Politics of Energy and the Environment
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
Introduces 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 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 Kyoto Protocol. Limited to 35. B. Rajagopal

11.163J Law and Society
(Same subject as 17.249J, 21A.219J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.219J. S. Silbey

11.164J Human Rights in Theory and Practice
(Same subject as 17.391J)
(Subject meets with 11.497)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
2-0-10 HASS-S (HASS-E)
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 torture, security, democracy promotion, the place of rights in development and globalization, women’s rights, ethnic, religious and racial discrimination and conflict, humanitarian intervention, post-conflict rebuilding, transitional justice, terrorism, and ethical issues in science and technology. Requires familiarity with global affairs or ethics and social justice issues. Students taking graduate version are expected to write a research paper. B. Rajagopal

11.165 Energy and Infrastructure Technologies
(Subject meets with 1.286J, 11.477J)
Prereq: 14.01 or permission of instructor
U (Fall)
3-0-9 HASS-S (HASS-E)
Examines efforts in developing and advanced nations and regions to create, finance, and regulate infrastructure and energy technologies from a variety of methodological and disciplinary perspectives. Explores how an energy crisis can be an opportunity for making fundamental changes to improve collapsing infrastructure technologies. Introduces the challenges to modern society concerning energy and infrastructure technologies. Reviews the moral hazard aspects of infrastructure and the common arguments for withholding adequate support from new energy and infrastructure technologies. Seminar is conducted with intensive in-class discussions and debates. Students taking the graduate version complete additional assignments. K. R. Polenske

11.166 Law, Social Movements, and Public Policy: Comparative and International Experience
(Subject meets with 11.496)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-S (HASS-E)
Examines 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. Primarily focuses on the interplay between law, social movements, and public policy in current areas such as gender, race, labor, trade, environment, and human rights. Introduces the theories of public policy, social movements, law and society, and transnational studies. Students taking the graduate version complete additional assignments. Limited to 15. B. Rajagopal

11.167 Economic Development and Technological Capabilities
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
The economic growth of developing countries requires the acquisition of technological capabilities. In countries at the world technological frontier, such capabilities refer to cutting edge skills to innovate entirely new products. In developing countries, the requisite technological capabilities are broader, and include production engineering, project execution and incremental innovation to make borrowed technology work. Theories of technology acquisition are examined. The empirical evidence is taken from two sets of developing countries; the most advanced (Taiwan, Korea, India, China and Brazil) and the least advanced (Africa and Middle Eastern countries). A. Amsden

11.168 Enabling an Energy-Efficient Society
(Subject meets with 11.379J, 15.231J)
Prereq: None
U (Fall)
4-0-8
Examines innovation in public policy, technology and business models that enable massive-scale improvements in energy efficiency. Explores how they help balance energy supply and demand and prevent unmanageable, irreversible climate change. Students apply analytic methods and design tools to assess strategies to enable energy efficiency. Particular focus on opportunities in US homes and buildings created by utility funding models, carbon cap-and-trade, energy-saving building codes, appliance standards, and green community practices. Limited to 25. H. Michaels

Laboratories

11.188 Urban Planning and Social Science Laboratory
Prereq: None
U (Spring)
3-6-3 Institute LAB
Credit cannot also be received for 11.520
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. Content similar to 11.520. J. Ferreira

11.189 Urban Fieldwork
Prereq: Permission of instructor
U (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

Tutorials, Fieldwork, and Internships

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

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

Undergraduate research opportunities in Urban Studies and Planning. For further information, consult the Departmental Coordinators.

E. Klopfer

11.THTJ Thesis Research Design Seminar
(Same subject as 4.THTJ)
Prereq: None
U (Fall)
3-0-9
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.THTJ
U (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

11.201 Gateway: Planning Action
Prereq: None
G (Fall)
4-1-7
Introduces the profession of urban and regional planning. Emphasizes the key sensibilities necessary for effective planning practice as well as professional writing and oral communication skills.

B. Sanyal

11.202 Gateway: Planning Economics
Prereq: 11.203
G (Fall; second half of term)
2-0-2
Introduces applications of microeconomic theory to planning problems including urban form and structure, government's role in urban settings and problems of housing finance.

F. Levy

11.203 Microeconomics
Prereq: None
G (Fall; first half of term)
3-0-5
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.

F. Levy

11.205 Introduction to Spatial Analysis
Prereq: None
G (Fall; first half of term)
3-0-5
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.

M. Flaxman

11.220 Quantitative Reasoning and Statistical Methods for Planning I
Prereq: Permission of instructor
G (Spring)
4-2-6
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.

Staff

Graduate Subjects

Master's Core Subjects

11.201 Gateway: Planning Action
Prereq: None
G (Fall)
4-1-7
Introduces the profession of urban and regional planning. Emphasizes the key sensibilities necessary for effective planning practice as well as professional writing and oral communication skills.

B. Sanyal

11.202 Gateway: Planning Economics
Prereq: 11.203
G (Fall; second half of term)
2-0-2
Introduces applications of microeconomic theory to planning problems including urban form and structure, government's role in urban settings and problems of housing finance.

F. Levy

11.203 Microeconomics
Prereq: None
G (Fall; first half of term)
3-0-5
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.

F. Levy

11.205 Introduction to Spatial Analysis
Prereq: None
G (Fall; first half of term)
3-0-5
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.

M. Flaxman

11.220 Quantitative Reasoning and Statistical Methods for Planning I
Prereq: Permission of instructor
G (Spring)
4-2-6
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.

Staff

Department-wide Subjects

Methods

11.221 Quantitative Reasoning and Statistical Methods for Planning II
Prereq: 11.220 or permission of instructor
G (Spring)
3-1-8
Credit cannot also be received for 11.241

Using the analytical skills developed in 11.220, this subject extends the statistical techniques to address topics in modeling and forecasting. Emphasizes the use and limitation of modeling in planning practice. Covers techniques of multiple regression and time series analysis. Uses data sets from actual planning applications for examples and problem sets.

Staff

11.225 Argumentation and Communication
Prereq: None
G (Fall)
2-0-4
Can be repeated for credit

A writing practicum associated with 11.201 that focuses on helping students write and present their ideas in cogent, persuasive arguments and other analytical frameworks. Reading and writing assignments and other exercises stress the connections between clear thinking, critical reading, and effective writing.

C. Abbanat

11.229 Advanced Writing Seminar
Prereq: None
G (Spring)
2-0-7
Can be repeated for credit

Focuses on writing and speaking skills. Students bring their writing from other classes to the workshop to practice reviewing and rewriting skills and make several oral presentations. Different types of writing including proposals, memos, thesis, press releases, and writing sound bites for the media.

C. Abbanat
11.233 Research Design for Policy Analysis and Planning
Prereq: Permission of instructor
G (Fall)
3-0-9
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.
J. Carmin

11.234 Making Sense: Qualitative Methods for Designers and Planners
Prereq: None
G (Spring)
3-3-6
Surveys uses of qualitative methods 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.
L. Vale

11.235 Analyzing Projects and Organizations
Prereq: 11.701 or Permission of Instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Analyzes how organizations behave—both government and nongovernment—drawing on the literature of the sociology of organizations, political science, and public administration. Demonstrates rationality in otherwise seemingly chaotic organizational environments and implementation experience. Builds analytic skills for evaluating programs and projects, organizations, and environments. Draws equally on developing-country and developed-country literature.
Staff

11.238J Ethics of Intervention: Anthropological Approaches
(Same subject as 21A.790J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 21A.790J.
E. C. James

11.241 Applied Regression Analysis in Urban Planning
Prereq: 11.220 or permission of instructor
G (Spring)
3-1-2
Credit cannot also be received for 11.221
Introduces regression analysis as a quantitative approach to urban planning questions. Develops a basic understanding of the concepts and techniques. Provides opportunity for extensive hands-on exercises. Same content as first half of 11.221.
Staff

11.248 Information Technology and the US Labor Market
(Subject meets with 11.128, 14.49)
Prereq: 14.01
G (Spring)
4-0-8
See description under subject 11.128.
F. Levy

11.249 Economics of Education
(Subject meets with 11.126J, 14.48J)
Prereq: 14.01
G (Spring)
4-0-8
See description under subject 11.126J.
F. Levy

11.252J Computer Games and Simulations for Investigation and Education
(Same subject as CMS.863J)
(Subject meets with 11.127J, CMS.590J)
Prereq: None
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 11.127J.
E. Klopfer

11.255 Negotiation and Dispute Resolution in the Public Sector
Prereq: None
G (Spring)
4-0-8
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

Program Group Subjects
City Design and Development

11.301J Introduction to Urban Design and Development
(Same subject as 4.252J)
Prereq: Permission of instructor
G (Fall)
3-0-9
Examines both the structure of cities and ways they can be changed. Includes historical forces that have produced cities, models of urban analysis, contemporary theories of urban design, implementation strategies. Core lectures supplemented by discussion sessions focusing on student work and field trips. Guest speakers present cases involving current projects illustrating the scope and methods of urban design practice.
D. Frenchman

11.302J Urban Design Politics
(Same subject as 4.253J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
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

subjects 11.UR to 11.302J
11.303J Real Estate Development Studio: Complex Urban Projects
(Same subject as 4.254J)
Prereq: Permission of instructor
G (Spring)
6-0-9 H-LEVEL Grad Credit
Focuses on the process of synthesizing projects for the real estate development industry, including the integration of finance and marketing with physical programming and design. Interdisciplinary student teams analyze how to maximize value in large-scale, mixed-use projects and then prepare professional development proposals. Reviews contemporary practice in residential and commercial development, as well as innovative new real estate products, to provide a foundation for project work. Projects are interspersed with lectures, field trips, and short sketch exercises. Integrates skills and knowledge in the MSRED program; also open to other students interested in real estate development.
D. Frenchman, P. Roth

11.304J Site and Environmental Systems Planning
(Same subject as 4.255J)
Prereq: Permission of instructor
G (Spring)
6-0-9
Introduces the 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 assignments and a client-based project. Topics include land inventory, spatial organization of uses, parcellization, design of roadways, grading, utility systems, stormwater runoff, parking, traffic, off-site impacts, and landscape architecture.
E. Ben-Joseph

11.306 Planning Studio
Prereq: Permission of instructor
G (Spring)
6-0-9 H-LEVEL Grad Credit
Provides experience in tackling city and regional planning problems in real world settings. Students work with local clients to define issues and synthesize approaches to change that enhances performance of the environment and improves the quality of life for users and residents. The focus of the studio changes each year; past problems have involved community development in downtown Santiago, Chile, and sustainable residential development in Shenzhen and Shanghai, China.
T. Lee

11.307 Beijing Urban Design Studio
(Subject meets with 4.166)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
0-18-0 H-LEVEL Grad Credit
Design and development studio that involves architects and planners, working in teams on a contemporary design project of importance in Beijing, China. Students analyze conditions, explore alternatives, and synthesize architecture, city design, and implementation plans. Supplemented by lectures and brief study tours that expose students to history and contemporary issues of urbanism in China. Offered every other summer in residence at Tsinghua University, Beijing, involving students and faculty from both schools. Limited to 10.
D. Frenchman, J. Wampler

11.308J Advanced Seminar: Urban Nature and City Design
(Same subject as 4.213J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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

11.309J Sensing Place: Photographing the Urban Landscape
(Same subject as 4.215J)
Prereq: None
G (Fall)
3-0-9
Explores photography as a disciplined way of seeing, or 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

11.310J Media Technology and City Design and Development
(Same subject as 4.243J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9
Explores the potential of media technology and the Internet to enhance communication and transform city design and community development in inner-city neighborhoods. Introduces a variety of methods for describing or representing a place and its residents, for simulating actions and changes, for presenting visions of the future, and for engaging multiple actors in the process of envisioning change and guiding action. Working with local clients, students learn tools like digital storytelling to build media rich representations of urban environments.
A. Spirn, C. McDowell

11.311J Ideal Forms of Contemporary Urbanism
(Same subject as 4.262J)
Prereq: 4.645, 4.241, or permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
See description under subject 4.262J.
A. D’Hooghe

11.314J Water, Landscape and Urban Design
(Same subject as 4.214J)
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.214J.
J. Wescoat

11.315J Disaster Resilient Design (New)
(Same subject as 4.217J)
Prereq: None
G (Fall)
3-0-6
See description under subject 4.217J.
J. Wescoat

11.316J Landscape and Urban Heritage Conservation
(Same subject as 4.216J)
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.216J.
J. Wescoat
11.318 Senseable Cities
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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 (Fall)
2-0-10 H-LEVEL Grad Credit
Students develop proposals, at the city and neighborhood scales, that integrate urban design, planning, and digital technology. Aims to create more efficient, responsive, and liveable urban places and systems that combine physical form with digital media, sensing, and advanced communications. Involves research and project work which is supported by lectures, case studies of digital city design, and involvement from experts and representatives of subject cities. Limited to 12.
D. Frenchman, C. Ratti

11.328J Urban Design Skills: Observing, Interpreting, and Representing the City
(Same subject as 4.240J)
Prereq: None
G (Fall)
4-2-9
Introduces methods of recording, evaluating, and communicating about 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

11.330J Theory of City Form
(Same subject as 4.241J)
Prereq: 4.252 or 11.001
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.241J.
J. Beinart

11.331J Advanced Seminar in City Form
(Same subject as 4.242J)
Prereq: 4.241
G (Fall)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.242J.
J. Beinart

11.332J Urban Design Studio
(Same subject as 4.163J)
Prereq: 4.145, 4.162, or permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.163J.
A. Berger, M. Dennis, A. D’Hooghe

11.333J Urban Design Seminar: New Century Cities
(Same subject as 4.244J)
Prereq: None
G (Spring)
2-0-7
Examines the changing nature of cities and emerging design challenges in the 21st century. Core lectures and discussions identify new technological, environmental, social and other trends that are transforming the way we build and use cities. Case studies illustrate cutting edge urban design projects and methods by which they may be evaluated. Work focuses on student teams, which identify and research key themes of future design.
D. Frenchman

11.334J Advanced Seminar in Landscape and Urbanism
(Same subject as 4.264J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

11.337J Urban Design Ideals and Action
(Same subject as 4.247J)
Prereq: 11.301 or permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
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
G (Spring)
0-12-9 H-LEVEL Grad Credit
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.
B. Ryan

11.339 Downtown
(Subject meets with 11.026J, 21H.321J)
Prereq: None
G (Spring)
2-0-7
See description under subject 21H.321.
R. M. Fogelson

11.342J Globalization and the Built Environment
(Same subject as 1.463J, ESD.53J)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
See description under subject 1.463J.
F. Moavenzadeh, D. Wolff
11.344| Innovative Project Delivery in the Public and Private Sectors
(Same subject as 1.472J)
Prereq: Permission of instructor
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
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

11.345J Entrepreneurship in Construction and Real Estate Development
(Same subject as 1.462J)
Prereq: Permission of instructor
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
Explains the role of the entrepreneur in the built environment using case studies to outline different steps in developing real estate, construction, architectural and related enterprises. Emphasizes strategic marketing and implementation of the plan in the development of these businesses. Addresses the progression of an idea, from an opportunity to a sustainable business. Guest lectures from entrepreneurs in the built environment outline the various entrepreneurial paths and characteristics they took to success. Team project consists of identifying an idea/opportunity and plan for developing a sustainable company.
J. F. Kennedy

11.351 Real Estate Ventures I: Negotiating Development-Phase Agreements (New)
Prereq: None
G (Fall)
3-0-6
Studies key issues of principal development-phase agreements, through the lens of the real estate developer, in connection with the site control, entitlement, capitalization, and construction phases of a real estate development venture. Students identify, discuss, and negotiate the most important business issues in each agreement, working closely with attorneys who specialize in the construction of such agreements.
W. T. McGrath

11.352 Real Estate Ventures II: Negotiating Leases, Financings, and Restructurings (New)
Prereq: None
G (Spring)
3-0-6
Building on 11.351, studies key issues of principal asset management agreements, through the lens of the real estate developer/investor, in connection with the value creation, financing and restructuring phases of a real estate venture. Value creation phase focuses on negotiating office and retail leases. Financing phase focuses on negotiating permanent and mezzanine loans and inter-creditor agreements. Restructuring phase addresses the important financial, legal, income tax and governance issues associated with a venture falling into financial distress and the need to negotiate standstill/forbearance and loan modification agreements.
W. T. McGrath

11.360 Community Growth and Land Use Planning
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Seminar and fieldwork 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. Projects arranged with small teams serving municipal clients.
T. S. Szold

Environmental Policy and Planning

11.361 International Environmental Management Practicum
Prereq: Permission of instructor
G (Spring)
3-6-3 H-LEVEL Grad Credit
Client-driven project that addresses environmental policy and planning issues in an international field setting. Students draw on their coursework and professional experience to address pragmatic environmental issues and concerns of either government agencies or non-governmental organizations in other countries. Location and substantive issue will vary.
EPP Staff

11.362 Environmental Management Practicum
Prereq: Permission of instructor
G (Fall)
3-6-3 H-LEVEL Grad Credit
Focuses on client-driven problems of environmental planning, with a particular emphasis on sustainable energy and integrated resource planning. Students use advanced analytic methods and interact with regulatory agencies, NGOs, corporations, and other stakeholder groups. Student team progress reviewed by a multidisciplinary advisory group and a final deliverable is presented to the client for review and comment.
Staff

11.363 Civil Society and the Environment
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines the roles civil society actors play in national and international environmental policy and politics. Considers theories pertaining to the development and import of civil society, social movement development and mobilization, and collaboration between state and non-state actors. Case studies of civil society response to specific environmental issues illustrate theoretical issues and assess the impacts that these actors have on domestic, foreign, and international policy and planning outcomes.
J. Carmin

11.364 International Environmental Negotiation
Prereq: 11.601, 11.362, 11.255
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6 H-LEVEL Grad Credit
Fourth subject in the Environmental Policy and Planning sequence. Seminar looks at problems of managing common resources, difficulties of achieving transboundary pollution control, and the dilemmas of regional harmonization of environmental protection standards. At the core of these problems are issues of how best to structure international treaty negotiations. Focuses especially on problems of representation, issue linkage, and enforcement.
L. E. Susskind
11.366J Planning, Participation, and Consensus Building for Sustainable Development
(Same subject as 1.817J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Examines the political economy of development planning and implementation, with a focus on developing countries in Asia, Africa, and Latin America. Assesses the concept of sustainable development and its application in planning processes. Asks when and how stakeholder participation, negotiation, and consensus building help or hinder attempts to promote sustainability. Emphasis on integration of theory and practice, using local, sectoral, national, and global cases.

EPP Staff

11.367 The Law and Politics of Land Use
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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. Szold

11.368 Environmental Justice
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Explores the foundations of the environmental justice movement, current and emerging issues, and the application of environmental justice analysis to environmental policy and planning. Examines claims made by diverse groups along with the policy and civil society responses that address perceived inequity and injustice. International issues and perspectives also considered.

J. Carmin

11.369J Energy Policy for a Sustainable Future
(Same subject as 17.398J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Focuses on a wide range of current energy and energy-related environmental policies that foster the development and mass deployment of sustainable energy technologies, fuels, and practices. Primary focus is US-based policies at the state, regional, and federal level that impact the electricity, transportation and buildings and facilities sectors. Detailed case studies, diverse readings, and guest lectures by prominent policy makers and practitioners. Limited to 35.

J. Layzer

11.371J Sustainable Energy
(Same subject as 1.818J, 2.65J, 10.391J, 22.811J, ESD.166J)
(Subject meets with 2.650J, 10.291J, 22.081J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit

See description under subject 22.811J.

M. W. Golay

11.372 Environmental Planning Methods
Modules
Prereq: 11.601
G (Fall, IAP, Spring)
Units arranged

Various methods modules cover a range of analytical tools and techniques used by practicing planners and resource management professionals. Modules cover environmental impact assessment, principles of landscape ecology, health risk assessment techniques, cost-benefit analysis techniques, and techniques of environmental leadership. Modules are two to four weeks long.

EPP Staff

11.373 Science, Politics and Environmental Policy
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Examines the role of science in the U.S. environmental policymaking process. Part I examines 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. Part II takes up novel approaches to integrating science into politics, such as ecosystem-based management, stakeholder collaboration, local knowledge, adaptive management, and the precautionary principle. Case studies help students compare theory and practice.

J. Layzer

11.376 Urban Sustainability in Action
Prereq: Permission of instructor
G (Spring)
3-0-12 H-LEVEL Grad Credit

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 identify opportunities to make Boston more sustainable and make a persuasive case for adopting their ideas.

J. Layzer

11.377 Food Systems and the Environment
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Explores the evolution of food production, from farm to plate, 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.

J. Layzer

11.378J Water Reading Group
(Same subject as 4.625J)
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

See description under subject 4.625J.

J. Wescoat

11.379 Enabling an Energy-Efficient Society
(Same subject as 15.231J)
(Subject meets with 11.168)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

Examines innovation in public policy, technology and business models that enable massive-scale improvements in energy efficiency. Explores how they help balance energy supply and demand and prevent unmanageable, irreversible climate changes.
change. Students apply analytic methods and design tools to assess strategies to enable energy efficiency. Particular focus on opportunities in US homes and buildings created by utility funding models, carbon cap-and-trade, energy-saving building codes, appliance standards, and green community practices. Limited to 25.

H. Michaels

Housing, Community, and Economic Development

11.401 Introduction to Housing and Community Development
Prereq: None
G (Fall)
3-0-9
Explores how public policy and private markets affect housing, economic development, and the local economy; provides an overview of techniques and specified programs policies and strategies that are (and have been) directed at neighborhood development; gives students an opportunity to reflect on their personal sense of the housing and community development process; emphasizes the institutional context within which public and private actions are undertaken.

J. P. Thompson

11.402 Urban Politics: Race and Political Change
Prereq: None
G (Fall)
3-0-9
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

11.404 Housing Policy and Planning in the US (New)
Prereq: None
G (Fall)
3-0-9
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.

J. Buckley

11.406 Key Ideas in City Planning History and Theory (New)
Prereq: None
G (Fall)
3-0-9
Investigates the evolution of the ideals, the profession, and the practice of city planning throughout history by looking at key ideas that have driven theorists and practitioners. Explores city and regional planning in the light of broader historical trends, such as changing ideas about who cities are for; different approaches to urban problem-solving; variable factors affecting how urban settlements should be organized and re-organized; the development of human understanding about relationships between the built and natural environments; and about the effects of urban form and organization on society. Focuses substantially but not entirely upon the American experience.

J. Buckley

11.410J Urban and Regional Economics
(Same subject as 1.283J, 14.573J, ESD.191J)
(Subject meets with 14.51)
Prereq: 14.04, 14.32
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 14.573J.

W. Wheaton

11.414J Labor and Politics
(Same subject as 17.188J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9
See description under subject 17.188J.

R. Locke

11.423 Information, Asset-building, and the Immigrant City
Prereq: Permission of instructor
G (Spring)
4-6-2 H-LEVEL Grad Credit
Practicum follows a participatory action research model whereby students work hand-in-hand with residents and such civic leaders as not-for-profit housing developers and municipal planners to create and implement green affordable housing strategies in Lawrence, Massachusetts. As the cornerstone of a sustained partnership between MIT and the people of Lawrence, practicum relies on strong relationships with community partners, including several MIT alumni, to advance new knowledge and practices to transform small, post-industrial cities. Emphasizes use of information technologies for asset-building, network organizing, and reflection.

E. Glenn

11.426 Cities and Globalization
Prereq: None
G (Fall)
3-0-9
Cities examined in the context of globalization. Subject examines changing nature and character of cities as produced by increased transnational migration flows, accelerated international trade, diminished institutional capacities of states (both local and national), and new forms of urban employment investment, and economic restructuring in an age of globalization. Among themes discussed are globalization’s impact on the economic health, social and ethnic composition, political dynamics, and urban policy priorities of cities. Readings focus mainly on the American urban experience, including Boston, and Detroit, with additional emphasis on “global cities” (New York City, Los Angeles, London, Tokyo, Mexico City, Sao Paolo), and how transformations in these locales produce increasing urban inequality both nationally and world-wide.

Staff

11.427J Urban Labor Markets and Employment Policy
(Same subject as 15.677J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.677J.

P. Osterman

11.430J Leadership in Real Estate
(Same subject as 15.941J)
Prereq: None
G (Fall; first half of term)
3-0-6
See description under subject 15.941J.

G. Schuck

11.431J Real Estate Finance and Investment
(Same subject as 15.426J)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Concepts and techniques for analyzing financial decisions in property development and investment. Topics: leasing and property income streams, pro forma analysis, equity valuation,
tax analysis, options, risk, and the financial structuring of real property ownership.

**Staff**

11.432J Real Estate Capital Markets
(Same subject as 15.427J)
Prereq: 11.431J; 15.401, 15.402, or 15.414
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit


**D. Geltner**

11.433J Real Estate Economics
(Same subject as 15.021J)
Prereq: 14.01, 15.010, or 15.011
G (Fall)
4-0-8 H-LEVEL Grad Credit

Develops an understanding of the economic factors that shape and influence the markets for real property. Includes an analysis of housing as well as commercial real estate, and 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**

11.436 Housing Studio: Neighborhood Sustainability Plan (New)
Prereq: 11.401, 11.301, or 11.601
G (Spring)
6-0-9 H-LEVEL Grad Credit

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.

**P. Roth**

11.437 Financing Economic Development
Prereq: None
G (Fall)
3-0-9

Focuses on financing tools and program models to support local economic development. 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. Policies and program models covered include 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.

**K. Seidman**

11.439 Revitalizing Urban Main Streets
Prereq: 11.401, 11.301J, or 11.328J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-11 H-LEVEL Grad Credit

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.

**K. F. Seidman**

11.441 Community Workshop I
Prereq: Permission of instructor
G (Fall)
3-2-4

11.442 Community Building Workshop II
Prereq: Permission of instructor
G (Spring)
3-2-4

Community workshops offered by the Center for Reflective Community Practice (CRCP). Subject centers on the social, economic, political, and technological complexities inherent in supporting the equitable development of poor and minority communities. The seminar/workshop format includes collaborative projects that include community residents, professionals, and faculty. Each year the subject focuses on a particular issue facing one of the current CRCP community partnerships.

**C. McDowell**

11.444J The New Global Planning Practitioner
(Same subject as 4.232J)
(Subject meets with 4.233)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 4.232J.

**R. Goethert**
Introduction to core writings in urban sociology, parasitology, and human behavior. Examine key theoretical paradigms that have constituted the field since its founding, assess how and why they have changed over time, and discuss the implications of these paradigmatic shifts for urban scholarship, social policy and the planning practice. Explore the nature and changing character of the city and the urban experience, including the larger social, political, and economic dynamics of urban change, to enhance appreciation of contemporary, comparative, and historical context in which urban planning skills and sensibilities have been developed and could be applied.

D. Davis

11.470 The Politics of Development Policy
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

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.

D. E. Davis

11.471 Political Economy of Development Projects: Targeting the Poor
Prereq: 11.701 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Examines economic activities of poorer groups and micro-regions in developing countries. Topics include local economic development; small enterprises; various forms of collective action; labor and worker associations; nongovernment organizations. Links these to literature on poverty, economic development, and reform of government, and to types of projects, tasks, and environments that are conducive to equitable outcomes.

D. Davis

11.472J D-Lab: Development
(Same subject as EC.781J)
Prereq: None
G (Spring)
3-0-6

Examines economic activities in developing and advanced nations and regions to create, finance, and regulate infrastructure from a variety of methodological and disciplinary perspectives. Explores how an energy crisis can be an opportunity for making fundamental changes to improve collapsing infrastructure networks. Introduces the challenges to modern society concerning energy security. Reviews the moral hazard aspects of infrastructure and the common arguments for withholding adequate support to the rebuilding of energy systems. Students taking the graduate version complete additional assignments.

K. R. Polenske

11.477J Energy and Infrastructure Technologies
(Same subject as 1.286J)
(Subject meets with 11.165)
Prereq: 14.01 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Examines economic activities in developing and advanced nations and regions to create, finance, and regulate infrastructure from a variety of methodological and disciplinary perspectives. Explores how an energy crisis can be an opportunity for making fundamental changes to improve collapsing infrastructure networks. Introduces the challenges to modern society concerning energy security. Reviews the moral hazard aspects of infrastructure and the common arguments for withholding adequate support to the rebuilding of energy systems. Students taking the graduate version complete additional assignments.

K. R. Polenske
11.479J Water and Sanitation Infrastructure in Developing Countries
(Same subject as 1.851J)
Prereq: None
G (Spring)
Units arranged
See description under subject 1.851J.
S. Murcott

11.480 Urbanization and Development
(Subject meets with 11.140)
Prereq: None
G (Fall)
3-0-9
See description under subject 11.140.
D. Davis

11.481J Analyzing and Accounting for Regional Economic Change
(Same subject as 1.284J, ESD.192J)
Prereq: 14.03, 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
Surveys theories of regional growth, factor mobility, clustering, industrial restructuring, learning regions, and global supply chains from a political-economic perspective. Examines critiques of 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.
K. R. Polenske

11.482J Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 1.285J, ESD.193J)
Prereq: 11.481J or permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
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 (Fall)
3-0-9 H-LEVEL Grad Credit
Students consider current urbanization rates and the global transition to land markets, and their implications on the core theories on how to understand urban land use and housing problems. Posits that the key issue concerns property rights. Reviews how law, economics, sociology and planning theories problematize the current situation and interplays them with physical approaches to space. Explores cases that use property rights strategies to increase economic growth and social justice, providing students insight for future design and policymaking. Topics include land trusts for affordable housing, fear in public space, and critical cartography.
A. M. Kim

11.484 Project Appraisal in Developing Countries
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
A. M. Kim

11.486J Economic Institutions and Growth Policy Analysis
(Same subject as 14.778J, 17.184J)
Prereq: 11.203
G (Spring)
3-0-6 H-LEVEL Grad Credit
Considers how institutions have been incorporated theoretically into explorations of growth and development. Four sets of institutions are examined in detail: the corporate sector, to study how ownership, strategy, and structure affect growth-related policies; financial institutions, to analyze how they condition savings and investment; labor market institutions, to investigate their impact on the determination of wage and production-related productivity; and the institutions associated with technology, such as universities, research laboratories, and corporate training centers, to consider how skill formulation is accomplished.
A. Amsden, M. Piore

11.487 Urban Public Finance in Developing Countries
(Subject meets with 11.147)
Prereq: 11.701, 11.426, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Addresses how cities grapple with providing urban services to some of the fastest growing populations in the developing world, with limited fiscal and institutional capacity. Explores ways to choose and pay for urban public services. Surveys both public finance theory and applied policy debates. Students gain facility in public finance analysis, familiarity with a variety of sources of public finance and their tradeoffs, and a general theoretical framework with which to approach real urban financing problems. Provides students with insights into the political economy of cities and the structural forces behind the urban physical environment.
A. M. Kim

11.488 Urban Development in Conflict Cities: Planning Challenges and Policy Innovations
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines urban development challenges in conflict cities. Case studies used to examine the basic infrastructural, governance, social, and economic dilemmas facing citizens and local officials. First half of course focuses on the national and transnational context in which urban conflict is likely to persist; the impacts of conflict on social, political, economic, and institutional capacities of citizens, markets, and states, both local and national; and the growing involvement of multilateral development agencies in identifying urban conflict as a barrier to economic growth. Course ends with a focus on policy innovations, and examination of potential planning, design, and policy solutions.
D. Davis

11.489 The Growth and Spatial Structure of Cities
Prereq: None
G (Spring)
3-0-9
Examines the economic, political, social, and spatial dynamics of urban growth and decline in cities and their key component areas (downtown, suburbs, etc.). Topics include impacts of industrialization, technology, politics, and social practices on cities. Examines the role of public and private sector activities, ranging from zoning and subsidies to infrastructure development and real estate investment, in affecting urban growth and decline. Readings are both theoreti-
11.490 Law and Development
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-10 H-LEVEL Grad Credit

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

11.491J Economic Development and Policy Analysis
(Same subject as 17.176J)
Prereq: 11.701
G (Fall)
3-0-9 H-LEVEL Grad Credit

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 de-colonization: the OPEC development role model, the East Asian role model, and the Brazilian role model.
A. Amsden

11.492J Economic Development and Policy Analysis, Part II
(Same subject as 17.190J)
Prereq: 11.491
G (Spring)
3-0-9 H-LEVEL Grad Credit

Analyzes economic development in “the remainder,” or in countries that largely failed to enter the orbit of modern world industry since the end of World War II. Looks at the reasons for falling behind in terms of history, geography/global transactions, institutions (including business enterprises), policies and knowledge-based assets. Explores potential policies for accelerating the process of industrial transformation and the control mechanism necessary to improve government planning.
A. Amsden

11.493 Legal Aspects of Property and Land Use
Prereq: None
G (Fall)
3-0-9

Examines legal and institutional arrangements for the establishment, transfer, and control over property 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 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

11.494 City and the Law
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9

Introduction to the legal and institutional issues that arise in local and city governance. Focuses on the way institutional arrangements and legal concepts influence how power is distributed, how it is exercised and by whom, and explores alternative arrangements. Illustrations from American local government law, and examples from comparative law.
B. Rajagopal

11.495 Governance and Law in Developing Countries
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
2-0-10 H-LEVEL Grad Credit

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 authority, political and legal, as a result of economic globalization. Topics include the role and reform of the state, the role of civil society and markets, global governance, good governance, the role of the judiciary and legal culture in development 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)
3-0-9

Examines 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. Primarily focuses on the interplay between law, social movements, and public policy in current areas such as gender, race, labor, trade, environment, and human rights. Introduces the theories of public policy, social movements, law and society, and transnational studies. Research paper required for graduate students. Limited to 15. Open to undergraduates with permission of instructor.
B. Rajagopal

11.497 Human Rights in Theory and Practice
(Subject meets with 11.164J, 17.391J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9

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 torture, security, democracy promotion, the place of rights in development and globalization, women’s rights, ethnic, religious and racial discrimination and conflict, humanitarian intervention, post-conflict rebuilding, transitional justice, terrorism, and ethical issues in science and technology. Requires familiarity with global affairs or ethics and social justice issues. Students taking graduate version are expected to write a research paper.
B. Rajagopal

11.498J Monitoring the Rights of Native Peoples
(Same subject as 21A.900J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-4-5

See description under subject 21A.900J.
J. Howe
11.520 A Workshop on Geographic Information Systems
Prereq: Permission of instructor
G (Fall)
3-6-3 H-LEVEL Grad Credit
Credit cannot also be received for 11.188
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.
Staff

11.521 Spatial Database Management and Advanced Geographic Information Systems
Prereq: Permission of instructor; or 11.520 and Coreq: 11.220
G (Spring)
3-3-6 H-LEVEL Grad Credit
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; 11.520 or 11.525
G (Fall)
2-4-6 H-LEVEL Grad Credit
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.
Staff

11.523 Fundamentals of Spatial Database Management
Prereq: Permission of instructor
G (Spring; first half of term)
2-2-2 H-LEVEL Grad Credit
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 H-LEVEL Grad Credit
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

11.526J Comparative Land Use and Transportation Planning
(Same subject as 1.251J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Discusses the meanings of urban space and the role of transportation planning in a contemporary metropolitan context. Topics include formation and evolution of land use patterns; job accessibility of low-skilled workers; strategies for improving accessibility; integration of transportation planning with housing, social service, and job placement; and impact of advanced communication and information technologies on urban space. Applies spatial analysis, GIS, and transportation planning methods to a case study of Boston.
Staff

11.527 Advanced Seminar in Transportation Finance (New)
Prereq: Permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
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

11.533 Ecological Planning with GIS
Prereq: 11.205
G (Spring)
3-3-6
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.
M. Flaxman
11.534 Simulating Sustainable Futures
Prereq: 11.523 or 11.533
G (Fall)
3-0-9 H-LEVEL Grad Credit
Working with a local client, this class applies alternative futures planning to a case study area which has both high quality environmental or cultural resources and significant growth pressure. Students use GIS to create spatial indicators of various aspects of sustainability such as biodiversity, social justice, water quality or energy consumption. These indicators are then used first to construct and then to evaluate a set of regional policy and physical design alternatives.
M. Flaxman

11.540J Urban Transportation Planning
(Same subject as 1.252J, ESD.225J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.252J.
F. Salvucci, M. Murga

11.541J Public Transportation Systems
(Same subject as 1.258J, ESD.226J)
Prereq: 1.201 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.258J.
N. H. M. Wilson

11.543J Transportation Policy and Environmental Limits
(Same subject as 1.253J, ESD.222J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.253J.
J. Coughlin, F. Salvucci

11.544J Transportation Systems Analysis: Performance and Optimization
(Same subject as 1.200J, ESD.21J)
Prereq: 1.010, permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.200J.
C. Barnhart, A. R. Odoni

11.545J Transportation Systems Analysis: Demand and Economics
(Same subject as 1.201J, ESD.210J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.201J.
N. H. M. Wilson, M. Ben-Akiva

11.601 Introduction to Environmental Policy and Planning
Prereq: None
G (Fall)
3-0-9
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 policy-making 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

11.630J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.811J, ESD.133J)
(Same subject meets with 1.801J, 11.021J, 17.393J)
Prereq: Permission of instructor for undergraduates
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.811J.
N. A. Ashford, C. C. Caldart

11.631J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 1.812J, ESD.134J)
(Same subject meets with 1.802J, 10.805J, 11.022J, ESD.136J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.812J.
N. A. Ashford, C. C. Caldart

11.701 Introduction to International Development Planning
Prereq: None
G (Fall)
3-0-9
Interaction between planners and institutions at both national and local levels. Overview of theories of state, organizational arrangements, implementation mechanisms, and planning styles. Case studies of planning: decentralization, provision of low-cost housing, and new-town development. Analyzes various roles planners play in different institutional contexts. Professional ethics and values amidst conflicting demands. Restricted to first-year MCP and SPURS students.
B. Rajagopal

Tutorials, Research, and Field Work Subjects

11.800 Doctoral Research Seminar
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Required subject for all entering PhD students. Dual focus is on formulating researchable questions (to help students write their first-year papers) and understanding how research knowledge comes to be influential in the world or not influential. Explores ways to make research knowledge more accessible, credible, and useful in the realm of public policy and practice. Addresses the politics of the policymaking process, the power of framing and agenda-setting, how knowledge diffuses along knowledge and influence networks, and how varied types of knowledge shape decision-making and action.
D. Davis

11.901 Independent Study: Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

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
(11.911)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

11.904 Supervised Readings in Urban Studies
(11.912)
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

11.905 Research Seminar in Urban Studies and Planning (11.913)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
11.906 Research Seminar in Urban Studies and Planning (New)
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 (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
11.908 Urban Fieldwork (New)
Prereq: None
G (Fall, IAP, Spring, Summer)
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

11.909 Graduate Tutorial
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Staff

11.910 Doctoral Tutorial
Prereq: None
G (Fall, IAP, Spring)
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

11.960 Independent Study: Real Estate
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Staff

11.961 Independent Study: Real Estate
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 H-LEVEL Grad Credit
Can be repeated for credit
Staff

11.964 Independent Study: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for independent study under regular supervision by a faculty member.
Staff

11.983 SPURS Seminar
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Provides skills to enable SPURS Fellows to grasp complex issues of urban and regional change. Aims to facilitate professional interactions with scholars, policy makers, and practitioners in the field. MIT faculty and outside specialists share expertise on issues related to globalization, urban development, infrastructure, and public policy. Fellows present their professional interests and research, and hone practical and professional skills. Fellows prepare a research paper that addresses an important issue in their practice and conducts an examination of that issue. Final research paper is presented to the larger MIT community. SPURS Fellows only.
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

11.5940–11.5949 Special Subject: Urban Studies and Planning (11.949)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
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 (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
11.5958, 11.5959 Special Seminar: Urban Studies and Planning (11.959)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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

11.5965–11.5969 Special Seminar: Real Estate (11.969)
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.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research and writing of thesis; to be arranged by the student with supervising committee.

**Staff**

### Bachelor of Science in Planning/Course 11

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>[can be satisfied by 11.188 in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:

- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics)

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.001J Introduction to Urban Design and Development, 12, HASS-H</td>
<td>57</td>
</tr>
<tr>
<td>11.002J Making Public Policy, 12, HASS-S, CI-H</td>
<td></td>
</tr>
<tr>
<td>11.123 Big Plans and Mega-Urban Landscapes, 9, HASS-S</td>
<td></td>
</tr>
<tr>
<td>14.01 Principles of Microeconomics, 12, HASS-S</td>
<td></td>
</tr>
<tr>
<td>11.188 Urban Planning and Social Science Laboratory, 12, LAB, CI-M</td>
<td></td>
</tr>
</tbody>
</table>

### Planned Electives

Course 11 majors are required to formulate or select one stream of coursework for concentration. They can select from the following recommended options or create their own stream tailored to a particular set of urban, policy, or planning concerns.

#### Urban and Environmental Policy and Planning

- 11.011 The Art and Science of Negotiation, 12, HASS-S
- 11.014J American Urban History II, 9, HASS-H
- 11.016 The Once and Future City, 12, HASS-H, CI-H
- 11.021 Environmental Law, Policy, and Economics: Pollution Prevention and Control, 12, HASS-S
- 11.026 Downtown, 9, HASS-H
- 11.122 Society and Environment, 12, HASS-S
- 11.162 Politics of Energy and the Environment, 12, HASS-E
- 11.165 Infrastructure in Crisis: Energy and Security Challenges, 12, HASS-S; 14.01*
- 11.168 Enabling an Energy-Efficient Society, 12
- 1.011 Project Evaluation, 9
- 1.041J Engineering System Design, 12; 1.011*

#### Urban Society, History, and Politics

- 11.013J American Urban History I, 9, HASS-H
- 11.014J American Urban History II, 9, HASS-H
- 11.015J Riots, Strikes, and Conspiracies in American History, 12, HASS-HF, CI-H
- 11.016 The Once and Future City, 12, HASS-H, CI-H
- 11.019J Migration and Immigration in US History, 12, HASS-S
- 11.026J Downtown, 9, HASS-H
- 11.150J Metropolis: A Comparative History of New York City, 12, HASS-H

#### Urban and Regional Public Policy

- 11.003J Methods of Public Policy Analysis, 12, HASS-S; 11.002J, 17.30J; 14.01
- 11.005 Introduction to International Development, 12, HASS-S
- 11.011 The Art and Science of Negotiation, 12, HASS-S
- 11.025 D-Lab: Development, 12, HASS-S
- 11.126 Economics of Education, 12, HASS-S; 14.01
- 11.152J The Ghetto: From Venice to Harlem, 12, HASS-S
- 11.164J Human Rights in Theory and Practice, 12, HASS-S; permission of instructor
- 11.166J Law, Social Movements, and Public Policy, 12, HASS-S; permission of instructor

#### Urban Field Experience

Declared majors are encouraged to take the optional urban field experience subject.

- 11.027 City to City: Comparing, Researching, and Writing about Cities (CI-M) is taught in the spring and includes a trip during spring break. This course may be taken multiple times, as the content differs each year, but may only be counted once as a planned elective.

#### Thesis

Majors are required to write a senior thesis or complete a senior project. The thesis/project writing process is accompanied by a required undergraduate thesis preparation seminar, which meets in the fall.

- 11.ThT Thesis Research Design Seminar, 12, CI-M
### Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(57)</td>
</tr>
</tbody>
</table>

### Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>105</td>
</tr>
</tbody>
</table>

### Total Units Beyond the GIRs Required for SB Degree

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>180</td>
</tr>
</tbody>
</table>

*No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

### Notes

*Alternate prerequisites and corequisites are listed in the subject description.

† Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.

Course 11 majors are not permitted to have a HASS concentration in Urban Studies.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
**Course 12**

**Earth, Atmospheric, and Planetary Sciences**

**Undergraduate Subjects**

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

12.IND Independent Study  
Prereq: 12.IND  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit

Independent reading, laboratory, or fieldwork in Earth, Atmospheric, and Planetary Sciences. Requires written report. To be arranged by student and an appropriate MIT faculty member.

12.UGR 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. EAPS Faculty

12.TIP Thesis and Independent Study Preparation  
Prereq: None  
U (Fall, Spring)  
2-0-4

Definition of and early-stage work on thesis project or independent study. Students develop a written research proposal and begin writing the supporting text of the thesis concurrent with conducting research for the thesis project or independent study. Supervision of the writing continues into the Spring term which concludes with an oral presentation of the research results.

12.001 Introduction to Geology  
Prereq: None  
U (Spring)  
3-4-5 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 and T. Perron

12.002 Physics of the Terrestrial Planets  
Prereq: Physics II (GIR), Calculus II (GIR)  
U (Fall)  
3-1-8 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 Physics of the Atmosphere and Ocean  
Prereq: Calculus II (GIR), Physics I (GIR)  
U (Fall)  
3-1-8 REST

The laws of classical mechanics and thermodynamics are used to explore how the properties of fluids on a rotating Earth manifest themselves in, and help shape, the global patterns of atmospheric winds, ocean currents, and the climate of the Earth. Theoretical discussion focuses on the physical processes involved. Underlying mechanisms are illustrated through laboratory demonstrations, using a rotating table, and through analysis of atmospheric and oceanic data. R. Ferrari

12.005 Applications of Continuum Mechanics to Earth, Atmospheric, and Planetary Sciences  
Prereq: Physics II (GIR), Calculus II (GIR); Coreq: 18.03  
U (Spring)  
3-2-7

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.

A. Malcolm, B. Evans
12.006J Nonlinear Dynamics I: Chaos
(Same subject as 2.050J, 18.353J)
Prereq: 18.03 or 18.034; Physics II (GIR)
U (Fall) 3-0-9


12.007 Geobiology: History of Life on Earth
Prereq: None
U (Spring) 3-0-9

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. R. Summons and T. Bosak

12.008 Classical Mechanics: A Computational Approach
(Subject meets with 6.946J, 8.351J, 12.620J)
Prereq: Physics I (GIR), 18.03, permission of instructor
U (Fall) 3-3-6


12.009 Theoretical Environmental Analysis
Prereq: Physics I (GIR); Coreq: 18.03
U (Spring) 3-0-9

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 I (GIR), Calculus II (GIR), Physics I (GIR)
U (Fall) 4-0-8

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

12.011J Archaeological Science
(Same subject as 3.985J, 5.24J)
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring) 3-1-5 HASS-S (HASS-E)

See description under subject 3.985J. H. N. Lechtman, J. Stubbe, F. A. Frey

12.021 Earth Science, Energy, and the Environment
Prereq: Physics I (GIR), Calculus I (GIR), Chemistry (GIR)
U (Fall) 3-1-8

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

12.080 EAPS Undergraduate Seminar
Prereq: None
U (Fall, Spring) 1-0-2 [P/D/F]

Can be repeated for credit

Covers topics in earth, atmospheric, and planetary sciences. Weekly seminars are presented by EAPS faculty members. Short weekly reading and writing assignments based on the seminar topics.

Staff

12.085 Seminar in Environmental Science
Prereq: 12.120, 12.103; or permission of instructor
U (Spring) 3-0-6

Stresses integration of central scientific concepts in environmental science. Emphasis on identifying the scientific foundation of environmental problems and proposals for their solution. Through independent study, group discussions, and periodic research reports, students produce an in-depth overview and critique of selected problems. Potential topics include: carbon sequestration, nuclear waste disposal, ocean fertilization, geoengineering, global warming, ocean acidification, and the ecological impact of environmental change.

EAPS Staff
**12.086 Modeling Environmental Complexity**  
(Subject meets with 12.586)  
Prereq: 18.03  
U (Fall)  
3-0-9  
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, IAP, Spring)  
Units arranged  
Can be repeated for credit

**12.091 Current Topics in Earth, Atmospheric, and Planetary Sciences**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

**12.092 Current Topics in Geology and Geochemistry**  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit

**12.093 Current Topics in Geology and Geochemistry**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

**12.094 Current Topics in Geophysics**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit

**12.095 Current Topics in Geophysics**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

**12.096 Current Topics in Atmospheric Science and Oceanography**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

**12.097 Current Topics in Atmospheric Science and Oceanography**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

**12.098 Current Topics in Planetary Science**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit

**12.099 Current Topics in Planetary Science**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

**12.100 Current Topics in Geophysics**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit

**12.101 Current Topics in Atmospheric Science and Oceanography**  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

**12.102 Environmental Earth Science**  
Prereq: None  
U (Fall)  
3-0-9 REST  
The geologic record demonstrates that our environment has changed over a variety of time scales from seconds to billions of years. Explores the many ways in which geologic processes control and modify the Earth’s environment. Topics include chemical and physical interactions between the solid Earth, its oceans and atmosphere; the effect of catastrophic events such as volcanic eruptions and earthquakes on the environment; geologic hazards; and our role in modifying the environment through Earth resource development. Serves as an introduction to 12.120, which addresses field applications of these principles in the American Southwest.  
S. A. Bowring

**12.104 Geochemistry of the Earth and Planets**  
Prereq: Calculus II (GIR)  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Fall)  
3-1-8  
Focuses on the processes that create chemical variability in the solid and fluid Earth, the moon, and meteorites. Includes nucleosynthesis, cosmochemistry, and basic geochemical concepts. Thermodynamics and phase equilibria are introduced and applied to problems of melting solid planetary interiors and the evolution of the Earth’s hydrosphere. Radiogenic and stable isotopic systems are used to document the timing of planetary formation and differentiation, formation, and evolution of volcanoes and continental crust, and to understand interactions between the solid and fluid Earth.  
S. Ono

**12.108 Structure of Earth Materials**  
Prereq: Chemistry (GIR)  
U (Spring)  
3-4-5  
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, S.-H. Shim

**12.109 Petrology**  
Prereq: 12.108  
Acad Year 2011–2012: U (Fall)  
Acad Year 2012–2013: Not offered  
3-6-6  
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

12.110 Sedimentary Geology
(Subject meets with 12.465)
Prereq: 12.001
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-3-6


J. B. Southard

12.113 Structural Geology
Prereq: 12.001, 12.005
U (Fall)
3-3-6

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.

B. C. Burchfiel and O. Jagoutz

12.114 Field Geology I
Prereq: 12.108 or permission of instructor; or Coreq: 12.113
U (Fall)
2-2-2 [P/D/F]

Introduces techniques of geological field study. Weather permitting, several weekend field exercises provide practical experience in preparation for 12.115. Presents introductory material on the regional geology of the locale of 12.115.

B. C. Burchfiel, O. Jagoutz

12.115 Field Geology II
Prereq: 12.113, 12.114
U (IAP, Spring)
0-18-0 Institute LAB

During January, students practice methods of modern geological field study during an intensive four-week subject. 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. Following term includes preparation of reports based on field studies conducted during January; report generally exceeds 30 pages in length and includes one major revision and rewrite. Instruction in writing techniques provided. Laboratory analysis of samples, interpretation of geological data, and where possible, geophysical and geochemical data. 12 units may be applied to the General Institute Laboratory Requirement.

Geology and Geochemistry Staff

12.119 Analytical Techniques for Studying Environmental and Geologic Samples
Prereq: None
U (Spring)
2-6-4 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.

S. Bowring, E. Boyle, F. Frey, T. Grove

12.120 Environmental Earth Science Field Course
Prereq: Permission of instructor
U (IAP)
1-5-0

Field study to foster understanding of natural hazards and human influence on the environment. Class conducted in the western United States, at locations such as Death Valley and the White Mountain Research Station in Bishop, California. Topics include water use and availability, climate change, earthquakes and faulting, and landslides. Also examines volcanic hazards and geothermal power, effects of river diversion, and the geology of the Yucca Mountain facility for the storage of radioactive waste. Students partially responsible for travel expenses. Designed to follow 12.001 or 12.102; other students will be accepted when space is available.

S. Bowring, T. L. Grove

12.141 Electron Microprobe Analysis
Prereq: None
U (IAP)
1-1-4 [P/D/F]

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
U (Fall)
2-4-3 [P/D/F]

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: 12.001, Physics I (GIR), Calculus I (GIR); or permission of instructor
U (Fall)
3-3-6

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: Physics II (GIR), Calculus II (GIR); or permission of instructor
U (Fall)
4-0-8
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.
L. Elkins-Tanton

12.172 Building Earth-like Planets: From Nebular Gas to Ocean Worlds
(Subject meets with 12.472)
Prereq: Physics II (GIR), Calculus II (GIR); or permission of instructor
U (Spring)
3-0-9
Examines the state of knowledge of planetary formation, beginning with planetary nebulae and continuing through accretion (from gas to planet). Studies the processes of planetary differentiation, crust formation, atmospheric degassing, and surface water condensation. Integrated discussion of compositional and physical processes based upon observations from our solar system and from exoplanets. Focuses on terrestrial (rocky and metallic) planets, as well as more volatile-rich bodies. Includes readings from literature, lectures, discussion, and problem solving. Students taking graduate version complete additional assignments.
L. Elkins-Tanton

Geophysics

12.201 Essentials of Geophysics
(Subject meets with 12.501)
Prereq: Physics II (GIR), 18.03
U (Fall)
4-0-8
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. D. van der Hilst

12.207 Nonlinear Dynamics II: Continuum Systems
(Same subject as 18.354J)
Prereq: 18.353 or permission of instructor
U (Spring)
3-0-9 (H except 18)
See description under subject 18.354J.
L. Bourouiba

12.213 Alternate Energy Sources
Prereq: None
U (IAP)
1-4-1 [P/D/F]
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.
M. N. Toksöz, F. D. Morgan

12.214 Environmental Geophysics
(Subject meets with 12.507)
Prereq: 18.03
U (Spring)
3-3-6
Introduction to basic geophysical methods that can be used for environmental site characterization and shallow geological investigations. Techniques include seismic, electrical, and electromagnetic sounding; ground-penetrating radar, magnetics, gravity, and borehole geophysics. Lectures emphasize basic principles and a physical understanding of the geophysical methods with environmental and engineering applications in mind. Some specific case histories are included. A few weekends of field measurements at representative local sites are included. Lab sessions cover modeling and interpretation of geophysical field data. Students taking the graduate version complete different assignments.
F. D. Morgan

12.222 Field Geophysics Analysis
Prereq: 12.221
U (Spring)
2-0-4
Focuses on in-depth data analysis and the development of the skills needed to report results both in writing and orally. In weekly meetings, students use data collected in 12.221 to develop written and oral reports of the results. Each student focuses on a different area of the results. For example, students can develop the geophysical modeling of the results or synthesis of the results into other studies in the area. The final written and oral reports from the students are structured so that they can be combined into a comprehensive report of the field camp and its results. A final oral presentation of results is required during the final few weeks of the spring term.
T. A. Herring, B. H. Hager

Atmospheres, Oceans, and Climate

12.300J Global Change Science
(Subject meets with 1.071J)
Prereq: 18.03; 5.60
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9
See description under subject 1.071J.
E. A. B. Eltahir
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.

C. Wunsch, E. Boyle, K. Emanuel

12.306 Atmospheric Physics and Chemistry
(Subject meets with 10.571J, 12.806J)
Prereq: 5.61, 18.075, or permission of instructor
U (Spring)
3-0-9
See description under subject 10.806J.
R. G. Prinn

12.307 Weather and Climate Laboratory
Prereq: Calculus II (GIR), Physics I (GIR)
U (Spring)
1-4-7 Institute LAB
A laboratory subject intended to illustrate, by means of hands-on projects, the basic dynamical and physical principles which govern the general circulation of the atmosphere and the day-to-day sequence of weather events. Real-time meteorological observations are studied together with laboratory fluid experiments. Projects based on real-time observations stress the analysis and dynamical interpretation of the real phenomena, while complementary rotating tank experiments stress planning and testing of ideas in a more controlled laboratory environment. Written critical summaries of the results of each project and oral presentations are an integral part of the subject.
L. Illari, J. Marshall

12.310 An Introduction to Weather Forecasting
Prereq: Physics I (GIR), Calculus I (GIR)
U (IAP)
1-1-4 [P/D/F]
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

12.312 Understand and Run Your Own Climate Model
Prereq: Physics I (GIR), Calculus I (GIR)
U (IAP)
1-1-4 [P/D/F]
Prereq: Physics I (GIR), Calculus I (GIR)
U (IAP)
1-1-4 [P/D/F]
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

12.314 Introduction to Hydrology
Prereq: Physics I (GIR), Calculus I (GIR), or permission of instructor; Coreq: 5.60
3-0-9
Provides students with a scientific foundation of anthropogenic climate change and an introduction to climate models. Focuses on fundamental physical processes that shape climate (e.g. solar variability, orbital mechanics, greenhouse gases, atmospheric and oceanic circulation, and volcanic and soil aerosols) and on evidence for past and present climate change. Discusses material consequences of climate change, including sea level change, variations in precipitation, vegetation, storminess, and the incidence of disease. Examines the science behind mitigation and adaptation proposals.
K. Emanuel, S. Seager

12.333 Atmospheric Dynamics
(Subject meets with 12.810)
Prereq: 12.003, 8.03, 18.03; or permission of instructor
U (Spring)
4-0-8
Discusses the dynamics of the atmosphere, with emphasis on the large scale. Topics include zonally symmetric circulations and the tropical Hadley circulation; internal gravity waves; balanced flows, potential vorticity conservation and Rossby waves; stability of zonal flows; baroclinic instability and extratropical storms; tropical waves, the Walker circulation, and El Niño and the Southern Oscillation; and the role of eddies in the general circulation. Students taking graduate version complete different assignments.
R. A. Plumb

12.335 Experimental Atmospheric Chemistry
(Subject meets with 12.835)
Prereq: Chemistry (GIR)
U (Fall)
2-4-6 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

12.340 Global Warming Science
Prereq: Physics I (GIR), Calculus I (GIR), or permission of instructor; Coreq: 5.60
U (Spring)
3-0-9
Provides students with a scientific foundation of anthropogenic climate change and an introduction to climate models. Focuses on fundamental physical processes that shape climate (e.g. solar variability, orbital mechanics, greenhouse gases, atmospheric and oceanic circulation, and volcanic and soil aerosols) and on evidence for past and present climate change. Discusses material consequences of climate change, including sea level change, variations in precipitation, vegetation, storminess, and the incidence of disease. Examines the science behind mitigation and adaptation proposals.
K. Emanuel, S. Seager

12.348J Global Climate Change: Economics, Science, and Policy
(Same subject as 15.026J)
(Subject meets with 12.848J, 15.023J, ESD.128J)
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
U (Spring)
3-0-6
See description under subject 15.026J.
H. D. Jacoby, R. G. Prinn, M. D. Webster
Planetary Science and Astronomy

12.400 The Solar System
Prereq: Physics I (GIR)
U (Spring)
3-0-9 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

12.402J Introduction to Astronomy
(Same subject as 8.282J)
Prereq: Physics I (GIR)
U (Spring)
3-0-6 REST

See description under subject 8.282J.
Staff

12.409 Hands-On Astronomy: Observing Stars and Planets
Prereq: None
U (Fall, Spring)
0-4-2 [P/D/F]

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 freshmen.
A. Bosh

12.410J Observational Techniques of Optical Astronomy
(Same subject as 8.287J)
Prereq: 8.282J, 12.402J, 12.409, or other introductory astronomy course; Coreq: 8.03
U (Fall)
3-4-8 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: 12.410J or 8.287J
U (IAP)
0-6-3 [P/D/F]

Can be repeated for credit

Individual research projects in observational astronomy involving supervised work at Lowell Observatory (located in Flagstaff, AZ). Written and oral reports required. Limited to 6.
J. L. Elliot

12.425 Extrasolar Planets: Physics and Detection Techniques
(Subject meets with 12.625)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Fall)
2-1-9 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

12.43J Space Systems Engineering
(Same subject as 16.831J)
Prereq: Permission of instructor
U (Fall)
3-3-6

See description under subject 16.831J.
D. L. Miller, K. Cahoy, S. Seager

12.431J Space Systems Development
(Same subject as 16.831J)
Prereq: Permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
2-10-6 Institute LAB

See description under subject 16.831J.
D. W. Miller, K. Cahoy, S. Seager

GRADUATE SUBJECTS

Prereq: Permission of instructor
G (Fall; second half of term)
3-0-3 [P/D/F] H-LEVEL Grad Credit

Focuses on developing oral presentation skills through practice, self-evaluation, and in-class feedback. Topics include slide preparation, answering difficult questions, explaining technical details and presenting to a general audience. Students make approximately 10 short presentations over the duration of the course. Research for presentations appropriate for national meetings must be completed in advance; consult instructor for details. Limited to 6.
A. Malcolm

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

12.450 Seminar in Geology and Geochemistry
Prereq: Permission of instructor
G (Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Seminar on topics of current interest in geology and geochemistry. Required background preparation for students taking predoctoral general examinations in these subjects.

Geology and Geochemistry Staff

12.451 Seminar in Regional Tectonics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-6 [P/D/F] H-LEVEL Grad Credit
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

12.453–12.454 Crosby Lectures in Geology
Prereq: Permission of instructor
G (Fall, Spring)
3-0-6 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
A series of presentations on an advanced topic in the field of geology by the visiting William Otis Crosby lecturer. The Crosby lectureship is awarded to a distinguished international scientist each year to introduce new scientific perspectives to the MIT community. Subject content and structure vary from year to year.

Consult Department Headquarters

12.455 Megascopic Strain Analysis in Orogenic Belts
Prereq: 12.113
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6 H-LEVEL Grad Credit
Introduction to modern techniques used to estimate the magnitude of strain in orogenic belts. Emphasis on megascopic strain analysis. Includes methods of determining sense of shear in various structural settings; the construction of 2-D balanced structural sections; the construction of 3-D structural sections; and graphical reconstruction of 2-D and 3-D sections to predeformational configurations.

EAPS Staff

12.456 Seminar in Rock Mechanics
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discussion of current research or advanced topics in continental tectonics, rock mechanics, or experimental structural geology.

B. Evans

12.457 Sedimentary Basins
Prereq: 18.03, 12.113
G (Spring)
3-0-6 H-LEVEL Grad Credit
Formation and evolution of basin systems in continental crust (including passive continental margins, foredeep accretionary basins, back-arc type basins, intraplate rifts, etc.) are examined with regard to tectonic settings, structural and sedimentary features, and deep lithospheric processes. Case studies of several sedimentary basins of each type.

L. H. Royden

12.458 Molecular Biogeochemistry
(Subject meets with 12.158)
Prereq: Permission of instructor
G (Fall)
2-4-3 [P/D/F]
See description under subject 12.158.

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] H-LEVEL Grad Credit
Can be repeated for credit
Investigations, laboratory work, or fieldwork in geology, petrology, mineralogy or geochemistry. 12.460 is letter-graded.

Geology and Geochemistry Staff

12.463 Geomorphology
(Subject meets with 12.163)
Prereq: 12.001, Physics I (GIR), Calculus I (GIR); or permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
See description under subject 12.163.

T. Perron

12.464 Seminar in Sedimentary Geology
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Discussion of current research or advanced topics in sedimentary geology including, but not restricted to, sediment transport, interactions between sedimentation and stratigraphic architecture, sedimentary geochemistry, carbonate platform development, and paleontology.

EAPS Staff

12.465 Sedimentary Geology
(Subject meets with 12.110)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-3-6 H-LEVEL Grad Credit
See description under subject 12.110.

EAPS Staff

12.467 Seminar in Geomorphology
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
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: Physics II (GIR), Calculus II (GIR); or permission of instructor
G (Fall, Spring)
4-0-8
See description under subject 12.170.

L. Elkins-Tanton

12.472 Building Earth-like Planets: From Nebular Gas to Ocean Worlds
(Subject meets with 12.172)
Prereq: Physics II (GIR), Calculus II (GIR); or permission of instructor
G (Spring)
3-0-9
See description under subject 12.472.

L. Elkins-Tanton
12.473 Paleomagnetism and Planetary Magnetism
Prereq: 12.002, 18.03; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
2-0-4
Introduces the study of natural remanent magnetization and the generation of planetary magnetic fields. Topics include paleomagnetism, rock magnetism, geomagnetism, magnetostriatigraphy, 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 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit

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.
S. Bowring, S. Rondey

12.475 Plate Tectonics and Continental Deformation
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6 H-LEVEL Grad Credit

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.
B. C. Burchfiel, L. H. Royden

12.476 Radiogenic Isotope Geology
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-3-6 H-LEVEL Grad Credit

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.
S. Bowring

12.478 Pressure-Temperature-Time Evolution of Orogenic Belts
Prereq: 3.01 or 5.60; 12.109, 18.03
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit

Multidisciplinary introduction to modern techniques used to analyze burial and uplift histories of metamorphic terrains. Includes: geochronologic systems; closure temperature theory and the use of geochronologic systems as thermochronometers; geothermometry and geobarometry; thermodynamic modeling of P-T paths; thermal structure of orogenic belts, with emphasis on characteristic length scales and time scales for thermal events; and geophysical analysis of burial and uplift trajectories for metamorphic terrains.
L. H. Royden

12.479 Trace-Element Geochemistry
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Focuses on element distribution in rocks and minerals using data obtained from natural and experimental systems. Emphasizes models describing trace-element partitioning and applications of trace-element geochemistry to problems in igneous geology.
F. A. Frey

12.480 Thermodynamics for Geoscientists
Prereq: 5.60 or 3.00
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-3-6 H-LEVEL Grad Credit

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: 12.108, 12.113, 12.114, 12.115
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
2-2-H-LEVEL Grad Credit
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.
B. C. Burchfiel

12.482 Advanced Field Geology II
Prereq: 12.481
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

In January, a geological and geomorphological study of a selected field area is conducted during a four-week excursion. The following term includes: preparation of maps and report based on field study conducted in January; and laboratory analysis of samples.
B. C. Burchfiel

12.484 Directed Field Studies
Prereq: Permission of instructor
G (IAP)
0-6-0
Can be repeated for credit

Intensive training in field geological methods. Includes specific exercises selected to complement the backgrounds of the students enrolled and provides supervised experience in applying field analytical techniques to geological problems. Cannot be taken as a substitute for 12.115. Preference will be given to students associated with Course 12. Enrollment limited; students should apply early.
B. C. Burchfiel

12.485 Advanced Directed Field Studies
Prereq: 12.484
G (IAP)
0-6-0
Can be repeated for credit

Continuation of 12.484. Designed to provide more advanced training in specific field geological methods. Can be taken during the same IAP period as 12.484. Preference will be given to students associated with Course 12. Enrollment limited; students should apply early.
Staff
12.486 Advanced Igneous Petrology
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-2-7 H-LEVEL Grad Credit
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 rifting 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 geoscience 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

12.488-12.489 Advanced Seminar in Structural Geology
Prereq: None
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Investigations, laboratory work, or fieldwork in structural geology.

Geology and Geochemistry Staff

12.490-12.491 Advanced Seminar in Geology and Geochemistry
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Problems of current interest in geology and geochemistry. Subject matter varies from term to term. 12.490 is letter-graded.

Geology and Geochemistry Staff

Geophysics

12.507 Environmental Geophysics
(Subject meets with 12.214)
Prereq: 18.03
G (Spring)
3-3-6

See description under subject 12.214.

F. D. Morgan

12.510 Introduction to Seismology
Prereq: 18.075 or 18.085
G (Spring)
3-1-8 H-LEVEL Grad Credit

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 (WKBJ 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.

R. D. van der Hilst

12.515 Data and Models
Prereq: 18.075 or 18.085
G (Fall)
3-0-9 H-LEVEL Grad Credit

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

12.520 Geodynamics
Prereq: 12.005; 18.075 or 18.085
G (Fall)
3-0-9 H-LEVEL Grad Credit

Mechanics of deformation of the crust and mantle, with emphasis on the importance of different rheological descriptions: brittle, elastic, linear and nonlinear fluids, and viscoelastic.

B. H. Hager

12.521 Computational Geophysical Modeling
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

An introduction to theory, design, and practical methods of computational modeling in geodynamics. Covers the most effective and widely used numerical modeling approaches and emphasizes problem-solving skills through illustrative examples of heat and mass transfer in the mantle, mechanisms of lithosphere deformation, and other meso-scale geodynamical topics. 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; 18.076 or 18.085
G (Fall)
3-0-9 H-LEVEL Grad Credit

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)

12.524 Mechanical Properties of Rocks
Prereq: 8.03, 18.03
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

A survey of the mechanical behavior of rocks in natural geologic situations. Topics: brief survey of field evidence of rock deformation, physics of plastic deformation in minerals, brittle fracture and sliding, and pressure-solution processes. Results of field petrologic and structural studies compared to data from experimental structural geology.

B. Evans

12.525 Mechanisms of Faulting and Earthquakes
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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
12.533 Rock Physics
Prereq: Permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit

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: Physics I (GIR), Calculus II (GIR), 18.06
G (Spring)
3-1-8 H-LEVEL Grad Credit

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 (Fall)
3-0-9 H-LEVEL Grad Credit

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.

S. Rondenay and A. Malcolm

12.560–12.561 Special Seminar in Exploration Geophysics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Advanced seminar focusing on areas of current interest in exploration geophysics and seismology. Taught by visiting lecturers. 12.560 is letter-graded.

Geophysics Staff

12.570 Topical Issues in Global Geophysics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
Units arranged H-LEVEL Grad Credit
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, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Problems of current interest in geophysics; subject matter varying from term to term.

Geophysics Staff

12.575 Introduction to Mineral Physics
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9

Develops knowledge of the materials that constitute the Earth and planetary interiors and are fundamental to understanding the structures and dynamics of the planets. Discusses crystal structures, elastic and thermodynamic properties, equations of state, chemical reactions, and phase relations of materials at the mantle and the core. Instruction on use of laboratory or theoretical mineral physics data for the interpretation of seismic observations and the construction of dynamic models for the Earth and planetary interiors.

S.-H. Shim

12.580–12.581 Current Research in Geophysics
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

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

See description under subject 12.086.

D. H. Rothman

12.590 Advanced Seminar in Geophysics
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

12.591 Advanced Seminar in Geophysics
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Problems of current interest in geophysics. Subject matter varies from term to term.

Geophysics Staff

12.601 Essentials of Planetary Science
Prereq: 8.03, 18.03
G (Spring)
3-0-9 H-LEVEL Grad Credit

Reviews fundamental physical concepts pertaining to the study of the solar system, and highlights recent spacecraft results. Topics include: meteorites, orbital dynamics, asteroids, impact craters, surfaces, atmospheres, atmospheric dynamics, interiors, magnetospheres, rings, comets, formation of the solar system.

B. Weiss

12.602 Asteroids and Small Bodies
Prereq: Physics II (GIR), 18.03
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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. Subject 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 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Introduction to chaotic behavior in conservative systems, with examples drawn primarily from the rotation and orbital dynamics of planets and satellites. Includes surfaces of section, Lyapunov exponents, perturbation theory, KAM theorem, resonances, onset of chaos, double pendulum, Henon-Heiles problem, restricted three-body problem, spin-orbit coupling, orbital resonances, adiabatic invariants, adiabatic chaos, tidal evolution, capture into resonance, and stability of the solar system.

J. Wisdom

12.611 Advanced Planetary Observations
Prereq: Permission of instructor
G (IAP)
0-6-3 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Astronomical observations involving several techniques are carried out at a major observatory, with focus on a particular set of objectives that change from year to year. Work includes: critical planning of the observations; acquiring the data; calibrating the data; and on-site data reduction.

J. L. Eliot

12.616 Occultations, Eclipses, and Transits
Prereq: 8.03, 18.03 or 18.034
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Basic principles underlying occultation, eclipse, and transit phenomena, by solar system bodies and extra-solar planets, as observed throughout the electromagnetic spectrum from spacecraft and Earth-based platforms. Methods for predicting the times and locations where these phenomena will be visible and the techniques used for their observation. Data interpretation through physical modeling of the interaction (including gravitational lensing) of electromagnetic radiation with planetary limbs, rings, and atmospheres.

J. L. Eliot

12.620J Classical Mechanics: A Computational Approach
(Same subject as 6.946J, 8.351J)
(Subject meets with 12.008)
Prereq: Physics I (GIR), 18.03, permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit

See description under subject 12.008.

J. Wisdom, G. J. Sussman

12.625 Extrasolar Planets: Physics and Detection Techniques
(Subject meets with 12.425)
Prereq: 8.03, 18.03
G (Fall)
3-0-9

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 2011–2012: Not offered
Acad Year 2012–2013: G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall, Spring)
3-0-9 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

In-depth discussion of current and classic literature on selected topics in the specialty areas of asteroids and the Pluto-Charon system. Topics vary from year to year.

R. P. Binzel

12.680 Advanced Seminar in Planetary Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

12.681 Advanced Seminar in Planetary Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Problems of current interest in planetary science. Subject matter varies from term to term.

Planetary Science Staff

12.690-12.691 Current Research in Planetary Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Investigations, laboratory work, or fieldwork in planetary science. 12.690 is letter-graded.

Planetary Science Staff

Geological, Geophysical, and Chemical Oceanography

12.707 Pre-Pleistocene Paleoceanography and Paleoclimatology
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Climate history of the Earth from the formation of the early atmosphere and ocean to the present. Evaluation of geochemical, sedimentological, and paleontological evidence for changes in ocean circulation, global temperatures, and atmospheric carbon dioxide levels. Theories and models of Phanerozoic climate change. Long-term history of the global carbon cycle.

WHOI Staff

12.708 Advanced Seminar in Paleoceanography
Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Advanced 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, J. McManus, O. Marchal (WHOI)
12.710 Marine Geology and Geophysics I
Prereq: Permission of instructor  
G (Fall)  
3-2-7 H-LEVEL Grad Credit  
An introduction to marine geology and geophysics suitable for any student interested in the ocean sciences. Also intended as part of a two-term sequence for first-year MIT-WHOI Joint Program students in marine geology and geophysics (MG&G). Topics include: deposition and preservation of marine sediments, climate proxies, Cenozoic to Holocene climate history, paleoceanography, marine stratigraphy and geochronology, structure of the earth, structure of oceanic crust, evolution of the oceanic lithosphere, mantle geodynamics, plate tectonics, ocean altimetry, and coastal sediment processes.

J. McManus, R. Reves-Sohn, K. Sims

12.711 Marine Geology and Geophysics II  
Prereq: 12.710  
G (Spring)  
3-2-7 H-LEVEL Grad Credit  
An introduction to marine geology and geophysics intended as part of a two-term sequence for first-year MIT-WHOI Joint Program students in marine geology and geophysics. Topics include: lithosphere evolution and mantle dynamics, the structure and composition of the oceanic crust and mantle, tectonic and magmatic processes at mid-ocean ridges, hotspot volcanism, subduction and arc magmatism, and the crustal structure and sedimentation history of continental margins.

N. Shimizu, D. Smith, S. Humphris

12.712 Advanced Marine Seismology
Prereq: 12.711  
Acad Year 2011–2012: G (Spring)  
Acad Year 2012–2013: Not offered  
3-0-6 H-LEVEL Grad Credit  
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 WKB 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 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
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 Igneous Processes at Oceanic Margins
Prereq: 12.710, 12.711, or permission of instructor  
Acad Year 2011–2012: G (Fall)  
Acad Year 2012–2013: Not offered  
3-2-4 H-LEVEL Grad Credit  
Can be repeated for credit  
Quantitative analysis of melting, melt transport, and igneous crustal accretion at oceanic spreading centers, rifted continental margins, and subduction-related arcs, applied to understanding variation in composition and volume of the Earth’s crust in different tectonic environments. Theoretical methods for calculation of melt volume and composition, solid-liquid equilibria and reaction rates, and liquid density and viscosity combined with field, petrographic, geochemical, and computational techniques. Topics vary from year to year.

H. Dick, G. Gaetani (WHOI)

12.721 Current Problems in Marine Geology and Geophysics at Woods Hole
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
Investigations, laboratory work, or fieldwork in marine geology and geophysics.

WHOI Staff

12.722 Current Problems in Chemical Oceanography at Woods Hole
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
For graduate students desiring to perform investigations, laboratory work, or fieldwork in chemical oceanography.

WHOI Staff

12.730–12.731 Current Problems in Marine Geology and Geophysics at MIT
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
For students in the MIT/WHOI Joint Program desiring to perform investigations, laboratory work, or fieldwork in marine geology and geophysics under the supervision of a faculty member in residence at MIT. 12.730 is letter-graded.

Marine Geology and Geophysics Staff

12.735–12.736 Current Problems in Chemical Oceanography at MIT
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
For students in the MIT/WHOI Joint Program desiring to perform investigations, laboratory work, or fieldwork in chemical oceanography under the supervision of a faculty member in residence at MIT. 12.735 is letter-graded.

Chemical Oceanography Staff

12.740 Paleoclimatology
Prereq: Permission of instructor  
Acad Year 2011–2012: G (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9 H-LEVEL Grad Credit  
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...
12.744 Marine Isotope Chemistry
Prereq: 12.748 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
2-0-4 H-LEVEL Grad Credit
Focuses on isotope systematics applied to important problems in marine chemistry, specifically isotope systematics of light stable isotopes and intermediate mass stable isotope systematics.
W. Jenkins, J. Hayes (WHOI)

12.745 Ore Deposition at Submarine Ridge Axes
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Staff

12.746 Marine Organic Geochemistry
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Provides an understanding of the distribution of organic carbon (OC) in marine sediments from a global and active systems 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, T. I. Eglinton (WHOI)

12.747 Modeling, Data Analysis, and Numerical Techniques for Geochemistry
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Emphasizes the basic skills needed for handling and assimilating data as well as the basic toolset 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. Glover, W. Jenkins, S. Doney (WHOI)

12.748 Introduction to Isotope Chemistry
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
Teaches fundamental aspects of isotope chemistry applied to the ongoing evolution of Earth and its major geochemical reservoirs (core, mantle, oceanic and continental crusts, seawater) in the context of solar system evolution. The course introduces students to nuclear physics, nucleosynthesis, mass spectrometry, isotope fractionation processes and the application of important isotope groups to fundamental processes in Earth’s chemical evolution.
W. Jenkins, J. Hayes, K. Sims (WHOI)

12.749 Solid Earth Geochemistry
Prereq: 12.748 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
2-0-4 H-LEVEL Grad Credit
Uses the isotopic methods and tools developed in 12.748, in conjunction with major and trace element systematics to examine in detail the fundamental processes of solid Earth accretion and differentiation. Introduces concepts of nebular condensation, meteorites and their parent bodies, origin and evolution of the moon, planetary differentiation, formation and evolution of the Earth’s mantle and crust, and magmatism in ocean basins.
K. Sims, G. Gaetani (WHOI)

12.751–12.759 Seminar in Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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)
Units arranged [P/D/F] H-LEVEL Grad Credit
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)
Units arranged [P/D/F] H-LEVEL Grad Credit
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

Atmospheres, Oceans, and Climate

12.800 Fluid Dynamics of the Atmosphere and Ocean
Prereq: 8.03, 18.04
G (Fall)
3-0-9 H-LEVEL Grad Credit
J. Pedlosky (WHOI)

12.801 The General Circulation of the Ocean
Prereq: 12.800
G (Spring)
3-0-9 H-LEVEL Grad Credit
Fundamental principles of geophysical fluid dynamics are applied to the ocean to understand and describe its global circulation patterns. Includes geostrophic dynamics, planetary geostrophy, Ekman pumping, wind and thermally driven ocean circulation, thermocline theory, western-boundary current dynamics, abyssal circulation, mixing, dynamics of circumpolar jets, baroclinic instability, geostrophic turbulence, eddy-mean flow interaction.
J. Marshall

12.802 Wave Motions in the Ocean and Atmosphere
Prereq: 12.800
G (Spring)
3-0-9 H-LEVEL Grad Credit
Basic ideas of geophysical wave motion in rotating, stratified, and rotating-stratified fluids. Subject begins with general wave concepts of phase and group velocity. The dynamics and kinematics of gravity waves with a focus on dispersion, energy flux, initial value problems, etc. Subject foundation used to study internal and inertial waves, Kelvin, Poincare, and Rossby waves in homogeneous and stratified fluids. Laplace tidal equations are applied to equatorial waves. Other topics include: resonant interactions, potential vorticity, wave-mean flow interactions, and instability.
G. Flierl and P. O’Gorman

12.803 Quasi-balanced Circulations in Oceans and Atmospheres
Prereq: 12.800, Coreq: 12.804
G (Fall)
3-0-9 H-LEVEL Grad Credit
Dynamics of large-scale circulations in oceans and atmospheres, taken concurrently with the laboratory subject 12.804. Basic concepts include mass and momentum conservation, hydrostatic and geostrophic balance, and pressure and other vertical coordinates. Barotropic vorticity equation: potential vorticity (PV) and invertibility; Greens functions/point vortices; balance in forced flow, waves, and vortices. Shallow water equations, geostrophic adjustment. Stratified atmospheres and oceans: thermodynamics. The quasi-geostrophic (QG) equations, pseudo potential vorticity. Barotropic and baroclinic instabilities and the Rayleigh, Fjortoft and Charney-Stern theorems. Eady and Charney models. The superposition theorem and the continuous spectrum. Effects of boundary friction, upward wave radiation, and phase change of water. Frontogenesis and semigeostrophy.
K. A. Emanuel

12.804 Large-scale Flow Dynamics Laboratory
Prereq: 12.800, Coreq: 12.803
G (Fall)
0-3-6 H-LEVEL Grad Credit
Laboratory component of subject 12.803. Analysis of observations of oceanic and atmospheric quasi-balanced flows, computational models, and rotating tank experiments. Illustrates the basic principles of potential vorticity conservation and inversion, Rossby wave propagation, baroclinic instability, and the behavior of isolated vortices.
L. Iliari, G. Flierl

12.805 Laboratory in Physical Oceanography
Prereq: 12.808
G (Spring)
2-2-5 H-LEVEL Grad Credit
An introduction to standard data analysis methods including time series analysis, objective mapping, empirical orthogonal functions, and dynamic analysis of hydrographic data. Emphasis on working with data in a computer laboratory setting using packaged software. Where appropriate, comparison is made with simple models. Some attention given to the instruments and algorithms used to acquire the data.
WHOI Staff

12.806J Atmospheric Physics and Chemistry
(Subject as 10.571J)
(Subject meets with 12.306)
Prereq: 5.61, 18.075, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

12.807J Atmospheric Chemistry
(Subject as 1.84J, 10.817J)
Prereq: 5.60
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.84J.
J. H. Kroll

12.808 Introduction to Observational Physical Oceanography
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
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.
F. Straneo, Y. Kwon (WHOI)
12.809 Hydraulic Phenomena in Geophysical Fluid Flows
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit

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 (WHOI)

12.810 Dynamics of the Atmosphere
(Subject meets with 12.333)
Prereq: 12.800
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 12.333.
R. A. Plumb

12.811 Tropical Meteorology
Prereq: 12.810 or Coreq: 12.803
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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, Coreq: 12.803, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Explains the main features of the general circulation of the Earth's atmosphere. Final part of the course explores possible changes in the general circulation associated with climate change.
P. O'Gorman

12.815 Atmospheric Radiation
(Subject meets with 12.816)
Prereq: 5.61, 18.075, or permission of instructor
G (Fall)
2-2-2 H-LEVEL Grad Credit

Introduction to the physics of atmospheric radiation and remote sensing, including use of computer codes. Radiative transfer equation including emission and scattering, spectroscopy, Mie theory, and numerical solutions. Solution of inverse problems in remote sensing of atmospheric temperature and composition.

S. Seager, R. A. McClatchey

12.816 Atmospheric Radiation: Independent Study
(Subject meets with 12.815)
Prereq: 5.61, 18.075 or Permission of instructor
G (Fall)
2-2-5 H-LEVEL Grad Credit

Lecture content is the same as 12.815, but it is augmented by the development of an independent student project with associated term paper. S. Seager

12.818 Introduction to Atmospheric Data and Synoptic Meteorology
Prereq: None. Coreq: 12.800
G (Fall)
3-3-6 H-LEVEL Grad Credit

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. Balance concepts as applied to the dynamics of frontal and synoptic scales are illustrated using real-time upper air and surface station data and gridded analyzed fields. Advanced meteorological software packages are used to access, manipulate, and graphically display the data.

L. Illari

12.820 Turbulence in the Ocean and Atmosphere
Prereq: 12.803
G (Spring)
3-0-6 H-LEVEL Grad Credit

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 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6 H-LEVEL Grad Credit


G. Flierl

12.824 Stability Theory for Oceanic and Atmospheric Flows
Prereq: 12.802 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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: 12.803; 12.802 or 12.810
G (Fall)
3-0-9 H-LEVEL Grad Credit

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.
R. S. Lindzen
12.831 Dynamics and Transport in the Stratosphere
Prereq: 12.803 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
R. A. Plumb

12.835 Experimental Atmospheric Chemistry
(Subject meets with 12.335)
Prereq: Permission of instructor
G (Fall)
2-4-6 H-LEVEL Grad Credit
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

12.836 Climate Physics and Chemistry
(Subject meets with 12.301)
Prereq: Chemistry (GIR), 18.03, or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 12.301.
C. Wunsch, E. Boyle, K. Emanuel

12.844j Modeling and Assessment for Policy
(Same subject as ESD.864j)
Prereq: ESD.10 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.864j.
N. Selin

12.845j Sustainability Science and Engineering
(Same subject as ESD.120j)
Prereq: permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.120j.
N. Selin

12.846j Global Environmental Science and Politics (New)
(Same subject as ESD.110j)
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-6
See description under subject ESD.110j.
N. Selin

12.848j Global Climate Change: Economics, Science, and Policy
(Same subject as 15.023j, ESD.128j)
(Subject meets with 12.348j, 15.026j)
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
G (Spring)
3-0-6
See description under subject 15.023j.
R. G. Prinn, M. D. Webster

12.860 Oceanography
Prereq: 12.800, 12.801, 12.802
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6 [P/D/F] H-LEVEL Grad Credit
Addresses the phenomena of tidal and solar insolation (Milankovitch theory) forcing in parallel, using one to illuminate the other. Describes their roles in the modern and paleoclimate systems. Uses real records as exercises in the practical application of time series and modeling methods.
C. Wunsch

12.862 Coastal Physical Oceanography
Prereq: 12.800
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to the dynamics of flow over the continental shelf, 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.
K. Brink (WHOI)

12.863 Special Topics in Coastal Physical Oceanography
Prereq: 12.862 or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit
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, 12.802
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
R. X. Huang (WHOI)

12.867 Orbital Forcing in the Climate System
Prereq: 12.301 or 12.842; 18.03 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6 [P/D/F] H-LEVEL Grad Credit
Addresses the phenomena of tidal and solar insolation (Milankovitch theory) forcing in parallel, using one to illuminate the other. Describes their roles in the modern and paleoclimate systems. Uses real records as exercises in the practical application of time series and modeling methods.
C. Wunsch

12.870 Air-Sea Interaction: Boundary Layers
Prereq: Graduate-level fluid mechanics and a subject on waves, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
J. Trowbridge, E. Terray (WHOI)
12.950–12.951 Seminar in Physical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
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 Problems in Physical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Special investigations, special laboratory work, or special fieldwork in oceanography. 12.960 is letter-graded.
Physical Oceanography Staff

12.970–12.971 Current Problems in Physical Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Reading, consultation, and original investigation on oceanographic problems. 12.970 is letter-graded.
Woods Hole Staff

12.980–12.981 Current Research in Meteorology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Reading, consultation, and original investigations on meteorological problems. 12.980 is letter-graded.
Meteorology Staff
## Bachelor of Science in Earth, Atmospheric, and Planetary Sciences
### Course 12

#### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Subjects

#### Core Material:

- **12.001** Introduction to Geology, 12, REST
- **12.003** Physics of the Atmosphere and Ocean, 12, REST; Physics I (GIR), Calculus II (GIR)
- **12.009** Theoretical Environmental Analysis, 12; Physics I (GIR); 18.03
- **18.03** Differential Equations, 12, REST; Calculus II (GIR)
- or **18.034** Differential Equations, 12, REST; Calculus II (GIR)
- **12.TIP** Thesis and Independent Study Preparation, 6
- **12.ThU** Undergraduate Thesis (at least 6 units), CI-M; 12.TIP

#### Laboratory/Field Subjects:

One of the following:

- **12.115** Field Geology II, 18, LAB, CI-M; 12.113, 12.114
- **12.221** Field Geophysics, 6
- and **12.222** Field Geophysics Analysis, 6, CI-M; 12.221
- **12.307** Weather and Climate Laboratory, 12, LAB, CI-M; Calculus II (GIR), Physics I (GIR)
- **12.335** Experimental Atmospheric Chemistry, 12, LAB, CI-M; Chemistry (GIR)
- **12.410J** Observational Techniques of Optical Astronomy, 15, LAB, CI-M; 8.282*; 8.03

The remainder of the program consists of 72 units from either the Discipline or Supporting Science subjects; no more than 48 units can be from Supporting Science. The program of study must be approved by the student’s academic advisor and the undergraduate committee of the department.

### Discipline Subjects

- **12.002** Physics of the Terrestrial Planets, 12, REST; Physics II (GIR), Calculus II (GIR)
- **12.005** Applications of Continuum Mechanics to Earth, Atmospheric, and Planetary Sciences, 12; Physics II (GIR), Calculus II (GIR); 18.03
- **12.006** Nonlinear Dynamics I: Chaos, 12; Physics II (GIR), 18.03*
- **12.007** Geology of Life on Earth, 12
- **12.008** Classical Mechanics: A Computational Approach, 12; Physics I (GIR), 18.03*, permission of instructor
- **12.023** Earth Science, Energy, and the Environment, 12; Physics I (GIR), Calculus I (GIR), Chemistry (GIR)
- **12.086** Observational Techniques of Optical Astronomy, 15, LAB, CI-M; 8.282*; 8.03
- **12.102** Environmental Earth Science, 12, REST
- **12.104** Geochemistry of the Earth and Planets, 12; Calculus II (GIR)
- **12.108** Structure of Earth Materials, 12; Chemistry (GIR)
- **12.109** Petrology, 15; 12.108
- **12.110** Sedimentary Geology, 12; 12.001
- **12.113** Structural Geology, 12; 12.001, 12.005
- **12.114** Field Geology I, 6; 12.108*, 12.113
- **12.119** Analytical Techniques for Studying Environmental and Geologic Samples, 12, LAB
- **12.120** Environmental Earth Science Field Course, 6; permission of instructor
- **12.158** Molecular Biogeochemistry, 9; permission of instructor
- **12.163** Geomorphology, 12; 12.001, Physics I (GIR), Calculus I (GIR); or permission of instructor
- **12.170** Essentials of Geology, 12; Physics II (GIR), Calculus II (GIR); or permission of instructor
- **12.172** Building Earth-like Planets: From Nebular Gas to Ocean Worlds, 12; Physics II (GIR), Calculus II (GIR); or permission of instructor
- **12.201** Essentials of Geophysics, 12; Physics II (GIR), 18.03
- **12.207** Nonlinear Dynamics II: Continuum Systems, 12; 12.006*
- **12.213** Alternate Energy Sources, 6
- **12.216** Environmental Geophysics, 12; 18.03
- **12.301** Past and Present Climate, 12; Chemistry (GIR)*
- **12.310** An Introduction to Weather Forecasting, 6; Physics I (GIR), Calculus I (GIR)
- **12.333** Atmospheric and Ocean Circulations, 12; 12.003
- **12.340** Global Warming Science, 12; Physics I (GIR)*, 5.60
- **12.348** Global Climate Change: Economics, Science, and Policy, 9; Calculus II (GIR), 5.60, 14.01*; or permission of instructor
<table>
<thead>
<tr>
<th>COURSE</th>
<th>Title</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.420</td>
<td>Physics and Chemistry of the Solar System, 12; 12.002*</td>
<td></td>
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<tr>
<td>12.425</td>
<td>Extrasolar Planets: Physics and Detection Techniques, 12, REST; Physics I (GIR), Calculus I (GIR)</td>
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<tr>
<td>12.43J</td>
<td>Space Systems Engineering, 12; permission of department</td>
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<tr>
<td>12.431J</td>
<td>Space Systems Development I, 12, LAB; 16.83J</td>
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</tbody>
</table>

**Supporting Science Subjects**

1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)
1.060 Engineering Mechanics II, 12; permission of instructor*
1.063 Transport Processes in the Environment, 12; 1.060; 1.070; or permission of instructor
1.080 Environmental Chemistry and Biology, 12; Chemistry (GIR), Biology (GIR)
3.002 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*
5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)
5.03 Principles of Inorganic Chemistry I, 12; 5.12
5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)
5.61 Physical Chemistry, 12; REST; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)
6.00 Introduction to Computer Science and Programming, 12, REST
7.03 Genetics, 12; REST; Biology (GIR)
7.05 General Biochemistry, 12, REST; 5.12*
7.21 Microbial Physiology, 12; 7.03, 7.05
8.03 Physics III, 12, REST; Physics II (GIR), Calculus II (GIR)
8.04 Quantum Physics I, 12, REST; 8.03*, 18.03*
8.044 Statistical Physics I, 12; 8.03, 18.03
8.07 Electromagnetism II, 12; 8.03, 18.03
8.09 Classical Mechanics III, 12; Physics I (GIR)
8.21 Physics of Energy, 12, REST; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)
12.010 Computational Methods of Scientific Programming, 12; Calculus II (GIR), Physics I (GIR)
12.320 Introduction to Hydrology, 12; 1.060; 1.070, 1.106
18.04 Complex Variables with Applications, 12; Calculus II (GIR), 18.03*
18.05 Introduction to Probability and Statistics, 12, REST; Calculus I (GIR)
18.06 Linear Algebra, 12, REST; Calculus II (GIR)
18.100 Real Analysis I, 12; Calculus II (GIR), 18.03*
18.311 Principles of Applied Mathematics, 12; Calculus II (GIR), 18.03*

*Alternate prerequisites and corequisites are listed in the subject description.

Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
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<td>36</td>
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Unrestricted Electives

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<tr>
<th>Units</th>
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<tr>
<td>66–72</td>
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</tbody>
</table>

**Total Units Beyond the GIRs Required for SB Degree**

180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

*Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
COURSE 14

ECONOMICS

GENERAL ECONOMICS AND THEORY

14.003 Microeconomic Theory and Public Policy (Subject meets with 14.03)
Prereq: 14.01
G (Fall, Spring)
4-0-8
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.
Fall: D. Autor
Spring: S. Ryan

14.01 Principles of Microeconomics
Prereq: None
U (Fall, Spring)
3-0-9 HASS-S (HASS-E)
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.
Fall: J. Gruber
Spring: J. Harris

14.02 Principles of Macroeconomics
Prereq: None
U (Fall, Spring)
3-0-9 HASS-S (HASS-E)
Provides an overview of macroeconomic issues: the determination of output, employment, unemployment, interest rates, and inflation. Monetary and fiscal policies are discussed. Important current policy debates such as the sub-prime crisis, social security, the public debt, and international economic issues are critically explored. Introduces basic models of macroeconomics and illustrates principles with the experience of the US and foreign economies.
Fall: R. Gurkaynak
Spring: F. Giavazzi

14.03 Microeconomic Theory and Public Policy (Subject meets with 14.003)
Prereq: 14.01
U (Fall, Spring)
4-0-8 HASS-S (HASS-E)
See description under subject 14.003.
Fall: D. Autor
Spring: S. Ryan

14.04 Intermediate Microeconomic Theory
Prereq: 14.01, Calculus II (GIR)
U (Fall)
4-0-8 HASS-S (HASS-E)
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.
J. Toikka

14.05 Intermediate Applied Macroeconomics
Prereq: 14.01, 14.02
U (Spring)
4-0-8 HASS-S (HASS-E)
Uses the tools of macroeconomics to study various macroeconomic policy problems in depth. The problems range from economic growth in the long run to government finances in the intermediate run and economic stability in the short run. Many economic models used today are surveyed. Requires a 20-page paper on the economics of long-run economic growth.
G. M. Angeletos

14.07 Technical Topics in Economics
Prereq: 14.01
U (Fall, Spring)
4-0-8 HASS-S (HASS-E)
Can be repeated for credit
Consider technical issues of current research interest in economics.
Consult Department Headquarters.

14.09 Reading Seminar in Economics
Prereq: 14.04, 14.06
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Readings and discussion of particular topics in economics. Open to undergraduate students by arrangement with individual faculty members.
Consult Department Headquarters.
S. Ellison

14.11 Special Topics in Economics
Prereq: 14.04, 14.06
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Consider issues of current research interest in economics.
Consult Department Headquarters

14.12 Economic Applications of Game Theory
Prereq: 14.01; 14.03, 6.041 or permission of instructor
U (Fall)
4-0-8 HASS-S (HASS-E)
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, permission of instructor
G (Fall; first half of term)
3-0-3 H-LEVEL Grad Credit
Covers consumer and producer theory, markets and competition, and general equilibrium. Stud-
ies the tools of comparative statics and their application to price theory. Enrollment limited.

P. Pathak

14.122 Microeconomic Theory II
Prereq: 14.121, permission of instructor
G (Fall; second half of term)
3-0-3 H-LEVEL Grad Credit

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, permission of instructor
G (Spring)
3-0-3 H-LEVEL Grad Credit

Models of individual decision-making under certainty and uncertainty. Additional topics in game theory. Enrollment limited.

M. Yildiz

14.124 Microeconomic Theory IV
Prereq: 14.123, permission of instructor
G (Spring)
3-0-3 H-LEVEL Grad Credit

Decision making under uncertainty, information economics, incentive and contract theory. Enrollment limited.

J. Toikka

14.126 Game Theory
Prereq: 14.122
G (Spring)
3-0-9 H-LEVEL Grad Credit

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, 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.

M. Yildiz

14.129 Advanced Contract Theory
Prereq: 14.121, 14.281, or permission of instructor
G (Spring)
3-0-3 H-LEVEL Grad Credit

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.

R. Townsend

14.13 Economics and Psychology
Prereq: 14.03
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8 HASS-S (HASS-E)

Introduction to theoretical and empirical literature in the new field of behavioral economics. Examines important and systematic departures from the predictions of the standard model in economics; covers intertemporal tradeoffs, risk preferences, social preferences, and intrinsic motivation; and applies theory to many different areas, such as credit card debt, addiction, portfolio choices, labor supply, and compensation policies of firms. Students review evidence from lab experiments, examine how the results can be integrated into models, and test models using field and lab data.

Consult Department Headquarters

14.137 Psychology and Economics
Prereq: None
G (Spring)
4-0-8

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 H-LEVEL Grad Credit

Advanced subject on topics of current research interest.

J. Toikka, M. Yildiz

14.15 Networks
(Same subject as 6.207J)
Prereq: 6.041 or 14.30
U (Fall)
4-0-8 HASS-S (HASS-E)

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.

D. Acemoglu, M. Dahleh

14.16 Strategy and Information
Prereq: 14.12 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8 HASS-S (HASS-E)

Introduces solution concepts for cooperative games and studies non-cooperative implementations. Other topics include matching and allocation problems, auctions and mechanism design, and reputation. Bargaining and networks are recurring themes.

Consult M. Manea

14.160 Experimental and Behavioral Economics
Prereq: 14.122
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit

Introduces techniques of experimental economics and their applications. Emphasizes the relative role of field and lab experiments for the generation of empirical knowledge and the methodology of laboratory experiments. Students design and run their own experiments, testing their chosen hypothesis. Covers the economics of individual economic decisions and social interactions. Discusses experiments on behavioral contract theory, principal-agent theory, labor markets, and asset markets. Considers the extent to which experimental markets approximate the predictions of competitive models; which motivational forces drive cooperation and collective action; how we can best model social preferences; and the systematic behavioral deviations from the homo economicus model.

Consult E. Fehr

14.19 Market Design (New)
Prereq: 14.12 or permission of instructor
U (Spring)
4-0-8 HASS-S

Covers topics in game theory and microeconomic theory beyond those covered in 14.12. Topics

209
may include matching and allocation problems, auctions and mechanism design, incentive and contract theory, networks, non-cooperative and cooperative bargaining, and decision theory.

P. Pathak

14.191 Independent Research Paper
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-12-0 H-LEVEL Grad Credit
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.

E. Duflo

14.198, 14.199 Teaching Introductory Economics
Prereq: None
G (Fall, Spring)
2-0-2 [P/D/F]
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.

14.198: J. Gruber, J. Harris
14.199: R. Gurkaynak, F. Giavazzi

INDUSTRIAL ORGANIZATION

14.20 Industrial Organization and Competitive Strategy
Prereq: 14.01
U (Fall)
4-0-8 HASS-S (HASS-E)

Analyzes the behavior and performance of firms in markets, with a particular focus on strategic interactions. Topics include monopoly power, behavior of firms in oligopoly markets, static and dynamic measurement of market performance, pricing and product choice decisions, advertising, research and development, and theory of the firm. Requires attendance and team participation in a Competitive Strategy Game.

S. Ellison

14.21 Health Economics
Prereq: 14.01
U (Spring)
3-0-9 HASS-S (HASS-E)

Applies theoretical and empirical tools of economics to problems of health and medical care delivery. Concentrates on selected topics such as decision-making under uncertainty, cost-

benefit analysis, health insurance, physician remuneration, government regulation, health care systems of developing countries, and the economics of AIDS.

J. E. Harris

14.26 Economics of Incentives: Theory and Applications
Prereq: 14.04
U (Spring)
4-0-8 HASS-S (HASS-E)

Rigorous, mostly non-technical introduction to the economic theory of incentives in conjunction with a wide range of applications. These include, among others, the optimal design of sales and CEO compensation schemes; the analysis of venture capital and other forms of financing; and the study of stock companies, co-operatives, and other types of organizations viewed as optimal adaptations to information and incentive problems.

B. Holmstrom

14.271 Industrial Organization I
Prereq: 14.04
G (Fall)
5-0-7 H-LEVEL Grad Credit

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.

G. Ellison

14.272 Industrial Organization II
Prereq: 14.271
G (Spring)
5-0-7 H-LEVEL Grad Credit

A continuation of 14.271. Topics covered include horizontal mergers and demand estimation, vertical integration and vertical restraints, natural monopoly and its regulation, public enterprise, political economy of regulation, network access pricing, deregulation of telecommunications, electric power, cable television, transportation sectors, and risk and environmental regulation.

S. Ryan

14.273 Advanced Topics in Industrial Organization
Prereq: 14.271
G (Spring)
5-0-7 H-LEVEL Grad Credit

Studies current research in industrial organization, focusing on specific topics that vary from year to year.

P. Jia, S. Ryan

14.281 Contract Economics
Prereq: 14.124
G (Fall)
4-0-8 H-LEVEL Grad Credit

Covers theoretical research on contracts organized around canonical models 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).

R. Holden, B. Holmstrom

14.282 Introduction to Organizational Economics
Prereq: 14.124
G (Fall)
5-0-7 H-LEVEL Grad Credit

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

14.283 Advanced Topics in Organizational Economics I
Prereq: 14.282
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

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 H-LEVEL Grad Credit

Builds on the work done in 14.282 to develop more in-depth analysis of topics in the field.

R. Gibbons
CONSULT J. E. Harris

Advanced subject in economics of health care sector. Considers selected topics in depth, such as design and financing of health insurance, behavior of nonprofit hospitals, role of competition in the medical care market, determinants of technological change, and effects of government regulations.

Consult J. E. Harris

STATISTICS AND ECONOMETRICS

14.30 Introduction to Statistical Method in Economics
Prereq: Calculus II (GIR)
U (Fall)
4-0-8 REST

Self-contained introduction to probability and statistics with some economic applications. Elements of probability theory, sampling theory, statistical estimation, and hypothesis testing. May not count toward HASS requirement.

14.32 Econometrics
Prereq: 14.30
U (Spring)
4-0-8

Introduction to econometric models and techniques, simultaneous equations, program evaluation, emphasizing regression. Advanced topics include instrumental variables, panel data methods, measurement error, and limited dependent variable models. Includes problem sets. May not count toward HASS requirement.

A. Mikusheva

14.33 Research and Communication in Economics: Topics, Methods, and Implementation
Prereq: 14.04, 14.05, 14.32
U (Fall, Spring)
3-4-5 Institute LAB

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.

Fall: H. Williams
Spring: S. Ellison

14.36 Advanced Econometrics
Prereq: 14.30, 14.32
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8

Covers a range of topics including duration models, discrete choice models, differentiated product models, count models and other advanced models that are used in a wide variety of applications in applied microeconomics, financial economics, and business economics. Mastery of one or more techniques taught in class demonstrated through the completion of an econometrics paper.

J. Hausman

14.381 Statistical Method in Economics
Prereq: Calculus II (GIR), permission of instructor
G (Fall)
5-0-7 H-LEVEL Grad Credit

Introduction to probability and statistics as background for advanced econometrics and introduction to the linear regression model. Covers elements of probability theory; sampling theory; asymptotic approximations; decision-theory approach to statistical estimation focusing on regression, hypothesis testing; and maximum-likelihood methods. Includes simple and multiple regression, estimation and hypothesis testing. Illustrations from economics and application of these concepts to economic problems. Enrollment limited.

V. Chernozhukov, A. Mikusheva

14.382 Econometrics
Prereq: 14.381 or permission of instructor
G (Spring)
5-0-7 H-LEVEL Grad Credit

Regression analysis, focusing on departures from the standard Gauss-Markov assumptions, and simultaneous equations. Regression topics include heteroskedasticity, serial correlation, and errors in variables, generalized least squares, nonlinear regression, and limited dependent variable models. Covers identification and estimation of linear and nonlinear simultaneous equations models. Economic applications are discussed. Enrollment limited.

J. Hausman

14.385 Nonlinear Econometric Analysis
Prereq: 14.382 or permission of instructor
G (Fall)
5-0-7 H-LEVEL Grad Credit

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.

V. Chernozhukov

14.386 New Econometric Methods
Prereq: 14.382
G (Spring)
4-0-8 H-LEVEL Grad Credit

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.

V. Chernozhukov

14.387 Topics in Applied Econometrics
Prereq: 14.382
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring; first half of term)
2-0-4 [P/D/F] H-LEVEL Grad Credit

Covers core econometric ideas and widely used empirical modeling strategies. Begins with instrumental variables, concepts, and methods; then moves on to discussion of differences-in-differences and regression discontinuity methods. Concludes with discussion of standard errors, focusing on issues such as clustering and serial correlation.

Consult J. Angrist

14.389 Econometrics Paper
Prereq: 14.382 or 14.32
G (IAP)
0-0-3 H-LEVEL Grad Credit

Paper in econometrics required of all PhD candidates. Paper due at the end of IAP.

J. Hausman

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 H-LEVEL Grad Credit

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.

V. Chernozhukov, W. Newey

14.386 New Econometric Methods
Prereq: 14.382
G (Spring)
4-0-8 H-LEVEL Grad Credit

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.

V. Chernozhukov

14.387 Topics in Applied Econometrics
Prereq: 14.382
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring; first half of term)
2-0-4 [P/D/F] H-LEVEL Grad Credit

Covers core econometric ideas and widely used empirical modeling strategies. Begins with instrumental variables, concepts, and methods; then moves on to discussion of differences-in-differences and regression discontinuity methods. Concludes with discussion of standard errors, focusing on issues such as clustering and serial correlation.

Consult J. Angrist

14.389 Econometrics Paper
Prereq: 14.382 or 14.32
G (IAP)
0-0-3 H-LEVEL Grad Credit

Paper in econometrics required of all PhD candidates. Paper due at the end of IAP.

J. Hausman

roots, cointegration, estimation of DSGE models, and Bayesian methods. Enrollment limited.

A. Mikusheva

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Prereq: 14.382 or permission of instructor
G (Fall)
5-0-7 H-LEVEL Grad Credit

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V. Chernozhukov, W. Newey

14.386 New Econometric Methods
Prereq: 14.382
G (Spring)
4-0-8 H-LEVEL Grad Credit

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.

V. Chernozhukov

14.387 Topics in Applied Econometrics
Prereq: 14.382
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring; first half of term)
2-0-4 [P/D/F] H-LEVEL Grad Credit

Covers core econometric ideas and widely used empirical modeling strategies. Begins with instrumental variables, concepts, and methods; then moves on to discussion of differences-in-differences and regression discontinuity methods. Concludes with discussion of standard errors, focusing on issues such as clustering and serial correlation.

Consult J. Angrist

14.389 Econometrics Paper
Prereq: 14.382 or 14.32
G (IAP)
0-0-3 H-LEVEL Grad Credit

Paper in econometrics required of all PhD candidates. Paper due at the end of IAP.

J. Hausman
14.391 Workshop in Economic Research
Prereq: 14.124, 14.454
G (Fall)
2-0-10 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
14.392 Workshop in Economic Research
Prereq: 14.124, 14.454
G (Spring)
2-0-10 [P/D/F] H-LEVEL Grad Credit
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.
Consult M. Greenstone

Civil and Environmental Engineering: 1.151, 1.155, 1.202J, 1.203J, 1.205J
Electrical Engineering and Computer Science: 6.041, 6.231, 6.245, 6.262, 6.431, and 6.435
Management: 15.034, 15.070, 15.075, and 15.098
Mathematics: 18.05, 18.175, 18.177, 18.440, 18.443, 18.445, and 18.465
See also: 2.830, 5.70, 5.72, 7.02, 8.044, 8.08, 10.816, 11.220, 11.221, 16.322, 22.38, HST.191, and MAS.622J.

14.42 Environmental Policy and Economics
(Subject meets with 14.420)
Prereq: 14.01
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 HASS-S (HASS-E)
14.420 Environmental Policy and Economics
(Subject meets with 14.42)
Prereq: 14.01
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit
Investigates the proper role of government in the regulation of the environment. Explores the tools necessary to estimate the costs and benefits of environmental regulations and to evaluate a series of current policy questions regarding air and water pollution, the costs of climate change in the US and abroad, and whether there is a “race to the bottom” in environmental regulation. Students help design and execute a research project that tests whether air pollution causes infant mortality. Students taking the graduate version complete additional assignments. Completion of 14.30 recommended.
Consult M. Greenstone

(Same subject as 11.161J, 15.031J, 21A.341J)
Prereq: 14.01 or permission of instructor
U (Spring)
4-0-8 HASS-S (HASS-E)
See description under subject 15.031J.
D. Lessard, R. Schmalensee

14.44J Energy Economics and Policy
(Same subject as 15.037J)
(Subject meets with 14.44J, 15.038J)
Prereq: 14.01
U (Spring)
4-0-8 HASS-S (HASS-E)
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 CO2 emissions. Students taking the graduate version complete additional assignments. 14.44J and 14.444 each limited to 60.
C. Knittel

14.45 Financial Economics
Prereq: 14.03 or 14.04; 14.32
U (Fall)
4-0-8 HASS-S (HASS-E)
Self-contained introduction to the theory of investment decisions under uncertainty. Topics include interest rates, net present value, fixed income securities, the term structure of interest rates, portfolio separation theorems, capital asset pricing models, factor models, risk neutral pricing, valuation of options, and intertemporal consumption and investment models. Emphasis on empirical implementation of theoretical concepts.
V. Chernozhukov

14.451 Dynamic Optimization Methods with Applications
Prereq: 14.06, permission of instructor
G (Fall; first half of term)
3-0-3 H-LEVEL Grad Credit
Provides an introduction to dynamic optimization methods, including discrete-time dynamic
Introduction to current macroeconomic concerns with particular emphasis on medium-run economic fluctuations, economic crises, and the role of asset markets. Topics include the explanation of high chronic unemployment in some nations, the source of modern liquidity crises, the origin and end of speculative bubbles, and the factors that lead to substantial periods of economic stagnation. Enrollment limited.

G. Lorenzoni
information technology in assisting students and workers to learn new skills.

F. Levy

INTERNATIONAL, INTERREGIONAL, AND URBAN ECONOMICS

14.51 Urban and Regional Economics
(Subject meets with 1.283J, 11.410J, 14.573J, ESD.191J)
Prereq: 14.04, 14.32
U (Spring)
3-0-9 HASS-S (HASS-E)

See description under subject 14.573J.

W. Wheaton

14.54 International Trade
Prereq: 14.01, 14.02
U (Fall)
4-0-8 HASS-S (HASS-E)

Introduction to the theory of international trade and finance with applications to current policy issues.

A. Costinot

14.573J Urban and Regional Economics
(Same subject as 1.283J, 11.410J, ESD.191J)
(Subject meets with 14.51)
Prereq: 14.04, 14.32
G (Spring)
3-0-9 H-LEVEL Grad Credit

Focuses on the theory of urban land and housing markets, and the spatial development of cities. Examines the roles played by transportation systems and local governments in shaping urban location patterns. Discusses interregional competition, economic development, and the migration of labor and capital. Students taking the graduate version complete additional assignments.

W. Wheaton

14.581 International Economics I
Prereq: 14.04
G (Fall)
5-0-7 H-LEVEL Grad Credit

Theory of international trade and foreign investment with applications in commercial policy.

A. Costinot

14.582 International Economics II
Prereq: 14.06
G (Spring)
5-0-7 H-LEVEL Grad Credit

Covers international capital flows, exchange rate fluctuations, global capital markets, emerging markets, crises, sovereign debt, international financial architecture, and bubbles.

A. Costinot, G. Lorenzoni

LABOR ECONOMICS AND INDUSTRIAL RELATIONS

14.64 Labor Economics and Public Policy
Prereq: 14.30 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
4-0-8 HASS-S (HASS-E)

Provides an introduction to the labor market, how it functions, and the important role it plays in people’s lives worldwide. 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, 14.32
G (Fall)
5-0-7 H-LEVEL Grad Credit

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, P. Pathak

14.662 Labor Economics II
Prereq: 14.64 or 15.660
G (Spring)
5-0-7 H-LEVEL Grad Credit

The development and evolution of labor market structures and institutions. Particular focus on competing explanations of recent developments in the distribution of wage and salary income and in key institutions and organizational structures. Special attention to theories of worker motivation and behavior, the determination of wages, technology, and social stratification.

D. Autor, H. Williams

14.663 Advanced Topics in Labor Economics
Prereq: 14.661
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit

Studies current research in labor economics, focusing on specific topics that vary from year to year.

Consult D. Autor

14.665J Labor Market Regulation and Career Mobility
(Same subject as 17.314J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 17.314J.

Consult M. Piore

ECONOMIC HISTORY

14.70J Medieval Economic History in Comparative Perspective
(Same subject as 21H.134J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 5); CI-H

See description under subject 21H.134J.

A. McCants

14.72 Capitalism and Its Critics
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-D 4)

Addresses the evolution of the modern capitalist economy and evaluates its current structure and performance. Various paradigms of economics are contrasted and compared (neoclassical, Marxist, socioeconomic, and neocorporate) in order to understand how modern capitalism has been shaped and how it functions in today’s economy. Readings include classics in economic thought as well as contemporary analyses. Stresses general analytic reasoning and problem formulation rather than specific analytic techniques. May not be used for economics concentration. One economics HASS-D subject may be used as an economics elective for the economics major and minor.

M. Piore
14.73 The Challenge of World Poverty
Prereq: None
U (Fall)
4-0-8 HASS-S (HASS-E)

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.
A. Banerjee

14.74 Foundations of Development Policy
(Subject meets with 14.740)
Prereq: 14.01, 14.30
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8 HASS-S (HASS-E)

14.740 Foundations of Development Policy
(Subject meets with 14.74)
Prereq: 14.01, 14.30
G (Spring)
4-0-8

Explores the foundations of policy making in developing countries. Goal is to spell out various policy options and to quantify the trade-offs between them. Special emphasis on education, health, gender, fertility, adoption of technological innovation, and the markets for land, credit, and labor. Students taking the graduate version complete additional assignments.
E. Duflo

14.75 Political Economy and Economic Development
Prereq: 14.01, 14.30
U (Spring)
4-0-8 HASS-S (HASS-E)

Explores the relationship between political institutions and economic development, covering key theoretical issues as well as recent empirical evidence. Topics include corruption, democracy, the natural resource curse, and war.
B. Olken

14.771 Development Economics: Microeconomic Issues
Prereq: 14.121, 14.122
G (Fall)
5-0-7 H-LEVEL Grad Credit

Addresses agricultural issues, such as peasant behavior, land tenancy, and interlinked markets; credit and insurance market problems and institutions; and health, nutrition, and productivity. Also covers gender bias, education, technological change, and government failures.
A. Banerjee, B. Olken

14.772 Development Economics: Macroeconomics
Prereq: 14.121, 14.451
G (Spring)
5-0-7 H-LEVEL Grad Credit

Dynamic models of growth and development emphasizing migration, modernization, and technological change; static and dynamic models of political economy; the dynamics of income distribution and institutional change; firm structure in developing countries; development, transparency, and functioning of financial markets; privatization; and banks and credit market institutions in emerging markets.
R. Townsend

14.773 Political Economy: Institutions and Development
Prereq: 14.121, 14.451
G (Spring)
5-0-7 H-LEVEL Grad Credit

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, B. Olken

14.778J Economic Institutions and Growth Policy Analysis
(14.778J)
Prereq: 11.203
5-0-6 H-LEVEL Grad Credit

See description under subject 11.486J.
A. Amsden, M. Piore

14.781J Political Economy I: Theories of the State and the Economy
(14.781J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 17.100J.
M. Piore, S. Berger

14.URG Undergraduate Research
Prereq: 14.02
U (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)
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
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 A. Mikusheva

COURSE 14

215
# Bachelor of Science in Economics/Course 14

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement <a href="1">three subjects can be satisfied by subjects in the Departmental Program</a></td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [one subject can be satisfied by 14.30 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 14.33 in the Departmental Program]</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree** 17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- and 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

**Subject names below are followed by credit units, and by prerequisites if any (corequisites in italics).**

### Required Subjects

<table>
<thead>
<tr>
<th>Subject ID</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01</td>
<td>Principles of Microeconomics, 12, HASS-S</td>
<td>12</td>
</tr>
<tr>
<td>14.02</td>
<td>Principles of Macroeconomics, 12, HASS-S</td>
<td>12</td>
</tr>
<tr>
<td>14.04</td>
<td>Intermediate Microeconomic Theory, 12, HASS-S</td>
<td>12</td>
</tr>
<tr>
<td>14.05</td>
<td>Intermediate Applied Macroeconomics, 12, HASS-S</td>
<td>12</td>
</tr>
<tr>
<td>14.30</td>
<td>Introduction to Statistical Method in Economics, 12, REST; Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>14.32</td>
<td>Econometrics, 12, 14.30</td>
<td></td>
</tr>
<tr>
<td>14.33</td>
<td>Research and Communication in Economics, 12, LAB, CI-M; 14.04, 14.05, 14.32</td>
<td></td>
</tr>
<tr>
<td>14.ThU</td>
<td>Thesis (15 units), 14.33(3)</td>
<td></td>
</tr>
</tbody>
</table>

### Restricted Electives

Elective subjects in economics

- **Units**: 60

### Departmental Program Units That Also Satisfy the GIRs

- **Units**: (60)

### Unrestricted Electives

- **Units**: 81–84

**Total Units Beyond the GIRs Required for SB Degree**: 180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

## Notes

- Alternate prerequisites and corequisites are listed in the subject description.
- (1) No more than three subjects in economics may be used for the Humanities, Arts, and Social Sciences Requirement.
- (2) Or an approved alternative in statistics.
- (3) May be replaced by an additional elective subject in economics.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
MANAGERIAL ECONOMICS

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.
T. Walor

15.010 Economic Analysis for Business Decisions
Prereq: 14.01
G (Fall)
4-0-5 H-LEVEL Grad Credit

15.011 Economic Analysis for Business Decisions
Prereq: None
G (Fall)
4-0-5
Introduces students to principles of microeconomic analysis used in managerial decision-making. Topics include demand, cost and surplus analysis, the behavior of competitive and non-competitive markets, sources and uses of market power, and game theory and competitive strategy, with applications to various business and public policy decisions. Antitrust policy and other government regulations are also discussed. 15.010 restricted to first-year Sloan master’s students. 15.011 primarily for non-Sloan School students.
J. Doyle

15.012 Applied Macro- and International Economics
Prereq: None
G (Spring; first half of term)
2-0-4
Uses case studies to investigate the macroeconomic environment in which firms operate. First half of course develops the basic tools of macroeconomic management: monetary, fiscal, and exchange rate policy. 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. Second half evaluates different strategies of economic development. Topics include growth, the role of debt and foreign aid, and the reliance on natural resources.

15.013 Industrial Economics for Strategic Decisions
Prereq: 15.010 or 15.011
G (Fall)
3-0-9 H-LEVEL Grad Credit
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)
2-0-4 H-LEVEL Grad Credit
Builds on 15.012 to establish an understanding of the development processes of societies and economies, the role of social entrepreneurship, and consequences for sustainability. Discusses current challenges that face emerging markets: health and the HIV epidemic, education and poverty, the emergence of financial and other markets, inflation and the role of commodity prices, macroeconomic management and the implications for policy. Across all dimensions, considers the roles of private and social entrepreneurs, as well as the public sector.
R. Rigobon

15.015 Macro and International Economics
Prereq: Permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Focuses on the policy and economic environment of firms. Subject divided in three parts: study of the closed economy and how monetary and fiscal policy interacts with employment, GNP, inflation, and interest rates; examination of national economic strategies for development and growth, and study of the recent financial and currency crises in emerging markets; study of the problems faced by transition economies and the role of institutions both as the engine of growth, and as the constraints for policy. Restricted to Sloan Fellows in Innovation and Global Leadership.
S. Johnson

15.021J Real Estate Economics
(Same subject as 11.433J)
Prereq: 14.01, 15.010, or 15.011
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 11.433J.
W. C. Wheaton

15.023J Global Climate Change: Economics, Science, and Policy
(Same subject as 12.848J, ESD.128J)
(Subject meets with 12.348J, 15.026J)
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
G (Spring)
3-0-6
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, M. D. Webster

15.024 Applied Economics for Managers
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.722
Develops facility with concepts, language, and analytical tools of economics. Primary focus on microeconomics, analysis of markets and strategic interactions among firms. Emphasizes integration of theory, data, and judgment in the analysis of corporate decisions, and in the assessment of the changing global business environment.
environment. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.

T. Stoker

15.025 Game Theory for Strategic Advantage
Prereq: 15.010
G (Spring)
3-0-6 H-LEVEL Grad Credit

Develops and applies principles of game theory relevant to managers' strategic decisions. Topics include how to reason about strategies; "irrational" actions, reputation, and beliefs; entry deterrence; strategic substitutes and complements; brinkmanship and negotiation; and auctions. Applications to a variety of business decisions that arise in different industries.

Staff

15.026J Global Climate Change: Economics, Science, and Policy
(Same subject as 12.348J)
(Subject meets with 12.848J, 15.023J, ESD.128J)
Prereq: Calculus II (GIR); 14.01 or 15.010; or permission of instructor
U (Spring)
3-0-6

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.

H. D. Jacoby, R. G. Prinn, M. D. Webster

15.031J Energy Decisions, Markets, and Policies
(Same subject as 11.161J, 14.43J, 21A.341J)
Prereq: 14.01 or permission of instructor
U (Spring)
4-0-8 HASS-S (HASS-E)

Structured around choices and constraints regarding sources and uses of energy by households, firms, and governments, introduces managerial, economic, political, social and cultural frameworks for describing and explaining behavior at various levels of aggregation. Includes examples of cost-benefit, organizational and institutional analyses of energy generation, distribution, and consumption. Topics include the role of markets and prices; financial analysis of energy-related investments; institutional path dependence; economic and political determinants of government regulation and the impact of regulation on decisions; and other forms of government action and social norms regarding desired behavior and opportunities for businesses and consumers, including feedback into the political/regulatory system. Examples drawn from a wide range of countries and settings.

D. Lessard, R. Schmalensee

15.032J Engineering, Economics, and Regulation of the Electric Power Sector
(Same subject as 6.695J, ESD.162J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject ESD.162J.

I. Perez-Arriaga, R. Schmalensee

15.034 Data Analysis for Management
Prereq: None
G (Fall)
3-0-6

Enables students to understand and conduct careful empirical work using regression analysis as used in business fields such as finance, marketing and strategy, as well as in general business planning and forecasting. Emphasizes model formulation, intuition, and critical evaluation of results. Learning is primarily through empirical work done by student groups; delivered through problem sets, short write-ups, presentations and debates.

R. Rigobon, T. Stoker

15.037J Energy Economics and Policy (New)
(Same subject as 14.44J)
(Subject meets with 14.44J, 15.038J)
Prereq: 14.01
U (Spring)
4-0-8 HASS-S (HASS-E)

See description under subject 14.44J.

C. Knittel

15.038J Energy Economics and Policy (New)
(Same subject as 14.44J)
(Subject meets with 14.44J, 15.037J)
Prereq: 14.01
G (Spring)
4-0-8

See description under subject 14.44J.

C. Knittel

15.040 Seminar in Managerial Economics
Prereq: 15.010, 15.012
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Group study of current topics related to managerial economics.

T. M. Stoker

OPERATIONS RESEARCH/STATISTICS

15.053 Optimization Methods in Management Science
Prereq: None
U (Spring)
4-0-8

Introduces students to the theory, algorithms, and applications of optimization. The optimization methodologies include linear programming, network optimization, integer programming, and decision trees. Applications to logistics, manufacturing, transportation, marketing, project management, and finance.

J. B. Orlin

15.054J The Airline Industry
(Same subject as 1.232J, 16.71J, ESD.217J)
Prereq: None
G (Fall)
3-0-9

See description under subject 16.71J.


15.060 Data, Models, and Decisions
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.730

Introduces students to the basic tools in using data to make informed management decisions. Covers introductory probability, decision analysis, basic statistics, regression, simulation, linear and nonlinear optimization, and discrete optimization. Computer spreadsheet exercises, cases, and examples drawn from marketing, finance, operations management, and other management functions. Restricted to first-year Sloan master’s students.

D. Bertsimas, R. Freund, G. Perakis, A. S. Schulz
15.062J Data Mining: Finding the Data and Models that Create Value
(Same subject as ESD.754J)
Prereq: 15.060 or 15.075
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit

Provides an introduction to data mining (i.e., machine learning), a class of methods that that assist in recognizing patterns and making intelligent use of massive amounts of electronic data collected via the internet, e-commerce, electronic banking, point-of-sale devices, bar-code readers, medical databases, search engines, and social networks. Topics selected from logistic regression, association rules, tree-structured classification and regression, cluster analysis, discriminant analysis, and neural network methods. Presents examples of successful applications in areas such as credit ratings, fraud detection, marketing, customer relationship management, and investments. Introduces data-mining software.

R. Welsch

15.063 Communicating with Data
Prereq: Permission of instructor
G (Summer)
3-0-6 H-LEVEL Grad Credit

Introduces statistical tools and communication skills for using data to influence management decisions. In real-life decisions, decision makers use both analytical and intuitive approaches to understand problems and to persuade others to act. Statistical tools are important, but statistical arguments are often met with skepticism. Subject covers decision analysis, communication principles, probability, testing theories, statistical sampling and regression, and misuses of statistics, with exercises and examples drawn from marketing, finance, operations management, strategy, and law. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.

A. Barnett

15.064j Engineering Probability and Statistics
(Same subject as ESD.751J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit

Modeling and analysis of uncertainty and variation. Covers probability models and distributions, regression, and basic statistical procedures pertinent to manufacturing and operations. Introduces experimental and robust design, statistical process control, forecasting, and data-mining. Students use a data analysis package, such as JMP, Minitab, or MATLAB. Primarily for Leaders for Global Operations students.

A. I. Barnett, C. Rudin, R. Welsch

15.066J System Optimization and Analysis for Operations
(Same subject as 2.855J, ESD.750J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit

Introduction to mathematical modeling, optimization, and simulation, as applied to manufacturing. Specific methods include linear programming, network flow problems, integer and nonlinear programming, discrete-event simulation, heuristics and computer applications for manufacturing processes and systems. Restricted to Leaders for Global Operations students.

V. Farias

15.067 Competitive Decision-Making and Negotiation
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall, Spring; partial term)
3-0-3

Learn tools to achieve negotiation objectives fairly and responsibly. Negotiation skills developed by active participation in a variety of negotiation settings: an oil price (repetitive Prisoners’ Dilemma) negotiation; fair division of a valuable art collection and a series of integrative bargaining cases between two and more than two parties over multiple issues; e.g. owners of an online vendor of mid-priced wines negotiate sale of the company to a large chain; two companies negotiate an IT deal. Several complex team negotiations follow. Grades depend solely on effective negotiation with class counterparts. Students must complete all negotiation exercises in order to receive a grade.

G. M. Kaufman

15.068 Statistical Consulting
Prereq: 15.060
G (Spring)
3-0-6 H-LEVEL Grad Credit

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

15.070J Advanced Stochastic Processes
(Same subject as 6.265J)
Prereq: 6.431, 15.085J, or 18.100
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Analysis and modeling of stochastic processes. Topics include measure theoretic probability, martingales, filtration, and stopping theorems; elements of large deviations theory; Brownian motion and reflected Brownian motion; stochastic integration and Ito calculus; functional limit theorems. Applications to finance theory, insurance, queueing and inventory models.

D. Gamarnik, D. Shah

15.071 The Analytical Edge
Prereq: 15.053 or 15.060
G (Spring)
3-0-6 H-LEVEL Grad Credit

Presents real-world examples in which quantitative methods provide a significant competitive edge that has led to a first order impact on a variety of some of today’s most important companies. Examples include finance (quantitative asset management and options pricing), sports, health care, revenue management, supply chains, and the Internet. Outlines the competitive landscape, presents the key quantitative methods that created the edge (data-mining, dynamic optimization, simulation), and discusses the impact of these methods. Includes team projects.

D. Bertsimas

15.072J Queues: Theory and Applications
(Same subject as 6.264J)
Prereq: 6.262
G (Spring)
3-0-9 H-LEVEL Grad Credit

Modeling and analysis of queueing systems, with applications in communications, manufacturing, computing, call centers, service industries and transportation. Topics include birth-death processes and simple Markovian queues, networks of queues and product form networks, single and multi-server queues, multi-class queueing networks, fluid models, adversarial queueing networks, heavy-traffic theory and diffusion approximations. Covers state of the art results which lead to research opportunities.

D. Bertsimas, D. Gamarnik, J. N. Tsitsiklis
15.073| Logistical and Transportation Planning Methods
(Same subject as 1.203J, 6.281J, 16.76J, 18.516J)
Prereq: 6.041
G (Fall)
4-0-9 H-LEVEL Grad Credit
See description under subject 1.203J.
R. C. Larson, A. R. Odoni, A. I. Barnett

15.074| Statistical Reasoning and Data Modeling
(Same subject as ESD.755J)
Prereq: 6.431, 15.060, or permission of instructor
G (Spring)
4-0-5 H-LEVEL Grad Credit
Designed for students who have some acquaintance with probability and/or statistics and want exposure to a wider range of topics and examples. Begins with a brief review of statistics and regression by addressing advanced topics, such as variable selection, data and regression diagnostics, visualization, and Bayesian and robust methods. The remainder starts with data mining, including stratified sampling, classification, logistic regression, and clustering. These topics are followed by time series analysis and forecasting, design of experiments and analysis of variance, and process control. Students use statistical computing systems, including Excel add-ins and stand-alone packages. Includes case studies involving finance, management science, consulting, and engineering systems.
R. E. Welsch

15.075| Statistical Thinking and Data Analysis
(Same subject as ESD.07J)
Prereq: 6.041 or 18.440
U (Fall)
4-0-8
Introduces statistical data analysis. Topics chosen from applied probability, sampling, estimation, hypothesis testing, linear regression, analysis of variance, categorical data analysis, and nonparametric statistics.
C. Rudin

15.076| Statistical Learning and Data Mining
(Same subject as ESD.753J)
Prereq: 6.431, 15.085, or 18.440; 18.06 or 18.700
G (Spring)
4-0-8 H-LEVEL Grad Credit
Advanced introduction to the theory and application of statistics and data mining, concentrating on techniques used in management science, finance, consulting, engineering systems, and bioinformatics. First half builds the statistical foundation for the second half, with topics selected from sampling, including the bootstrap, theory of estimation, testing, nonparametric statistics, analysis of variance, categorical data analysis, regression analysis, MCMC, EM, Gibbs sampling, and Bayesian methods. Second half focuses on data mining, supervised learning, and multivariate analysis. Topics selected from logistic regression; principal components and dimension reduction; discrimination and classification analysis, including trees (CART), partial least squares, nearest neighbor and regularized methods, support vector machines, boosting and bagging, clustering, independent component analysis, and nonparametric regression. Uses statistics software packages, such as R, S+, MATLAB, and SAS, for data analysis and data mining.
R. E. Welsch

15.078| Models, Data and Inference for Socio-Technical Systems
(Same subject as ESD.86J)
Prereq: ESD.83, 6.041, or permission of instructor
G (Spring)
3-0-9
See description under subject ESD.86J.
R. Larson, R. Welsch

15.081| Introduction to Mathematical Programming
(Same subject as 6.251J)
Prereq: 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 6.251J.
J. N. Tsitsiklis, A. Schulz

15.082| Network Optimization
(Same subject as 6.855J, ESD.78J)
Prereq: 6.046, 15.081, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Focuses on network models for industrial logistics systems, transportation systems, communication systems, and other applications. Emphasizes a rigorous treatment of algorithms and their efficiency. Covers algorithms for shortest paths, maximum flows, minimum cost flows, and network design, as well as implementation issues.
J. Orlin

15.083| Integer Programming and Combinatorial Optimization
(Same subject as 6.859J)
Prereq: 15.081J or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
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. Bertsimas, A. S. Schulz

15.084| Nonlinear Programming
(Same subject as 6.252J)
Prereq: 18.06, 18.100
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.252J.
R. M. Freund, D. P. Bertsekas, G. Perakis

15.085| Fundamentals of Probability
(Same subject as 6.436J)
Prereq: Calculus II (GIR)
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 6.436J.
J. N. Tsitsiklis, D. Gamarnik

15.093| Optimization Methods
(Same subject as 6.255J)
Prereq: 18.06
G (Fall)
4-0-8 H-LEVEL Grad Credit
Introduces the principal algorithms for linear, network, discrete, nonlinear, dynamic optimization and optimal control. Emphasis on 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.
D. Bertsimas, P. Parrilo
15.097 Seminar in OR/Statistics
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Group study of current topics related to operations research/statistics.
G. Perakis, A. S. Schulz

15.098 Seminar in Applied Probability and Stochastic Processes
Prereq: 6.431
G (Spring)
2-0-4 H-LEVEL Grad Credit
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: 15.081J
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Doctoral student seminar covering current topics related to operations research.
D. Bertsimas, R. Freund, T. L. Magnanti, J. B. Orlin, G. Perakis, A. S. Schulz

Civil and Environmental Engineering: 1.151, 1.155, 1.202, 1.203, 1.205, and 1.732
Electrical Engineering and Computer Science: 6.041, 6.231, 6.245, 6.262, 6.431, 6.432, and 6.435
Management: 15.034, 15.070, 15.075, and 15.098
Mathematics: 18.05, 18.175, 18.177, 18.440, 18.443, 18.445, and 18.465
See also: 2.830, 2.870, 5.70, 5.72, 7.02, 8.044, 8.08, 10.816, 11.220, 11.221, 16.322, 22.38, HST.191 and MAS.622

HEALTH CARE MANAGEMENT

15.121J Clinical Trials in Biomedical Enterprise
(Same subject as HST.975J)
Prereq: None
G (Fall)
2-0-4
See description under subject HST.975J.
H. Golub

15.122J Critical Reading and Technical Assessment of Biomedical Information
(Same subject as HST.977J)
Prereq: SB degree in Biological Science or permission of instructor
G (Spring; first half of term)
1-0-2 H-LEVEL Grad Credit
See description under subject HST.977J.
S. Lapidus, S. Sengupta

15.123J Dynamics of Biomedical Technologies
(Same subject as HST.979J)
Prereq: None
G (Fall, Spring)
2-0-1 [P/D/F]
Can be repeated for credit
See description under subject HST.979J.
R. Cohen, R. Anders, C. Berke, T. Dagi

15.124J Evaluating a Biomedical Business Concept
(Same subject as HST.973J)
Prereq: HST.971
G (Spring)
1-0-0 H-LEVEL Grad Credit
See description under subject HST.973J.

15.127J Designing and Sustaining Technology Innovation for Global Health Practice
(Same subject as HST.939J)
Prereq: None
G (Spring)
Units arranged
See description under subject HST.939J.
U. Demirci, J. Blander

15.128J Neurotechnology Ventures
(Same subject as 9.455J, 20.454J, MAS.883J)
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
See description under subject MAS.883J.
E. S. Boyden, R. Ellis-Behnke, J. Bonsen

15.136J Principles and Practice of Drug Development
(Same subject as 7.547J, 10.547J, ESD.691J, HST.920J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
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, N. Finkelstein, R. H. Rubin, A. J. Sinskey, G. K. Raju

15.137J Case Studies and Strategies in Drug Discovery and Development
(Same subject as 7.549J, 20.486J, HST.916J)
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 20.486J.
S. R. Tannenbaum, A. J. Sinskey, A. Wood

15.141J Economics of the Health Care Industries
(Same subject as HST.918J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Focuses on economic issues in various health care and allied industries, such as the pharmaceutical, biotechnology, medical device, vaccine and diagnostic sectors. Addresses differences between health care and other industries; regulatory issues, in the US and globally, that involve establishment of the efficacy and cost-effectiveness of treatments; managing those who manage research and development; policies to incentivize research and development for neglected tropical diseases; strategic issues in global pricing and marketing; use of e-commerce and information technology; and formation and management of various alliances. Visiting speakers from academia, government, non-government organizations (non-profits), and industry. Assignments include 4 to 6 essays; no final exam.
E. R. Berndt

GLOBAL ECONOMICS & MANAGEMENT

15.218 Global Economic Challenges and Opportunities (New)
Prereq: None
G (Spring)
3-0-6
Begins with analysis of financial crises from historical examples in emerging markets, to the Great Depression, to the recent global crisis. Topics include bubbles, financial contagion, capital controls, currency mismatch and crisis prediction. Remainder of the subject explores major global economic challenges and evaluates...
policy responses. Topics include unsustainable debt, currency wars, future of the European Union, aging populations, global warming, trade imbalances, inequality and poverty, oil and commodity markets, foreign aid, international institutions, and the implications of rapid growth in the BRICs (Brazil, Russia, India, and China) and “frontier” economies. Some background in international economics recommended.

K. Forbes

15.220 Global Strategy and Organization
Prereq: None
G (Spring; partial term)
3-0-3
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.
S. Johnson, E. Obukhova

15.223 Global Markets, National Policies and the Competitive Advantages of Firms
Prereq: None
G (Fall, Spring, Summer; partial term)
3-0-3
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.
S. Johnson, E. Obukhova

15.225 Economy and Business in Modern China and India
Prereq: None
G (Spring; first half of term)
3-0-3
Provides an integrated approach to understand and analyze the economies and global status of China and India. Focuses on their similarities and what makes them unique, using a learning model heavily based on class discussions and participation. A select group of students will have the opportunity to travel to China and India where they will undertake lab projects, such as creating business plans or other deliverables for their host companies. 15.012 and 15.223 highly recommended.
S. Johnson, Y. Huang

15.227–15.229 Seminar in International Management
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit
Group study of current topics related to international business.
S. Johnson, Y. Huang

15.231J Enabling an Energy-Efficient Society (New)
(Same subject as 11.379J)
(Subject meets with 11.168)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 11.379J.
H. Michaels

15.249 Institutions, Society, and International Business
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit
Advanced seminar in the study of international management. Covers major theoretical work and approaches to empirical research in the fields of national business systems and globalization, linking them to the core frameworks of strategy and organization theory. Restricted to doctoral students.
E. Obukhova

15.268 Choice Points: Readings on the Exercise of Power and Responsibility
Prereq: None
G (Spring)
3-0-6 [P/D/F]
Managerial power and responsibility. Examines conflicts between power and moral responsibility and the contexts for choice in dealing with a number of such problems. Readings are principally "classics" used to illustrate several enduring issues. Restricted to Sloan Fellows in Innovation and Global Leadership.
Consult S. Sacca

15.269 Literature, Ethics, and Authority
Prereq: None
G (Fall)
3-0-6
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 universality of ethical standards, and social enterprise, as well as questions of gender, cultural and individual identity, the balance of family and work life, and the relation of science to ethics. Readings include work by Robert Bolt, Michael Frayn, Timothy Mo, Wole Soyinka, H.D. Thoreau, and others; films include Crouching Tiger, Hidden Dragon, Hotel Rwanda, 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

15.270 Ethical Practice: Professionalism, Social Responsibility, and the Purpose of the Corporation
Prereq: None
G (Spring; partial term)
3-0-3
Introduction to ethics in business, with a focus on business management. Over thirteen sessions, 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

15.277 Seminar in Communications
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit
15.278 Seminar in Communications
Prereq: None
G (Fall, Spring)
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

Required seminar for Management Science majors to develop the writing, speaking, teamwork, and interpersonal communication skills necessary for managers. Students learn communication principles, strategies, and methods through discussions, exercises, examples, and cases. Assignments include writing memos and business letters, and giving oral presentations in labs outside of class. A major project is the production of a team report and presentation on a topic of interest to a managerial audience. Priority given to Course 15 students.

L. Hafrey

15.280 Communication for Leaders
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
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.

L. Hafrey, N. Hartman, C. Kelly, R. Pittore, V. Healy-Tangney, K. Blackburn

15.281 Advanced Leadership Communication
Prereq: 15.279, 15.280, or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

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

15.289 Doctoral Seminar: Communication Skills for Academics
Prereq: Permission of instructor
G (IAP)
3-0-3 H-LEVEL Grad Credit

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, 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. Restricted to doctoral students who have completed their first year. Limited to 20; priority to Sloan students.

J. Yates, L. Breslow

15.301 Managerial Psychology Laboratory
Prereq: None
U (Fall, Spring)
3-3-9 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.

Fall: J. Carroll
Spring: P. Osterman

15.305 Leadership and Management
Prereq: Permission of instructor
U (Fall)
3-0-6

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.

Information: A. Cronin, D. G. Ancona

15.310 Managerial Psychology
Prereq: None
G (Fall, Spring)
2-1-6

Surveys social psychology and organization theory interpreted in the context of the managerial environment. Shares lectures with 15.301, with a separate recitation required. Equivalent of 15.311 intended primarily for non-Course 15 students, both graduate and undergraduate. Deals with a number of diverse subjects, including motivation and reward systems, social influence, groups and teams, leadership, power, organizational design and culture, and networks and communication patterns in the organization.

J. Carroll

15.311 Organizational Processes
Prereq: Permission of instructor
G (Fall)
2-3-4 H-LEVEL Grad Credit

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.

R. Fernandez, D. Loyd, R. Reagans

15.316 Building and Leading Effective Teams
Prereq: None
G (Summer)
2-1-0 [P/D/F]

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.

Consult J. S. Carroll
15.317 Organizational Leadership and Change  
Prereq: None  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit  
Course spans the entire two-year Leaders for Global Operations program, focusing on practical experience that blends theory and practice. Students reflect on prior leadership experiences and then apply lessons learned to further develop their leadership capabilities. Requires active participation in all leadership classes and/or activities as well as short deliverables throughout the program.  
*J. Klein*

15.318 Leadership and Change in Organizations  
Prereq: 15.311, 15.315, 15.322, or permission of instructor  
Acad Year 2011–2012: G (Spring; first half of term)  
Acad Year 2012–2013: Not offered  
2-0-4 H-LEVEL Grad Credit  
Can be repeated for credit  
Provides the tools to better understand one’s unique way of leading change, i.e., leadership signature. Involves intensive self-assessment and interactive exercises aimed to help students identify their key strengths and weaknesses and hone their leadership skills. Focuses on the individual leadership credo and techniques for building confidence and credibility. Students explore alternative approaches to leadership, compare and contrast various leadership styles, and look at a range of leadership capabilities.
*D. G. Ancona*

15.320 Strategic Organizational Design  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-6  
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, crew-based organizations, internal resource markets, and other forms of collective intelligence. Team projects include inventing new possibilities for real organizations.  
*T. Malone*

15.322 Leading Organizations  
Prereq: None  
G (Fall, Summer)  
4-0-5 [P/D/F]  
Credit cannot also be received for 15.716  
Analyzes through lectures, discussions, and class exercises, the human processes underlying organizational behavior. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.  
*J. Van Maanen*

15.325 Seminar in Leadership I  
Prereq: None  
G (Fall)  
2-0-1 [P/D/F]  
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. Seminar includes a one week field trip to a domestic location. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.  
*Consult S. Sacca*

15.326 Seminar in Leadership II  
Prereq: 15.325  
G (Spring)  
2-0-1 [P/D/F] H-LEVEL Grad Credit  
Continuation of subject 15.325 on the identification and analysis of important management issues. Students prepare briefings and meet with senior government and international leaders during field trips in selected international areas. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.  
*S. Sacca*

15.328 Seminar in Organizational Studies  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
15.329 Seminar in Organizational Studies  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Group study of current topics related to organizational studies.  
*Consult D. G. Ancona*

15.341 Individuals, Groups, and Organizations  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall, Spring)  
3-0-9 H-LEVEL Grad Credit  
Develops basic concepts for understanding individual, group, and organizational behavior through critical analysis of important works in the field. Areas covered: individual affect and cognition; group process and performance; and organizational culture and adaptation. Emphasizes use of behavioral science concepts for stimulating new and useful organizational behavior research. Primarily for doctoral candidates in the Sloan School of Management.  
*J. Curhan*

15.342 Organizations and Environments  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
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*

15.343 Managing Sustainable Work Systems and Organizations  
Prereq: None  
G (Spring; first half of term)  
3-0-6  
Examines changing relations among work, organizations, and society and their implications for management and sustainability. Focuses on the skills managers need to build and lead sustainable organizations and to adapt to increasing workforce diversity; modular, dispersed and team-based work systems; and customer-employee interactions in a service-based economy. Discusses the role of the corporation in society, its responsibilities to multiple stakeholders, and interactions with community groups, labor market institutions, and national and global
governmental bodies. Students conduct an action-based research project in an organization of their choice.

T. Kochan

15.345 Doctoral Proseminar in Behavioral and Policy Sciences
Prereq: Permission of instructor
G (Fall)
2-0-4 [P/D/F] H-LEVEL Grad Credit
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.
L. Bailyn

15.347 Doctoral Seminar in Research Methods I
(Subject meets with 21A.861)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
R. Fernandez

15.348 Doctoral Seminar in Research Methods II
Prereq: 15.347 or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
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, count models, event history models) or qualitative methods (e.g., ethnography, interviewing, participant observation).
E. J. Castilla

15.349Q Qualitative Research Methods
(Same subject as 21A.760J)
Prereq: None
G (Spring)
3-6-3
See description under subject 21A.760J.
G. Jones

TECHNOLOGY, INNOVATION AND ENTREPRENEURSHIP

15.350 Managing Technological Innovation and Entrepreneurship
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
F. Murray

15.352 Innovation in the Internet Age: Emerging Trends
Prereq: None
G (Spring; half-term subject)
3-0-3
Important emerging trends in innovation are identified and their implications for innovation management explored. Major topics include the trend to open information (open source) rather than protected intellectual property; distribution of innovation over many independent but collaborating actors; and toolkits that empower users to innovate for themselves.
E. A. von Hippel

15.353 Research Themes in Management of Technology
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Studies successful origination, development, implementation, and diffusion of product and process innovations in industry. Reviews effective organization and management of the technological change process (marketing, R&D, engineering, and manufacturing) in new ventures and multidivisional and multinational enterprises. Covers current research topics of MIT faculty, as well as thesis research models and methods. Preference to doctoral students.
Staff

15.354 Innovation and Entrepreneurship: How to Do It
Prereq: None
U (Spring)
3-0-6
Examines how to be a successful innovator in a big company and how to be an entrepreneur. Covers both internet-age and traditional businesses. Research findings are combined with practical advice from experienced innovators to help launch students on a successful innovation trajectory. Lecture-based course. Periodic, short projects enable students to explore topics of special interest to them independently or in small groups.
J. M. Utterback

15.355 Managing New Ventures
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall; second half of term)
3-0-3 H-LEVEL Grad Credit
Presents the main themes of managing innovation ventures in firms of varying size and establishment. First half develops an understanding of the issues involved in establishing and building new firms, including their potential benefits and limitations. Examines the different developmental patterns adopted by start-ups, many which involve linkages between new and established firms. Second half focuses on the problems established firms face in maintaining their competitiveness and growth. Discusses ways to make them behave more like smaller, nimble organizations. Also covers ways to expand the innovation process beyond traditional firm boundaries, including collaborations between large and young emerging companies. Restricted to Sloan Fellows Program in Innovation and Global Leadership
F. Murray, E. B. Roberts

15.356 How to Develop Breakthrough Products and Services
Prereq: None
G (Spring; half-term subject)
3-0-3
Firms must develop major innovations to prosper but they don’t know how. Recent research into the innovation process has made it possible to develop breakthroughs systematically. Explore several practical idea generation development methods. Presentations of real cases by invited experts conveys the art required to implement each.
E. A. von Hippel
15.358 The Business of Software and Digital Platforms
Prereq: 15.900 or 15.902
G (Spring)
3-0-6 H-LEVEL Grad Credit

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

15.360 Introduction to Technological Entrepreneurship
Prereq: Permission of instructor
G (Fall)
2-0-1 H-LEVEL Grad Credit

Provides an overview of entrepreneurial theory and practice for founding, developing and growing new enterprises, primarily but not exclusively focused on companies with a technological base. Weekly lectures and dinner discussion sessions by academic and practitioner faculty engaged in the MIT Entrepreneurship Program, supplemented by leaders of related activities, e.g., Technology Licensing Office, Deshpande Center, and Venture Mentoring Service, as well as successful entrepreneurs and venture capitalists. Includes student open mic presentations and discussion of new business ideas. Enrollment in 15.362 for the following spring term required. Restricted to students in MIT Sloan MBA Entrepreneurship and Innovation track.

E. Roberts, W. Aulet

15.363J Strategic Decision Making in the Life Sciences
(Same subject as HST.971J)
Prereq: None
G (Spring)
3-0-6

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

15.365J Disruptive Technologies: Predator or Prey?
(Same subject as ESD.58J)
Prereq: None
G (Spring)
3-0-6

Focuses on the management of product and process innovation and on economic, management, and technological influences on innovation. Both sustaining and disruptive innovations in products and manufacturing processes covered in lectures and cases presented by the leaders of change in different industries. Emphasis on emerging and disruptive technologies as seen from the points of view of entering firms (predators) and incumbent firms (prey) are covered in a class exercise, and project (preferably done in small groups).

J. M. Utterback

15.366 Corporate Entrepreneurship: Strategies for Technology-Based New Business Development
Prereq: 15.311
G (Fall; partial term)
3-0-3 H-LEVEL Grad Credit

Examines strategic and organizational issues for existing firms in developing new technologies and new business areas, from the perspectives of both large corporations and emerging technology-based enterprises. Studies linkages between internal and external sources of technology in major new business development. Examines internal entrepreneurial ventures, alliances (especially between large and new companies), joint ventures, acquisitions, corporate venture capital investments, and licensing as alternative business development approaches. Covers aspects of corporate business development other than mergers and acquisitions. Outside speakers supplement faculty lectures. Student teams prepare term reports on a competitive analysis of some aspect of corporate business development.

E. B. Roberts, V. Livada

15.371J Innovation Teams
(Same subject as 10.807J)
Prereq: 15.911 or permission of instructor
G (Fall, Spring)
4-4-4

Students work in teams to develop commercialization strategies for innovative research projects generated in MIT laboratories. Projects cover critical aspects of commercialization, from selecting the target application and market for the technology to developing an intellectual property strategy and performing a competitive analysis. Instruction provided in communication and teamwork skills, as well as analysis of the challenges and benefits of technology transfer. Includes lectures, guest speakers, and extensive team coaching. Designed primarily for students in engineering, science, and management. Applications, resumes, and a brief statement of interest are required prior to registration.

L. Perez-Breva
15.387J Development Ventures  
(Same subject as MAS.665J)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 15.385 to 15.390  
A. Pentland, J. Bonsen

15.376j Media Lab Entrepreneurship: Digital Innovations  
(Same subject as MAS.664j)  
Prereq: None  
G (Spring)  
3-0-6  
Can be repeated for credit  
See description under subject 15.385 to 15.390  
A. Pentland, J. Bonsen, F. Moss

15.381 The Human Side of Technology  
Prereq: Permission of instructor  
G (IAP)  
2-1-6  
Examines the human side of managing technical professionals and teams throughout innovative processes, including micro and macro issues. Topics include motivational commitment and performance; dealing with complacency; understanding the relationships among innovation, change, motivation, and uncertainty; managing creative individual contributors; effective recognition and reward systems; leading decision making processes; staffing critical roles and cross-functional relationships; information/knowledge transfer; organizational diagnosis for change. Restricted to SDM students; others with permission of instructor.  
Staff

15.383 Entrepreneurship and Sustainable Economic Development: The Case of Puerto Rico (New)  
Prereq: None  
G (Fall, IAP; second half of term)  
3-0-6  
Examines the role entrepreneurship can play in promoting sustainable economic development. Focuses on the causes of socioeconomic maladies such as unemployment, poverty, out-migration, and economic stagnation, as well as how entrepreneurship can alleviate them. A core component of the subject is a team-based internship during IAP that is based at an entrepreneurial firm in Puerto Rico.  
R. Locke

15.385 Social Innovation and Entrepreneurship  
Prereq: 15.911  
G (Fall; first half of term)  
3-0-3 H-LEVEL Grad Credit  
Students work in teams to develop a feasibility plan for a social venture (either a for profit or nonprofit), integrating the marketing, financial, operational and organizational activities required to realize an opportunity. Examines the theory and practice of social innovation (e.g., business, environment, education, and human services) and entrepreneurship in the private, public and nonprofit sectors. Topics include social impact modeling, social capital markets, and social impact assessment. Students gain practical knowledge on how to identify potential social venture opportunities; develop skills and competencies for creating, developing and implementing ideas; and examine ways to measure the success and value of social entrepreneurial activity.  
A. Walk

15.386 Managing in Adversity  
Prereq: 15.900  
G (Fall; Spring; second half of term)  
3-0-3 H-LEVEL Grad Credit  
Provides the skills required for a CEO to deal with complex problems under highly adverse conditions. Cases and guest CEO speakers present real-life, high adversity situations that students then deal with through role play.  
Emphasis on how to quickly define the issues at stake and take critical and precipitous actions to address them. No listeners.  
H. Anderson, P. Kurzina

15.387 Technology Sales and Sales Management  
Prereq: None  
G (Fall, Spring)  
3-0-9  
Practical and tactical ins and outs of how to sell technical products to a sophisticated marketplace. How to build and manage a sales force; building compensation systems for a sales force, assigning territories, resolving disputes, and dealing with channel conflicts. Focus on selling to customers, whether through a direct salesforce, a channel salesforce, or building an OEM relationship.  
H. Anderson, P. Levine

15.388 Designing and Leading the Innovative Organization  
Prereq: None  
G (Spring)  
2-0-4  
Covers the building, running and growing of an organization. Central themes include how to think analytically about designing organizational systems; how leaders play a critical role in shaping an organization’s culture; what really needs to be done to build a successful organization for the long-term; and what one can do to improve the likelihood of personal success. Covers principles of organizational architecture, group behavior and performance, interpersonal influence, leadership and motivation. Through a series of cases, lectures, readings and exercises, students develop competencies in organizational design, human resources management, leadership, and organizational behavior. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.  
Staff

15.389 Global Entrepreneurship Lab: Emerging Markets  
Prereq: None  
G (Fall, IAP, Spring)  
6-0-9  
Enables teams of students to work with the top management of global start-ups and gain experience in running, and consulting to, a new enterprise outside the United States. Focuses on start-ups operating in emerging markets throughout the world. Combines an internship in a growing firm with in-class discussions of the issues and policies that affect the climate for innovation and start-up success around the world. Begins in Fall term and continues for three weeks during IAP, which students spend at their client firms’ sites. Concludes with poster session on G-Lab day at beginning of the Spring term. Students must complete all three components to receive credit. Restricted to graduate students.  
S. Johnson, Y. Huang, J. Lehrich

15.390 New Enterprises  
Prereq: None. Coreq: 15.911  
G (Fall, Spring)  
2-1-6 H-LEVEL Grad Credit  
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.

Entrepreneurship Center Staff

15.391 Early Stage Capital
Prereq: Permission of instructor
G (Fall; second half of term)
3-0-3 H-LEVEL Grad Credit

Focuses on the strategy as well as the tactics involved in negotiating and building effective, long-term relationships with investors, particularly venture capitalists, in an extremely difficult funding environment. Other topics include an introduction to understanding venture capital as a business; an introduction to search funds; the legal framework of the investment process and its related jargon; market practice and standards for term sheet negotiation; and strategies in identifying the optimal form of early stage capital. Coursework is team-centered: in two rounds of simulations, student teams assume the roles of founders of a start-up and first meet with practicing lawyers to gain advice and practical experience working with professional advisers. Teams then negotiate final terms of investment for their company with leading local VCs. Simulations are outside of class, off-campus at lawyers’ and VCs’ offices.

Staff

15.394 Dilemmas in Founding New Ventures
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-6

Explores key organizational decisions that have far-reaching consequences for founders and their ventures. Though a series of cases, readings, and simulations, students examine five founder’s dilemmas: whether and when to found; whom to include in the founding team; how to allocate equity among co-founders; whether to involve external investors; when and how to exit. 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.

M. Marx

15.396 Seminar in Entrepreneurship
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Group study of current topics related to entrepreneurship.

W. Aulet

15.397 Seminar in Entrepreneurship
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
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: 15.900 or permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit

Focus is on the role of the CEO. Students learn from some of the world’s leading CEOs who are invited to speak in the class. Topics include the job of the CEO, corporate strategy, and career learnings and advice. Particular emphasis on how the CEO is reacting to the crossroads where he currently finds his company. Sessions are highly interactive, with questions from the students. Before each class, a small group of students has dinner with the guest CEO, a truly unique experience for the students.

H. Anderson, P. Kurzina

15.399 Entrepreneurship Lab
Prereq: 15.910 or 15.911; permission of instructor
G (Fall, Spring)
2-9-H H-LEVEL Grad Credit

Teams of science, engineering, and management students participate actively one day a week on site with the top management of high tech start-ups in order to gain experience in starting and running a new venture. Student projects focus on one urgent aspect of the start-up, such as selection of target market, design of market-entry strategy, choice of sales approach to initial customers, etc. In addition to the regular MIT registration process, students should register at the course website one month before class to facilitate formation of student teams and matching of teams with potential host companies.

Consult Entrepreneurship Center Staff

See also 15.136.

FINANCE

15.401 Finance Theory I
Prereq: None
G (Fall, Spring)
4-0-5

Core theory of modern financial economics and financial management, concentrating on capital markets and investments. Topics include functions of capital markets and financial intermediaries, asset valuation, fixed income securities, common stocks, capital budgeting, diversification and portfolio selection, equilibrium pricing of risky assets, the theory of efficient markets, and an introduction to derivatives.

A. Lo

15.402 Finance Theory II
Prereq: 15.401
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit

Continuation of 15.401, concentrating on corporate financial management. Topics include capital budgeting, investment decisions and valuation; working capital management, security issues; dividend policy; optimal capital structure; and real options analysis.

N. Bergman, C. Frydman, G. Manso

15.403 Introduction to the Practice of Finance
Prereq: None
G (Fall)
2-0-1

Proseminar exposes students to some of the basic institutions and practices of the financial industry. Includes panel discussions with representatives from leading financial institutions, MIT alumni currently engaged in the financial services sector, and leading industry vendors. Preference to first-year Finance track MBA students.

J. Minahan

15.414 Financial Management
Prereq: 15.511
G (Summer)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.724

Provides a rigorous introduction to the fundamentals of modern financial analysis and applications to business challenges in capital budgeting, project evaluation, corporate investment and financing decisions, and basic security analysis and investment management. Focuses on five key sections: an introduction to the financial system, the six unifying principles of modern finance, and fundamental present-value relations; valuation models for both stocks
and bonds and capital budgeting; methods for incorporating uncertainty into valuation models; valuation of derivative securities; and applications to corporate financial decisions. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.

A. Lo

15.415 Finance Theory
Prereq: None
G (Summer)
6-0-9
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

15.416 Introduction to Financial Economics
(Same subject as 14.416)
Prereq: 14.121, 14.122
G (Fall)
4-0-8 H-LEVEL Grad Credit
Foundations of modern financial economics; individuals’ consumption and portfolio decisions under uncertainty; valuation of financial securities. Topics include expected utility theory; stochastic dominance; mutual fund separation; portfolio frontiers; capital asset pricing model; arbitrage pricing theory; Arrow-Debreu economies; consumption and portfolio decisions; spanning; options; market imperfections; no-trade theorems; rational expectations; financial signaling. Primarily for doctoral students in accounting, economics, and finance.
S. A. Ross

15.419 Practice of Finance: Private Equity and Hedge Funds
Prereq: None
G (Spring; second half of term)
2-0-1 [P/D/F]
Introduction to the field of alternative investments—principally private equity and hedge funds—within the context of the larger investment domain. Covers the structure and operation of alternative funds, valuation, and topics such as deal sourcing, exits, value added, and alpha strategies. Discusses the evolution of the field as well as what the future may bring. Summarizes subfields such as venture capital, leveraged buyouts, distressed investing, and the spectrum of hedge funds. Addresses investor perspectives, portfolio construction and risk management with alternatives. Encourages active student participation, and includes a project and reading list.
P. Cooper

15.420 Practice of Finance: International Financial Management
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall, Spring)
2-0-4
Uses case studies and current events discussion to review the applications of international finance that impact social issues. Topics include multinational enterprises, international trade, international activities of domestic firms, foreign competition, and foreign exchange risks.
C. Kane

15.423 Practice of Finance: Advanced Corporate Risk Management
Prereq: 15.402, 15.414, or 15.415
G (Spring)
3-0-6 H-LEVEL Grad Credit
Focuses on how corporations make use of the insights and tools of risk management. Taught from the perspective of potential end-users of derivatives (not the dealer), such as manufacturing corporations, utilities, and software firms. Topics include how companies manage risk, instruments for hedging, liability management and organization, and governance and control. 15.437 recommended.
J. Parsons

15.426 Real Estate Finance and Investment
(Same subject as 11.431)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 11.431.
Staff

15.427 Real Estate Capital Markets
(Same subject as 11.432)
Prereq: 11.431J; 15.401, 15.402, or 15.414
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 11.432.
D. Geltner

15.428 Tools for Analysis: Design for Real Estate and Infrastructure Development
(Same subject as 11.434J, ESD.712J)
Prereq: None
G (Spring; second half of term)
2-0-4
See description under subject 11.434J.
D. Geltner, R. de Neufville

15.431 Entrepreneurial Finance
Prereq: 15.402, 15.414, or 15.415
G (Spring)
3-0-6 H-LEVEL Grad Credit
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 the 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.
A. Schoar

15.433 Investments
Prereq: 15.401, 15.414, or 15.415
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Financial theory and empirical evidence for making investment decisions. Topics include portfolio theory; equilibrium models of security prices, including the capital asset pricing model and the arbitrage pricing theory; the empirical behavior of security prices; market efficiency; performance evaluation; and behavioral finance. Preference to Course 15 students.
J. Pan

15.434 Advanced Corporate Finance
Prereq: 15.401; 15.402, 15.414, or 15.415
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Advanced topics in corporate finance including complex valuations, static and dynamic capital structure, risk management, and real options. Considers the asymmetric information and incentive problems, security design, restructuring, bankruptcy, and corporate control and governance issues.
Staff
15.437 Options and Futures Markets
Prereq: 15.401, 15.414, or 15.415
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Examines the economic role of options and futures markets. Topics: 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, implied binomial trees, advanced hedging techniques, exotic options, applications to corporate securities and other financial instruments.
Consult J. C. Cox

15.438 Fixed Income (New)
Prereq: 15.401, 15.414, or 15.415
G (Spring)
3-0-6 H-LEVEL Grad Credit
Designed for students seeking to develop a sophisticated understanding of fixed income valuation and hedging methods, and to gain familiarity with the major markets and instruments. Emphasizes tools 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 related derivatives; mortgages; and securitization. 15.437 strongly recommended.
S. Lucas

15.440J Advanced Financial Economics I
(Same subject as 14.440J)
Prereq: 15.416
G (Fall, Spring)
5-0-7 H-LEVEL Grad Credit
Covers advanced topics in the theory of financial markets with a focus on continuous time models. Topics include multiperiod securities markets and martingales; pricing of contingent securities such as options; optimal consumption and portfolio problems of an individual; dynamic equilibrium theory and the intertemporal capital asset pricing model; term structure of interest rates; and equilibrium with asymmetric information, transaction costs, and borrowing constraints. Primarily for doctoral students in accounting, economics, and finance.
L. Kogan

15.441J Advanced Financial Economics II
(Same subject as 14.441J)
Prereq: 14.121, 14.122, or 15.416
G (Spring)
3-0-9 H-LEVEL Grad Credit
Surveys selected topics in current advanced research in corporate finance. Theoretical and empirical analyses of corporate financing and investment decisions. Some background in information economics and game theory is useful. Primarily for doctoral students in accounting, economics, and finance.
A. Schoar

15.442J Advanced Financial Economics III
(Same subject as 14.442J)
Prereq: 13.82, 15.416, or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Recent empirical methods in finance, including: the estimation and testing of market efficiency; the random walk hypothesis; the CAPM/APT; various term structure models; option pricing theories; and market microstructures; performance evaluation; bond rating and default analysis; event study methodology; continuous-time econometrics; and general time series methods. An empirical term project is required. Some econometric background and rudimentary computer programming skills are assumed. Primarily for doctoral students in finance, accounting, and economics.

15.450 Analytics of Finance
Prereq: 15.401, 15.414, or 15.415
G (Fall)
5-0-4 H-LEVEL Grad Credit
Covers the practical aspects of the analytics of finance from the perspective of a quantitative investment manager. Considers investment strategies, backtest simulation, data and computational architecture, portfolio construction, trading implementation, and risk management within the context of a specific quantitative equity trading strategy. Study of these topics follows the natural sequence of research, development, testing, and implementation. Emphasizes financial applications, but also covers mathematical and statistical techniques in some depth, along with their computational implementation in software.
A. Lo

15.451 Proseminar in Financial Engineering
Prereq: 15.401, 15.414, or 15.415; 15.437
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Provides a unique opportunity to tackle original research problems in financial engineering 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.
M. Kritzman, J. Minahan

15.452 Proseminar in Financial Management
Prereq: 15.402, 15.414, or 15.415
G (Fall)
3-0-3 H-LEVEL Grad Credit
Bridges the gap between finance theory and finance practice, and introduces students to the broader financial community. Students participate in a series of proseminars with industry guest speakers. Each guest, in collaboration with finance faculty, provides a problem and materials to a team of students. Each team then prepares a report and presents their analysis to the guest speaker and other students for evaluation and feedback.
C. Holderness

15.460 Analytics of Finance II (New)
Prereq: 15.401, 15.414, or 15.415
G (Spring)
4-0-5
Covers the practical aspects of the analytics of finance from the perspective of a quantitative investment manager. Considers investment strategies, backtest simulation, data and computational architecture, portfolio construction, trading implementation, and risk management within the context of a specific quantitative equity trading strategy. Study of these topics follows the natural sequence of research, development, testing, and implementation. Emphasizes financial applications, but also covers mathematical and statistical techniques in some depth, along with their computational implementation in software.
A. Lo
ACCOUNTING

15.501 Corporate Financial Accounting
(Subject meets with 15.516)
Prereq: None
U (Fall, Spring)
3-0-9
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.
R. Watts, S. Keating

15.511 Financial Accounting
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 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 Fellows in Innovation and Global Leadership.
J. Weber

15.514 Financial and Managerial Accounting
Prereq: None
G (Summer)
3-0-9
An intensive introduction to the preparation and interpretation of financial information for investors (external users) and managers (internal users) and to the use of financial instruments to support system and project creation. Adopts a decision-maker perspective on accounting and finance. Restricted to System Design and Management students.
S. Keating

15.515 Financial Accounting
Prereq: Permission of instructor
G (Fall)
4-0-5 H-LEVEL Grad Credit
An intensive introduction to the preparation and 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. Keating

15.516 Corporate Financial Accounting
(Subject meets with 15.501)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9
See description under subject 15.501. If subject is oversubscribed, priority is given to Course 15 students.
R. Watts

15.518 Taxes and Business Strategy
Prereq: 15.501, 15.511, 15.515, or 15.516
G (Spring)
3-0-6 H-LEVEL Grad Credit
Provides a conceptual framework for thinking about taxation. Topics include the taxation of various investments and types of compensation; retirement planning; considerations of choosing an organizational form when starting a business; the various methods of merging, acquiring, and divesting business entities; international tax planning rules and strategies; and high wealth planning and the estate tax. Applies current debates on various tax policy options to class discussions. Intended for investment bankers and consultants who need to understand how taxes affect the structure of deals, managers and analysts who need to understand how firms strategically respond to taxes, and entrepreneurs who want to structure their businesses and finances in a tax-advantaged manner.
M. Hanlon

15.521 Management Accounting and Control
Prereq: 15.501, 15.511, 15.515, or 15.516
G (Spring)
3-0-6 H-LEVEL Grad Credit
Introduces participants to the language and methodologies of internal accounting practices. Topics include cost allocations, absorption costing, standard costing, transfer pricing, and performance measurement and evaluation. Major focus is on identifying which information is useful and which is useless and potentially misleading.
S. Keating

15.522 Security Design and Corporate Financing
Prereq: 15.401; 15.402 or 15.414; 15.433 or 15.434
G (Spring)
3-0-6 H-LEVEL Grad Credit
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; 15.411, 15.414 or 15.401
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Presents a framework for business analysis and provides students with tools for financial statement analysis, including strategic, accounting, financial, and prospective analysis. Concepts are then applied to a number of decision making contexts, such as credit analysis, company performance assessment, merger analysis, financial policy decisions, and securities analysis.
J. Ng

15.539 Doctoral Seminar in Accounting
Prereq: 15.515
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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

15.545 Mergers and Acquisitions: The Market for Corporate Control
Prereq: 15.402, 15.414, or 15.415; 15.511 or 15.515; 15.516
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Probably the most dramatic events in a corporation’s history involve the decision to acquire another firm or the decision to oppose being acquired. This is also one of the areas of management most thoroughly documented in the financial press and the academic literature.
Subject explores three aspects of the merger and acquisition process: the strategic decision to acquire, the valuation decision of how much to pay, and the financing decision on how to fund the acquisition. Class sessions alternate between discussions of academic readings and applied cases.

**Staff**

### INFORMATION TECHNOLOGIES

**15.561 Information Technology Essentials**
- **Prereq:** None
- **G (Spring)** 3-0-6
- 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)** 3-0-6
- 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, for managing innovative IT-dependent projects. Overall emphasis on business process automation and e-services.
  - **S. Madnick**

**15.565j Evolution Towards Web 3.0 and the Emergence of Management 3.0**
- **(Same subject as ESD.565j)**
- **Prereq:** Permission of instructor
- **G (Spring)** 3-0-6 H-LEVEL Grad Credit
- 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. 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
- **G (Fall)** 3-0-6 H-LEVEL Grad Credit
- Analysis of the underlying economics of information with management implications. Studies effects of digitization and technology on industry, organizational structure, and business strategy. Examines pricing, bundling, and versioning of digital goods, including music, video, software, and communication services. Considers the managerial implications of social networks, search, targeted advertising, personalization, privacy, network externalities, open source, and alliances. Discusses key principles. Includes case studies, industry speakers, and a team project.
  - **E. Brynjolfsson**

**15.569 Leadership Lab: Leading Sustainable Systems**
- **Prereq:** Permission of instructor
- **G (Fall, IAP)** 6-0-9 H-LEVEL Grad Credit
- 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, assignments, guest speakers, and an immersive project experience that focuses on systems change.
  - **W. Orlikowski, P. Senge**

**15.571 Business Strategy and the Role of IT**
- **Prereq:** None
- **G (Spring)** 3-0-6 H-LEVEL Grad Credit
- Designed to help students understand how top performing firms use information technology (IT) to distinguish themselves from their competitors. Explores how firms manage, use, and invest in IT to execute and define business strategy in a digital economy. Includes case studies about firms using IT to enhance competitiveness, with executives from these firms responding to student observations. Student teams work on consulting projects for companies, such as Bank of America, ExxonMobil, PepsiCo, and State Street.
  - **J. W. Ross**

**15.575 Economics of Information and Technology in Markets and Organizations**
- **Prereq:** Permission of instructor
- **Acad Year 2011–2012:** Not offered
- **Acad Year 2012–2013:** G (Spring) 3-0-9 H-LEVEL Grad Credit
- Builds upon relevant economic theories and methodologies to analyze the changes in organizations and markets enabled by IT, especially the Internet. Typical perspectives examined include industrial organization and competitive behavior, price theory, information economics, intangible asset valuation, consumer behavior, privacy, network externalities, open source, and alliances. Discusses key principles. Includes case studies, industry speakers, and a team project.
  - **E. Brynjolfsson**

**15.576 Research Seminar in Information Technology and Organizations: Social Perspectives**
- **Prereq:** Permission of instructor
- **Acad Year 2011–2012:** Not offered
- **Acad Year 2012–2013:** G (Spring) 3-0-9 H-LEVEL Grad Credit
- Examines the assumptions, concepts, theories, and methodologies that inform research into the social aspects of information technology. Extensive reading and discussion of research literature aimed at exploring the application of these theories to business issues and challenges raised by the internet and related technologies. Primarily for doctoral students.
  - **W. J. Orlikowski**

**15.578 Global Information Systems: Strategic, Technical, and Organizational Perspectives**
- **Prereq:** Permission of instructor
- **G (Spring)** 3-0-6 H-LEVEL Grad Credit
- Explores critical issues of communications and connectivity of global and internet-based infor-

S. E. Madnick

15.579–15.580 Seminar in Information Technology
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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)
2-0-4
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 Basic Business Law for the Entrepreneur and Manager
Prereq: None
G (Fall, Spring)
3-0-6
One of three alternative courses (15.615, 15.616, and 15.617) designed to provide managers with the foundation in business law needed to exercise judgment and leadership when confronting a broad range of complex law-sensitive issues. Topics vary from year to year but typically include organizing a new company, venture capital, contracts, liability, employment, intellectual property, business disputes, managerial and corporate crime, taking a company public, selling a business, and bankruptcy and reorganization. Focuses on US law but includes comparisons to other systems.
J. Akula

15.616 Basic Business Law, Tilted Towards Innovation and Strategy
Prereq: None
G (Fall)
3-0-6
One of three alternative courses (15.615, 15.616, and 15.617) each designed to provide managers with the foundation in business law needed to exercise judgment and leadership when confronting a broad range of complex law-sensitive issues. Topics vary from year to year but typically include most subjects covered in 15.615, some at a quicker pace, with extra attention to the legal frameworks of transnational business, cutting-edge technologies and products, and restructuring and repositioning major corporations. May appeal to students interested in strategic management and consulting.
J. Akula

15.617 Basic Business Law, Tilted Towards Finance
Prereq: None
G (Spring)
3-0-6
One of three alternative courses (15.615, 15.616, and 15.617) designed to provide managers with the solid foundation in business law needed to exercise judgment and leadership when confronting a broad range of complex law-sensitive issues. Topics vary from year to year but typically include most subjects covered in 15.615, some at a quicker pace, with extra attention to mergers and acquisitions, capital markets and private equity, the regulation of financial service providers, and legal risks associated with innovative financial products and services. May appeal to students interested in finance.
J. Akula

15.628 Patents, Copyrights, and the Law of Intellectual Property
Prereq: None
U (Spring)
2-0-4
Introductory examination of the US law of intellectual property, with emphasis on patents and copyrights, and a brief look at trademarks and trade secrets. Includes comparisons of what can and cannot be protected, what rights the owner does and does not obtain, and how these rights come into being. Highlights issues relating to information technology, biogenetic materials, and business methods. Readings include judicial opinions and statutory material. No listeners.
J. A. Meldman

15.647–15.649 Seminar in Law
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to law.
J. L. Akula

15.655J Law, Technology, and Public Policy
(Same subject as ESD.132J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.132J.
N. A. Ashford, C. C. Caidart

15.657J Sustainability, Trade, and the Environment
(Same subject as 1.813J, 11.466J, ESD.137J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.137J.
N. A. Ashford

INDUSTRIAL RELATIONS AND HUMAN RESOURCE MANAGEMENT

15.660 Strategic Human Resource Management
Prereq: 15.311
G (Spring)
3-0-6 H-LEVEL Grad Credit
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
15.664 Careers, Leadership, and Negotiations in the New Economy
Prereq: None
U (Fall)
4-0-8
Discusses how work, careers, and organizations are changing and the leadership skills required of professionals in contemporary organizations and society. Topics include the changing nature of work and careers, the role of knowledge in organizations and the economy, work-family integration, negotiations and conflict management, teamwork, leadership, and the management of diversity. Classes involve simulations, cases and negotiation exercises. Students develop a personal leadership and career development plan and work in teams to conduct an action-research project on campus related to one of the subject’s topics.

P. Osterman, T. Kochan

15.665 Power and Negotiation
Prereq: Permission of instructor
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 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 experimentally and to understand negotiation in useful analytical frameworks. Emphasizes simulations, exercises, role playing, and cases. Undergraduates may register for this subject provided they are ready to participate with the intensity expected for an H-level graduate subject

J. Curhan

15.666 Negotiation and Conflict Management
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Presents negotiation theory—strategies and styles—with an employment context. Special emphasis on sources of power in negotiation. Covers conflict management as a first party and as a third party (third-party skills include helping others deal directly with their conflicts, mediation, investigation, arbitration, and helping the system itself to change as a result of a dispute). Special cases include abrasiveness, dangerousness, racism, sexism, whistling, and ethics. Simulations of difficult situations such as cross-cultural mentoring and an emergency. One double class. Requires a commitment to attend all classes. Undergraduates may register for this subject provided they are ready to participate

M. P. Rowe, T. Kochan

15.668 People and Organizations
Prereq: None
U (Spring)
3-0-6
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 problem exercises 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, J. Carroll, P. Osterman

15.670 Leadership and Change
Prereq: 15.668, permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall; first half of term) 2-0-4
Applies concepts introduced in 15.668. Explores leadership and organizational change learned as a result of fieldwork experience. Alternative styles of leadership analyzed. Development of personal leadership plans. Approved fieldwork experience required for admission.

Staff

15.676 Work, Employment, and Industrial Relations Theory
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad Credit
Can be repeated for credit
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, R. Locke, P. Osterman, E. Castilla, O. Sharone

15.677J Urban Labor Markets and Employment Policy
(Same subject as 11.427J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

15.678J Political Economy I: Theories of the State and the Economy
(Same subject as 14.781J, 17.100J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 17.100J.

M. Piore, S. Berger

15.691 Research Seminar in Work, Employment and Industrial Relations
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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 Special Seminar in Industrial Relations and Human Resource Management
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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, or Coreq: 15.714, 15.722
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Consult J. Lehrich

Investigates the values firms should pursue, the different perspectives a general manager must take, 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.

15.701 Executive Module: Strategic Management of Innovation and Entrepreneurship
Prereq: 15.714 or permission of instructor
G (Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Weeklong intensive module that covers new product innovation and business plan development. Restricted to Executive MBA students.
Consult J. Lehrich

15.702 Leading in a Global Context (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Intensive module on international management, combining the key perspectives of macroeconomics, global business, and global strategy. Focuses on the policy and economic environment of firms, as well as on the development of a truly global market in products, services, and capital, and its effect on competition for businesses and industries. Presents key insights into national policies and strategies affecting the climate for innovation and organizational growth outside of North America, and the stages, processes, and challenges of strategic consulting in complex global organizations. Restricted to Executive MBA students.
Consult J. Lehrich

15.703 Managing Complexity for Strategic and Organizational Effectiveness I (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
15.704 Managing Complexity for Strategic and Organizational Effectiveness II (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Consult J. Lehrich

Strengthens students’ skills in recognizing, developing, and taking advantage of opportunities created by organizational complexity. Focuses on key topics in corporate strategy, organizational design, organizational economics, and strategic human resource management, and themes such as integrative management, global leadership, and innovation and entrepreneurship strategy. Emphasizes teaching through integrative, multi-perspective cases, and reflection to prepare students for the next steps in their careers as general managers. Restricted to Executive MBA students.

15.705 Organizations Lab
Prereq: Permission of instructor or Coreq: 15.716
G (Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
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. Restricted to Executive MBA students.
Consult J. Lehrich

15.706 Organizations Lab: Action Learning Project
Prereq: Permission of instructor or Coreq: 15.705
G (Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
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. Students work closely both with their organizational colleagues and with classmates in their learning groups. Restricted to Executive MBA students.
Consult J. Lehrich

15.707 Global Organizations Lab (New)
Prereq: Permission of instructor; Coreq: 15.708
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Preparation for action learning project in 15.708. Combines in-class discussions and case readings with team project development. Emphasizes two themes: the issues and policies affecting the climate for innovation and organizational growth outside of North America, and the stages, processes, and challenges of strategic consulting in complex global organizations. Restricted to Executive MBA students.
Consult J. Lehrich

15.708 Global Organizations Lab: Action Learning Project (New)
Prereq: Permission of instructor; Coreq: 15.707
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Student teams collaborate with senior management at a global organization to complete a strategic consulting project. Includes a weeklong site visit for research. Teams conclude their projects with rigorous analyses and persuasive recommendations for their clients, including detailed implementation plans. Restricted to Executive MBA students.
Consult J. Lehrich

15.710 Communication for Leaders
Prereq: Permission of instructor
G (Summer)
3-0-3 H-LEVEL Grad Credit
Credit cannot also be received for 15.280
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, including work integrated with the 15.706 Organizations Lab project. Restricted to Executive MBA students.
Consult J. Lehrich

15.712 Power and Negotiation
Prereq: Permission of instructor
G (IAP, Spring, Summer)
3-0-3 H-LEVEL Grad Credit
Credit cannot also be received for 15.665
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 experi-
15.714 Competitive Strategy
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-3 H-LEVEL Grad Credit
Credit cannot also be received for 15.902
Focuses on some of the important current issues in strategic management. Concentrate on modern analytical approaches and enduring successful strategic practices. Designed with a technological and global outlook since this orientation in many ways highlights the significant emerging trends in strategic management. Provides students with a pragmatic approach that guides the formulation and implementation of corporate, business, and functional strategies. Restricted to Executive MBA students.
Consult J. Lehrich

15.716 Leading Organizations
Prereq: None
G (IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Credit cannot also be received for 15.322
Promotes awareness of and ways to meet the challenges managers face today (and tomorrow). Acquaints students with some of the psychological and sociological dynamics that regularly operate in organizational settings—the less visible “forces” that influence employee and managerial behavior—and how these dynamics shape the way managers respond to a changing world. Restricted to Executive MBA students.
Consult J. Lehrich

15.720 Financial Accounting
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.511
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 user of accounting information (especially senior managers), rather than the preparer (the accountant). Restricted to Executive MBA students.
Consult J. Lehrich

15.722 Applied Economics for Managers
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
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. Lehrich

15.724 Financial Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.414
Introduction to corporate finance and capital markets. Topics include project and company valuation, real options, measuring risk and return, stock pricing and the performance of trading strategies, corporate financing policy, the cost of capital, and risk management. Subject provides a broad overview of both theory and practice. Restricted to Executive MBA students.
S. Myers

15.730 Data, Models, and Decisions
Prereq: Permission of instructor
G (IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
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. Lehrich

15.732 Marketing Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.809, 15.810, 15.812
In-depth study of the disciplinary framework for marketing and its applications to target markets and the optimization of marketing decisions. Students develop and practice techniques in five key stages of the framework: market orientation and research, segmentation and positioning, marketing mix, branding, and retailing and B2B. Emphasizes marketing management for the general manager, in particular profit optimization in chosen markets, and pricing, promotion, and product issues. Restricted to Executive MBA students.
Consult J. Lehrich

15.734 Introduction to Operations Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.761
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. Lehrich

15.735 Product Design and Development
Prereq: Permission of instructor
G (IAP, Spring, Summer)
3-0-3 H-LEVEL Grad Credit
Credit cannot also be received for 15.783
Covers modern tools and methods for product design and development. The cornerstone is a project in which teams of management, engineering, and industrial design students conceive, design, and prototype a physical product. Class sessions employ cases and hands-on exercises to reinforce the key ideas. Topics include product planning, identifying customer needs, concept generation, product architecture, industrial design, concept design, robust design, and green design practice. Restricted to Executive MBA students.
Consult J. Lehrich

15.736 Introduction to System Dynamics
Prereq: Permission of instructor
G (IAP, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
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. Lehrich

OPERATIONS MANAGEMENT

15.760 Introduction to Operations Management
Prereq: 15.060 or 6.041
G (Spring)
2-0-4 H-LEVEL Grad Credit

Introduction to problems and analysis related to the design, planning, control and improvement of manufacturing and service operations. Includes process analysis, project analysis, materials management, production planning and scheduling, quality management, supply chain design and coordination, reengineering, design for manufacturing, capacity and facilities planning, and operations strategy.

J. Gallien, R. Levi

15.761 Introduction to Operations Management
Prereq: 15.060, 6.041, or permission of instructor
G (Spring, Summer)
4-0-5 H-LEVEL Grad Credit

Credit cannot also be received for 15.734

In-depth introduction to the fundamental concepts and techniques related to the design, planning, control, and improvement of strategic, operational and tactical execution capabilities of business environments in various application domains, including manufacturing and service operations. Covers a broad range of applications and industries, such as high-tech, financial services, insurance, automotive, health care, leisure, fashion, and retail. Special emphasis on the effects of uncertainty on strategic and operational decision-making and to the interplay between high-level financial objectives and low-level operational guidelines. Topics include process description, flow diagrams, capacity analysis, capacity ROI, cycle time analysis, inventory management, delayed postponement, production control, risk pooling, quality management, process design and revenue management. Summer section is primarily for Leaders for Global Operations students.

I. Ashlagi, R. Levi, D. Rosenfield

15.762J Supply Chain Planning
(Same subject as 1.273J, ESD.267J)
Prereq: 1.260J, 15.760, or 15.761
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

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.

S. C. Graves, D. Simchi-Levi

15.763J Manufacturing System and Supply Chain Design
(Same subject as 1.274J, ESD.268J)
Prereq: 1.260, 15.760, or 15.761
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit

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 tradeoffs. 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.

S. C. Graves, D. Simchi-Levi

15.764J The Theory of Operations Management
(Same subject as 1.271J, ESD.274J)
Prereq: 15.081J or 6.251J, 6.436J; or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Focus on theoretical work for studying operations planning and control problems. Topics vary from year to year, and include supply chain design and coordination, logistic and distribution systems, make-to-order systems, call centers and service operations, procurement, pricing, revenue management, the sales/production interface, inventory theory, flexible manufacturing systems.

Fall: V. Farias
Spring: R. Levi

15.765J International Supply Chain Management
(Same subject as 1.265J, 2.965J, ESD.265J)
Prereq: 1.260, 1.261, 1.262, 15.760, or permission of instructor
Acad Year 2011–2012: G (Spring; first half of term)
Acad Year 2012–2013: Not offered
2-0-4 H-LEVEL Grad Credit

See description under subject 2.965J.

Staff

15.768 Management of Services: Concepts, Design, and Delivery
Prereq: 15.760, 15.761, or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

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

15.769 Operations Strategy
Prereq: 15.760, 15.761, 15.778, or permission of instructor
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit

Provides unifying framework for analyzing strategic issues in manufacturing and service operations. Analyzes relationships between manufacturing and service companies and their suppliers, customers, and competitors. Also covers decisions in technology, facilities, vertical integration, human resources and other strategic areas. Explores means of competition such as cost, quality, and innovativeness. Provides an approach to make operations decisions in the era of outsourcing and globalization.

C. H. Fine, D. B. Rosenfield

15.770J Logistics Systems
(Same subject as 1.260J, ESD.260J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduction to supply chain management from both analytical and practical perspectives. Stressing a unified approach, the course allows the student to develop a framework for making intelligent decisions within the supply chain. Key logistics functions are covered to include de-
mand planning, procurement, inventory theory and control, transportation planning and execution, reverse logistics, and flexible contracting. Concepts explored include postponement, portfolio management, dual sourcing, and others. Emphasis is placed on being able to recognize and manage risk, analyze various tradeoffs, and model logistics systems.

Y. Sheffi, C. Caplice

15.771J Case Studies in Logistics and Supply Chain Management
(Same subject as 1.261J, ESD.261J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

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

15.778 Management of Supply Networks for Products and Services
Prereq: None
G (Summer)
3-0-6

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 MIT Sloan Fellows in Innovation and Global Leadership.

Consult G. Bitran

15.783J Product Design and Development
(Same subject as 2.739J, ESD.32J)
Prereq: 2.009, 15.760, 15.761, or permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.735

Covers modern tools and methods for product design and development. The cornerstone is a project in which teams of management, engineering, and industrial design students conceive, design, and prototype a physical product. Class sessions employ cases and hands-on exercises to reinforce the key ideas. Topics include product planning, identifying customer needs, concept generation, product architecture, industrial design, concept design, robust design, and green design practice.

S. Eppinger, W. P. Seering

15.792J Global Operations Leadership Seminar
(Same subject as 2.890J, 10.792J, 16.985J)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
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.

D. B. Rosenfield

15.794 Research Project in Operations
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

A special projects subject 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.

D. B. Rosenfield

15.795 Seminar in Operations Management
Prereq: 15.760 or 15.761
G (Spring)
3-0-6 H-LEVEL Grad Credit
Can be repeated for credit

Topics vary from year to year. Typical examples from past years: manufacturing strategy, technology supply chains.

C. H. Fine

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 Marketing Management
Prereq: None
G (Summer)
3-0-6
Credit cannot also be received for 15.732, 15.810, 15.812

Marketing is a rigorous, disciplined science that applies a reasoned framework to the selection of target markets and the optimization of marketing decisions. The subject has two parts: a tactical portion and a strategic portion. The strategic portion focuses on identifying target markets. The tactical portion reviews how firms optimize profits in their chosen markets. Tactical topics include pricing, promotion, channel and product issues. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.

D. Simester

15.810 Marketing Management
Prereq: None
G (Fall, Spring)
3-0-6
Credit cannot also be received for 15.732, 15.809, 15.812

Develops skills in marketing analysis and planning, and introduces key marketing ideas and phenomena, especially the core theme of delivering benefits to customers. Presents the four Ps of marketing and enhances problem solving
15.812 Marketing Management
Prereq: None
U (Spring)
3-0-6
Credit cannot also be received for 15.732, 15.809, 15.810
Provides a comprehensive introduction to contemporary marketing concepts and techniques, such as customer analysis, market segmentation, targeting, positioning, branding, product design, pricing, promotion, and distribution. Uses lectures, case studies, and class demonstrations to illustrate concepts. Emphasizes turning technology into market value. Primarily for undergraduate and non-MBA graduate students.
J. R. Hauser, M. Braun

15.818 Pricing
Prereq: None
G (Spring)
3-0-6
Framework for understanding pricing strategies and tactics. Topics covered include economic value analysis, price elasticities, price customization, pricing complementary products, pricing in platform markets and anticipating competitive price responses. Lectures and cases.
C. Tucker

15.821 Listening to the Customer
Prereq: None
G (Fall; first half of term)
3-0-3
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 uses techniques like “listening in,” virtual customer, and trust-based marketing. Group project allows students to apply lessons to the design and marketing of a real product—a “green” auto (hydrogen, electric, or plug-in hybrid).
G. L. Urban

15.828 Design and Marketing New Products
Prereq: 15.809, 15.810 or 15.812
G (Spring; first half of term)
3-1-5 H-LEVEL Grad Credit
Practical introduction to the process of designing and marketing new products. Covers the major phases of product development: opportunity identification (customer input, generating ideas, market definition), product design and positioning, pre-market testing and forecasting, launch marketing, and managing the life cycle. Presents proven techniques, but emphasizes state-of-the-art methods like “listening in,” virtual customer, information acceleration, and trust-based marketing. Group project allows students to apply lessons to the design and marketing of a real product—a “green” auto (hydrogen, electric, or plug-in hybrid).
D. Prelec

15.833 Business-to-Business Marketing
Prereq: None
G (Fall; second half of term)
3-0-3
Applies marketing concepts, analyses and tools used in business-to-business (B2B) marketing which accounts for more than half of the economic activity in the US. Develops an understanding of customer value management as a strategy for delivering superior value to targeted business segments while maintaining equitable returns. Using an analytical framework, students assess components of customer value and translate them into actionable marketing strategies and programs. Focuses on 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. Discusses ethical issues and various B2B contexts such as products and services, for-profits and non-profits, domestic and global markets. Emphasis on applications in technology and healthcare domains. Includes case studies, applied exercises, and readings.
S. Chatterjee

15.834 Marketing Strategy
Prereq: None
G (Spring; half-term subject)
3-0-6
Introduces tools from strategy and economics to look systematically at marketing strategy. Topics include how to maximize value for the customer-firm-supplier triad and how to develop new sources of competitive advantage. Taught mostly with cases.
B. Wernerfelt

15.836 New Product and Venture Development Proseminar
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-3 [P/D/F]
Provides an overview and feel for what is involved in new product development within a larger organization, as well as in start-up firms. The key question is: How does an idea or an invention become a successful innovation in the marketplace? Seminar features a series of speakers who focus on specific aspects of this process, from topics such as “the fuzzy front end” that seed teams face, championing an idea through an organization, keeping an entrepreneurial spirit alive, growing pains, designing the business plan, meeting communications challenges, and using creative marketing techniques.
D. Prelec

15.838 Research Seminar in Marketing
Prereq: 15.810
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
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 D. Prelec

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
MANAGEMENT

15.840–15.843 Seminar in Marketing
Prereq: 15.809, 15.810, or 15.812
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to marketing.
Staff

15.846 Branding
Prereq: 15.809, 15.810, or 15.812
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit
Provides a foundation for building, managing, and defending brands at various stages in the brand lifecycle. 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.
R. Gosline

15.847 Consumer Behavior
Prereq: 15.810
G (Spring)
3-0-6 H-LEVEL Grad Credit
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.
J. Ackerman

SYSTEM DYNAMICS

15.871 Introduction to System Dynamics
Prereq: Permission of instructor
G (Fall, Spring; first half of term)
3-0-3 H-LEVEL Grad Credit
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, supply chains, product development, and others. Principles for effective use of modeling in the real world. A. Sastry, D. Centola

15.872 System Dynamics II
Prereq: 15.871
G (Fall, Spring; second half of term)
3-0-3 H-LEVEL Grad Credit
Continuation of 15.871, emphasizing tools and methods needed to apply systems thinking and simulation modeling successfully in complex real-world settings. 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 learn how to use qualitative and quantitative data to formulate and test models, and how to work effectively with senior executives to implement change successfully. Prerequisite for further work in the field.
J. D. Sterman, N. P. Repenning, D. Centola

15.875 Applications of System Dynamics
Prereq: 15.872
G (Spring)
3-0-6 H-LEVEL Grad Credit
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.
A. Sastry, J. Sterman

15.877 Professional Seminar in Sustainability (New)
Prereq: None
G (Fall, Spring)
2-0-1 [P/D/F]
Focuses on the challenges in bringing about fundamental changes to achieve sustainability in areas of human activity, such as products and services, buildings and communities, and organizations and institutions. Considers how individuals and networks develop and function as agents of change and examines the question of what it means to be an effective agent of change through a series of dialogs with a variety of professionals in business and industry. Students analyze and evaluate the implications of ongoing work in the field, with a focus on how to address systemic change in their own careers.
J. Jay

15.879 Research Seminar in System Dynamics
Prereq: 15.874 and permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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 J. D. Sterman, N. P. Repenning

STRATEGIC MANAGEMENT

15.900 Competitive Strategy
Prereq: None
G (Spring; first half of term)
3-0-3
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.
P. Yin

15.902 Strategic Management
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall; first half of term)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.714
Focuses on some of the important current issues in strategic management. Concentrate on modern analytical approaches and enduring successful strategic practices. Designed with a technological and global outlook since this orientation in many ways highlights the significant emerging trends in strategic management. Provides students with a pragmatic approach that guides the formulation and implementation of corporate, business, and functional strategies. Half-term subject. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
A. Hax
15.903 Managing the Modern Organization: Organizational Economics and Corporate Strategy
Prereq: 15.900, 15.010, 15.311
G (Fall, Spring; first half of term)
3-0-3 H-LEVEL Grad Credit

Focuses on how managers build and manage complex organizations to achieve strategic goals. Develops theoretical frameworks that build on 15.010, 15.311, and 15.900. 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, 15.902, or permission of instructor
Acad Year 2011–2012: G (Fall, Spring; second half of term)
Acad Year 2012–2013: Not offered
3-0-3 H-LEVEL Grad Credit

Builds on 15.900 and 15.902 to explore key concepts that have shaped “best practices” and logic in 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 and research, the role of randomness in strategic outcomes, strategic thinking versus planning, 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 for SDM
Prereq: None
G (Spring)
3-0-3

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. SDM students only, except with instructor permission.

M. Davies

15.910 Innovation Strategy
Prereq: 15.900
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit

Establishes a solid foundation for students interested in managing innovation in high-technology industries. Emphasizes the development and application of conceptual models, clarifying the interactions among competition, patterns of technological and market change, and the structure and development of internal firm capabilities. Topics include appropriating the returns from innovation, competition with demand-side increasing returns, managing joint ventures and collaborative innovation, organization of R&D and technology platforms, and theories of diffusion and adoption. Key conceptual frameworks are linked to applications in a variety of industry and case settings.

P. Azoulay

15.911 Entrepreneurial Strategy
Prereq: 15.900
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit

Provides a strategic management framework for the management of entrepreneurial firms. Develops a set of powerful conceptual frameworks that allow entrepreneurs to evaluate and implement key strategic choices: the selection of novel technological and market opportunities, the organization and funding of early-stage ventures, and the development of a commercialization path. Emphasizes the dynamic nature of entrepreneurship; highlights the role of strategy in the management of uncertainty, and innovation in periods of industry disruption. Briefly considers the role of entrepreneurial and entrepreneurs in economic growth.

S. Stern

15.912 Strategic Management of Innovation and Entrepreneurship
Prereq: 15.910 or 15.911
G (Fall; partial term)
3-0-3 H-LEVEL Grad Credit

Considers the challenges and opportunities involved in managing innovation in high-growth and large organizations, including the design and execution of innovation portfolios, technology alliances, acquisitions and corporate venturing in large organizations. Also focuses on issues concerning organizational structure and incentives for scientists and engineers engaged in innovation and product development.

F. Murray

15.913 Strategies for Sustainable Business
Prereq: None
G (Spring; first half of term)
3-0-3

Develops a pragmatic, action-oriented approach to sustainability: the alignment between healthy businesses, healthy environments, healthy societies, and an economy that meets human needs. Discusses how sustainability is changing existing business models and market structures, how to develop sustainable management practices, and how firms can implement those practices successfully. In-class simulations, cases, role-playing, and guest speakers explore emerging strategies for sustainable businesses and organizations.

R. Locke, A. Hoffman, J. Jay, J. Sterman

15.914 Competitive Dynamics and Strategy—Winning in Technology Markets
Prereq: 15.871 or 15.874; 15.365, 15.350, 15.351, 15.900, 15.902 or 15.912
G (Spring)
2-0-7 H-LEVEL Grad Credit

Focuses on competitive strategy in technology-driven markets. Explores the signature dynamics common to almost all such markets: innovation, technology substitution, product lifecycles, commoditization, disruption, transformation of mature businesses, and technology ecosystems. Over the term students acquire a portfolio of models of the signature dynamics. They use the models in projects with participating companies to analyze technology markets, formulate competitive strategies, and illuminate the challenges of execution. Issues addressed are critical for both established incumbents and new market entrants. It is a “master class” in applied corporate strategy. Restricted to graduate students.

H. B. Weil

15.915 Laboratory for Sustainable Business
Prereq: 15.913
G (Spring)
3-0-3 H-LEVEL Grad Credit

Focuses on what organizations can do to address the challenges we face as a society and as a species. Explores how commercial firms, nonprofits, and government agencies respond to problems including climate change, environmental degradation, and social dislocation. Provides tools and methods as well as practical applications of sustainability committed to both the reality of “the bottom line” and the need to sustain the natural and human systems on which we rely. Students work in teams with a company/organization on a real-world sustainability project throughout the term.

R. Locke, A. Hoffman, J. Jay, J. Sterman
15.916 Professional Seminar in Sustainability
Prereq: None
G (Spring)
2-0-1 [P/D/F]
Provides an opportunity for in-depth exploration of the social, economic, political and environmental contexts of organizational sustainability programs. Students interact with professionals from a diverse set of commercial, nonprofit, policy and governmental organizations that are actively pursuing sustainability in operations, products, strategy, and other areas. Includes detailed discussions with these leaders, and student reflections on their career experience and vision in light of the speakers’ work.
Staff

15.933 Strategic Opportunities in Energy
Prereq: 15.900 or permission of instructor
G (Fall; first half of term)
4-0-2 H-LEVEL Grad Credit
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, A. J. M. Meggs

15.941J Leadership in Real Estate
(Same subject as 11.430J)
Prereq: None
G (Fall; first half of term)
3-0-6
Provides theories, concepts and tools to craft, articulate and refine a “leadership point of view.” Students complete multiple self-assessments to better understand their leadership style and their strengths and opportunities for growth; interact with leaders in the real estate industry to gain insight on the leaders’ experiences and development; and increase their ability to “connect” with others. Students design a plan for the ongoing development of their leadership capabilities.
G. Schuck

15.949 Seminar in Strategy
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for group study by graduate students on current topics related to strategy.
Consult E. Zuckerman

SPECIAL SUBJECTS

15.501–15.519 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Group study of current topics related to management not otherwise included in curriculum.
Consult Undergraduate Program Headquarters

15.520–15.526 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.

15.530–15.533 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

15.540–15.541 Special Seminar in Management
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

THESIS, RESEARCH, AND PRACTICE

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

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

15.950 Independent Study in Management
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For students who desire to do advanced work or to carry out some special investigation of a management problem not specifically covered elsewhere and not qualifying as a thesis. Readings, conferences, laboratory and fieldwork, and
reports. Projects require prior approval, as well as a written proposal and a final report.

J. A. Meldman

15.960 Independent Study in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

15.961 Independent Study in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

For students who desire to do advanced work or to carry out some special investigation of a management problem not specifically covered elsewhere and not qualifying as a thesis. 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

15.999 Curricular Practical Training (CPT)
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Students participate in off-campus work or internship experience and apply topics of management and/or culture to their experience. Requirements include mandatory attendance at one workshop and a paper. Students must have a formal employment offer prior to enrolling. Restricted to MIT Sloan students who have been in legal F1 status for nine consecutive months and who wish to work in the United States in an area related to their field of study.

Consult Sloan Educational Services

15.THG Graduate Thesis
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

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

Consult Sloan Educational Services
# Bachelor of Science in Management Science/Course 15

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>2</td>
</tr>
<tr>
<td>[two subjects can be satisfied by 14.01 and 14.02 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>8</td>
</tr>
<tr>
<td>[can be satisfied by 6.041 and 18.06 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>2</td>
</tr>
<tr>
<td>[can be satisfied by 15.301 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
<td>123</td>
</tr>
<tr>
<td>6.041 Probabilistic Systems Analysis, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>14.01 Principles of Microeconomics, 12, HASS-S</td>
<td></td>
</tr>
<tr>
<td>14.02 Principles of Macroeconomics, 12, HASS-S</td>
<td></td>
</tr>
<tr>
<td>15.053 Optimization Methods in Management Science, 12</td>
<td></td>
</tr>
<tr>
<td>15.075 Statistical Thinking and Data Analysis, 12; 6.041*</td>
<td></td>
</tr>
<tr>
<td>15.279 Management Communication for Undergraduates, 12, CI-M</td>
<td></td>
</tr>
<tr>
<td>15.301 Managerial Psychology Laboratory, 15, LAB, CI-M</td>
<td></td>
</tr>
<tr>
<td>15.501 Corporate Financial Accounting, 12</td>
<td></td>
</tr>
<tr>
<td>18.06 Linear Algebra, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
</tbody>
</table>

### Restricted Electives

One of the following four subjects:
- 15.354 Innovation and Entrepreneurship: How to Do It, 9
- 15.401 Finance Theory I, 9
- 15.812 Marketing Management, 9
- 15.761 Introduction to Operations Management, 9; 6.041*

**Concentration Subjects:**
Two to three additional subjects as specified in one of the following concentrations: Finance, Information Technologies, Marketing Science, Operations Research

### Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(60)</td>
</tr>
</tbody>
</table>

### Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>72–90</td>
</tr>
</tbody>
</table>

### Total Units Beyond the GIRs Required for SB Degree

180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

## Notes

* Alternate prerequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
16.00 Introduction to Aerospace and Design
Prereq: None
U (Spring)
3-1-5
The fundamental concepts and approaches of aerospace engineering are highlighted through lectures on aeronautics, astronautics, and design. Active learning aerospace modules make use of information technology. Student teams are immersed in a hands-on, lighter-than-air (LTA) vehicle design project where they design, build, and fly radio-controlled LTA vehicles. The connections between theory and practice are realized in the design exercises. Required design reviews precede the LTA race competition. The performance, weight, and principle characteristics of the LTA vehicles are estimated and illustrated using physics, mathematics, and chemistry known to freshmen, the emphasis being on the application of this knowledge to aerospace engineering and design rather than on exposure to new science and mathematics. Includes exercises in written and oral communication and team building.
J. A. Hoffman

16.001 Unified Engineering I
Prereq: Physics II (GIR); Coreq: 18.03 or 18.034; Chemistry (GIR)
U (Fall)
5-1-6
16.002 Unified Engineering II
Prereq: Physics II (GIR); Coreq: 18.03 or 18.034; Chemistry (GIR)
U (Fall)
5-1-6
16.001 and 16.002 require simultaneous registration. Presents fundamental principles and methods of aerospace engineering, as well as their interrelationship and applications, through lectures, recitations, design problems, and labs. Materials and structures, including statics, analysis of trusses, the analysis of statically determinate and indeterminate systems, and the stress-strain behavior of materials. Fluid mechanics, including conservation laws for fluid flows, the integral momentum theorem and applications, potential flow, vorticity and circulation, and the characterization of airfoil performance. Thermodynamics, including the thermodynamic state of a system, work, heat and various forms of energy, the first law of thermodynamics, heat engines, reversible and irreversible processes, entropy, and the second law of thermodynamics. Signals and systems, including linear and time invariant systems, convolution, and transform analysis.
P. A. Lagacé, P. Lozano, E. H. Modiano, Z. S. Spakovszky

16.003 Unified Engineering III
Prereq: 16.001, 16.002
U (Spring)
5-1-6
16.004 Unified Engineering IV
Prereq: 16.001, 16.002
U (Spring)
5-1-6
16.003 and 16.004 require simultaneous registration. Presents fundamental principles and methods of aerospace engineering, as well as their interrelationship and applications, through lectures, recitations, design problems, and labs. Materials and Structures, including analysis of beam bending, buckling and torsion, material and structural failure, including plasticity, fracture, fatigue, and their physical causes. Fluid Mechanics, including thin airfoil theory, three-dimensional wing theory, lifting line theory, induced drag and optimal lift distributions, wing design, aircraft performance, compressible flows, shocks, supersonic airfoils, nozzles. Thermodynamics and Propulsion, including applications of the integral momentum theorem to aerospace propulsion systems, ideal and non-ideal cycle analysis, energy exchange in compressors and turbines, and an introduction to heat transfer. Applications of Signals and Systems to aerospace, including modulation, filtering, sampling, and navigation systems.
P. A. Lagacé, H. Balakrishnan, J. Peraire, Z. S. Spakovszky

COURSE 16
AERONAUTICS AND ASTRONAUTICS

16.00A] Fundamentals of Engineering Design: Explore Space, Sea and Earth
(Same subject as 2.00A)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-3-3
See description under subject 2.00A.
A. H. Techet, D. Newman

16.06 Principles of Automatic Control
Prereq: 16.004
U (Fall)
3-2-7
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 state space methods. Application to a variety of aircraft and spacecraft systems.
S. R. Hall

16.07 Dynamics
Prereq: 16.004
U (Fall)
3-1-8
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.
S. E. Widnall

16.09 Statistics and Probability (New)
Prereq: Calculus II (GIR)
U (Spring)
3-0-9
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.
M. Z. Win
16.100 Aerodynamics
Prereq: 16.004
U (Fall)
3-1-8
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.
Y. M. Marzouk

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 study abroad under either the department’s Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may be used to satisfy specific SB degree requirements. Requires prior approval. Consult department.
B. C. Williams

16.102 Manufacturing with Advanced Composite Materials
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
1-3-2
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. Lagacé

16.110 Flight Vehicle Aerodynamics
Prereq: 16.100
G (Fall)
3-1-8
M. Drela

16.120 Compressible Internal Flow and Aeroacoustics
Prereq: 2.25 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Internal compressible flow and fundamentals of acoustics and aerodynamic sound with applications in turbomachinery and propulsion systems. Quasi-one-dimensional compressible flow (channel flow) and extensions, including effects of shock waves, friction, energy and mass addition, swirl, and flow non-uniformity. Unsteady compressible flow, theory of sound, sources of sound and wave propagation, Lighthill’s acoustic analogy, and characterization and estimation of noise sources encountered in turbomachinery and aircraft applications.
Z. S. Spakovszky, Q. Wang

16.13 Aerodynamics of Viscous Fluids
Prereq: 16.100, 16.110, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
M. Drela, Y. Marzouk

16.201 Topics in Materials and Structures
Prereq: Permission of department
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Provides credit for work in materials and structures outside of regularly scheduled subjects. Intended for study abroad under either the department’s Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may be used to satisfy specific SB degree requirements. Requires prior approval. Consult department.
B. C. Williams

16.221J Structural Dynamics and Vibrations
(Subject meets with 1.058)
(Subject meets with 1.581J, 2.060J)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
1-3-2
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. Lagacé
INFORMATION AND CONTROL ENGINEERING

16.30 Feedback Control Systems
(Subject meets with 16.31)
Prereq: 16.06, 16.060, 2.010, or 6.302
U (Fall)
4-0-8
Reviews classical control design using root locus and frequency domain methods (Nyquist diagrams and Bode plots). Studies state-space representation of dynamic systems, including model realizations, controllability, and observability. Introduces the state-space approach to control system analysis and synthesis, including full state feedback using pole placement, 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. Students taking the graduate version complete additional assignments.
J. P. How, E. Frazzoli

16.31 Feedback Control Systems
Prereq: Permission of department
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 study abroad under either the department’s Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may be used to satisfy specific SB degree requirements. Requires prior approval. Consult department.
B. C. Williams

16.32 Principles of Optimal Control
Prereq: 16.31 or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Studies basic optimization and the principles of optimal control. Considers deterministic and stochastic problems for both discrete and continuous systems. Solution methods include numerical search algorithms, model predictive control, dynamic programming, variational calculus, and approaches based on Pontryagin’s maximum principle. Includes many examples and applications of the theory.
S. R. Hall

16.323 Principles of Optimal Control
Prereq: 18.085, 16.31
G (Spring)
3-0-9 H-LEVEL Grad Credit
Studies basic optimization and the principles of optimal control. Considers deterministic and stochastic problems for both discrete and continuous systems. Solution methods include numerical search algorithms, model predictive control, dynamic programming, variational calculus, and approaches based on Pontryagin’s maximum principle. Includes many examples and applications of the theory.
S. R. Hall

16.33 Aircraft Stability and Control
Prereq: 16.31 or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
E. Frazzoli
AERONAUTICS AND ASTRONAUTICS

16.338J Dynamic Systems and Control (New)  
(Same subject as 6.241J)  
Prereq: 6.003, 18.06  
G (Spring)  
4-0-8 H-LEVEL Grad Credit  
See description under subject 6.241J.  
M. A. Dahleh, A. Megretski, E. Frazzoli

16.343 Spacecraft and Aircraft Sensors and Instrumentation  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
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.  
R. J. Hansman, K. Cahoy

16.346 Astrodynamics  
Prereq: 18.03  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
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, 6.01, or 6.005  
U (Fall)  
3-0-9  
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.  
N. Roy, J. A. Shah

(Same subject as ESD.355J)  
Prereq: 16.35, ESD.33, or permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
A reading and discussion subject 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 lifecycle; 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  
Prereq: 16.004 or 6.003; 16.09 or 6.041  
U (Spring)  
3-0-9  
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.  
E. H. Modiano

16.37J Data-Communication Networks  
(Same subject as 6.263J)  
Prereq: 6.041 or 18.313  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 6.263J.  
D. P. Bertsekas, E. Modiano, D. Shah

16.391J Statistics for Engineers and Scientists  
(Same subject as 6.434J)  
Prereq: Calculus II (GIR), 18.06, 6.431, or permission of instructor  
Acad Year 2011–2012: G (Fall)  
Acad Year 2012–2013: Not offered  
3-0-9 H-LEVEL Grad Credit  
See description under subject 6.434J.  
M. Win, J. N. Tsitsiklis

16.395 Principles of Wide Bandwidth Communication  
Prereq: A strong background in digital communication, e.g. 6.011, 16.36, or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
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 Factors Engineering  
(Subject meets with 16.453J, ESD.773J)  
Prereq: None  
U (Fall)  
3-3-6  
See description under subject 16.453J.  
L. R. Young
16.401 Topics in Communication and Software
Prereq: Permission of department
U (Fall, IAP, Spring)
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 study abroad under either the department’s Year Abroad Program or the Cambridge-MIT Exchange Program. Credit may be used to satisfy specific SB degree requirements. Requires prior approval. Consult department. B. C. Williams

16.405J Robotics: Science and Systems I
(Same subject as 6.141J)
Prereq: Permission of instructor
U (Spring)
2-6-4 Institute LAB
See description under subject 6.141J. N. Roy, D. Rus, S. Teller

16.406J Robotics: Science and Systems II
(Same subject as 6.142J)
Prereq: 6.141 or permission of instructor
U (Fall)
2-6-4
See description under subject 6.142J. D. Rus, S. Teller, N. Roy

16.410 Principles of Autonomy and Decision Making
(Subject meets with 16.413)
Prereq: 1.00 or 6.01
U (Fall)
3-0-9 Survey of reasoning, optimization and decision making methodologies for creating highly autonomous systems and decision support aids. Focus on principles, algorithms, and their application, taken from the disciplines of artificial intelligence and operations research. Reasoning paradigms include logic and deduction, heuristic and constraint-based search, model-based reasoning, planning and execution, and machine learning. Optimization paradigms include linear programming, integer programming, and dynamic programming. Decision-making paradigms include decision theoretic planning, and Markov decision processes. B. C. Williams

16.412J Cognitive Robotics
(Same subject as 6.834J)
Prereq: 6.041, 6.042, or 16.09; 16.410, 16.413, 6.034, or 6.825
G (Spring)
3-0-9 H-LEVEL Grad Credit
Algorithms and paradigms for creating a wide range of robotic systems that act intelligently and robustly, by reasoning extensively from models of themselves and their world. Examples range from autonomous Mars explorers and cooperative air vehicles, to everyday embedded devices. Topics include deduction and search in real-time; temporal, decision-theoretic and contingency planning; dynamic execution and re-planning; reasoning about hidden state and failures; reasoning under uncertainty, path planning, mapping and localization, and cooperative and distributed robotics. B. C. Williams

16.413 Principles of Autonomy and Decision Making
(Subject meets with 16.410)
Prereq: 1.00 or 6.01
G (Fall)
3-0-9 H-LEVEL Grad Credit
Graduate-level version of 16.410; see description under 16.410. Additional material on reasoning under uncertainty and machine learning, including hidden Markov models, graphical models and Bayesian networks, computational learning theory, reinforcement learning, decision tree learning and support vector machines. Assignments include the application of autonomy algorithms to practical aerospace systems, as well as more advanced programming assignments. B. C. Williams, E. Frazzoli

16.420 Planning Under Uncertainty
Prereq: 16.413
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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. N. Roy

16.422J Human Supervisory Control of Automated Systems
(Same subject as ESD.774J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-1-8 H-LEVEL Grad Credit
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. Fall: J. A. Shah
Spring: M. L. Cummings

16.423J Aerospace Biomedical and Life Support Engineering
(Subject meets with 16.65J, HST.515J)
Prereq: 16.400, 16.06, 16.060, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-1-8 H-LEVEL Grad Credit
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| Sensory-Neural Systems: Spatial Orientation from End Organs to Behavior and Adaptation
(Same subject as HST.514J)
Prereq: Neuroscience or systems engineering or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
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.
C. M. Oman, L. R. Young

16.453J| Human Factors Engineering
(Same subject as ESD.773J)
(Special meets with 16.400)
Prereq: 6.041 or permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
Provides a fundamental understanding of the human factors that must be considered in the design and engineering of complex aviation and space systems. Focuses on the derivation of human engineering design criteria from sensory, motor and cognitive sources. Students, individually and in teams, apply design principles from topic areas including displays, controls and ergonomics, manual control, the nature of human error, basic experimental design, and human-computer interaction. Includes aviation accident case presentations and interactive projects. Graduate students also complete an additional research-oriented project with a final written report and oral presentation.
M. L. Cummings

16.456| Biomedical Signal and Image Processing
(Same subject as 6.555J, HST.582J)
Prereq: 6.003, 2.004, 16.004, or 18.085
G (Spring)
3-6-3 H-LEVEL Grad Credit
See description under subject HST.582J.
J. Greenberg, E. Adalsteinsson, W. Wells, G. Clifford

16.459| Bioengineering Journal Article Seminar
Prereq: None
G (Fall, Spring)
0-2-0
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.
C. M. Oman, L. R. Young

16.470J| Statistical Methods in Experimental Design
(Same subject as ESD.756J)
Prereq: 6.041, 16.09, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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. Alternate years.
M. L. Cummings

16.475J| Human-Computer Interface Design Colloquium
(Same subject as ESD.775J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
2-0-2
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.
M. L. Cummings

16.50| Introduction to Propulsion Systems
Prereq: 16.004 or 2.005
U (Spring)
3-0-9
Presents aerospace propulsion 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.
M. Martínez-Sánchez

16.511| Aircraft Engines and Gas Turbines
Prereq: 16.50 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Performance and characteristics of aircraft engines and industrial gas turbines, as determined by thermodynamic and fluid mechanistic behavior of components: inlets, compressors, combustors, turbines, and nozzles. Discusses various engine types, including turbojet, turbofan, and turboprop. Limitations imposed by material properties and stresses. Emphasizes future design trends, including reduction noise, pollutant formation, fuel consumption, and weight.
S. Barrett

16.512| Rocket Propulsion
Prereq: 16.50 or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
M. Martínez-Sánchez
16.522 Space Propulsion  
Prereq: 8.03, 16.50; or permission of instructor  
G (Spring)  
3-3-6 H-LEVEL Grad Credit  
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 2011–2012: G (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9 H-LEVEL Grad Credit  
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. Alternate years.  
E. M. Greitzer, Z. S. Spakovszky

16.55 Ionized Gases  
Prereq: 8.03  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
M. Martínez-Sánchez

OTHER UNDERGRADUATE SUBJECTS

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

16.URG Undergraduate Research  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit  
Undergraduate research opportunities in aeronautics and astronautics. For further information, contact Manuel Martínez-Sánchez, departmental coordinator.  
Staff

16.EPE UPOP Summer Practice Experience  
Engineering School-Wide Elective Subject  
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 22.EPE)  
Prereq: 2.EPW or permission of instructor  
U (Fall, Spring)  
0-1-0 [P/D/F]  
Can be repeated for credit  
See description under subject 2.EPE.  
S. Luperfoy

16.EPR UPOP Reflective Learning Experience  
Engineering School-Wide Elective Subject  
(Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 22.EPR)  
Prereq: 2.EPE or permission of instructor  
U (Fall)  
0-0-3 [P/D/F]  
Can be repeated for credit  
See description under subject 2.EPR.  
S. Luperfoy

16.EPW UPOP IAP Workshop  
Engineering School-Wide Elective Subject  
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 20.EPW, 22.EPW)  
Prereq: None  
U (IAP)  
3-0-0 [P/D/F]  
See description under subject 2.EPW.  
S. Luperfoy

16.5685 Special Subject in Aeronautics and Astronautics (New)  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit  
Basic undergraduate topics not offered in regularly scheduled subjects. Subject to approval of faculty in charge.  
B. C. Williams

16.5686 Special Subject in Aeronautics and Astronautics (New)  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit  
Opportunity for study or lab work related to aeronautics and astronautics but not covered in regularly scheduled subjects. Requires approval of department.  
Staff

16.5688 Special Subject in Aeronautics and Astronautics (New)  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit  
Opportunity for study or lab work related to aeronautics and astronautics but not covered in regularly scheduled subjects. Requires approval of department.  
B. C. Williams

16.621 Experimental Projects I  
Prereq: None. Coreq: 16.06 or 16.07  
U (Fall, Spring)  
2-1-3  
First part of a two-term sequence addresses the conception and design of a student-selected experimental project carried out by a team. Principles of project 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 team basis. Selection and detailed planning of a research project, including in-depth design of components and equipment. Preparation of a detailed proposal for the selected project, which is then carried through to completion in 16.622.  
E. M. Greitzer, J. L. Craig, S. E. Widnall
AERONAUTICS AND ASTRONAUTICS

16.622 Experimental Projects II
Prereq: 16.621
U (Fall, Spring)
1-7-4 Institute LAB

Execution of project experiments based on the designs developed in 16.621. Students construct their defined experiment, carry out experimental measurements of the relevant phenomena, analyze the data, and then apply the results to assess the hypothesis they developed previously. Written final report on the entire project and formal oral presentation. Includes instructions on effective report writing and oral presentation.
E. M. Greitzer, J. L. Craig, D. Perdichizzi, S. E. Widnall

16.64 Flight Measurement Laboratory
Prereq: 16.002
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
2-2-2

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

16.653 Management in Engineering
Engineering School-Wide Elective Subject
(Offered under: 2.96, 6.930, 10.806)
Prereq: None
U (Fall)
3-1-8

See description under subject 2.96.
H. S. Marcus

16.660J Introduction to Lean Six Sigma Methods
(Same subject as ESD.62J)
Prereq: None
U (IAP)
1-1-0 [P/D/F]

Covers the fundamental principles, practices and tools of lean six sigma methods that underlay modern organizational productivity approaches applied in aerospace, automotive, health care, and other sectors. Includes lectures, active learning exercises, a plant tour, talks by industry practitioners, and videos. One third of the course is devoted to a physical simulation of an aircraft manufacturing enterprise to illustrate the power of lean six sigma methods. Students taking the graduate version complete additional assignments.
A. L. Weigel, E. M. Murman

16.68 Modern Space Science and Engineering Seminar (New)
Prereq: None
U (Spring)
2-0-4 [P/D/F]

Exposes students to the broad variety of scientific and technology experiments being carried out in space, and the complex engineering required to implement them. Fosters an appreciation for the interaction of science and engineering in the space enterprise. Specific topics vary from year to year.
J. A. Hoffman, L. Young

16.680 Project in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring, Summer)
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 department.

B. C. Williams

16.681 Topics in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring, Summer)
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 department.

B. C. Williams

16.682 Selected Topics in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring)

Study by qualified students. Topics selected in consultation with the instructor.

B. C. Williams

16.687 Selected Topics in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Study by qualified students. Topics selected in consultation with the instructor.

B. C. Williams

FLIGHT TRANSPORTATION

16.71J The Airline Industry
(Same subject as 1.232J, 15.054J, ESD.217J)
Prereq: None
G (Fall)
3-0-9

Overview of the global airline industry, focusing on recent industry performance, current issues and challenges for the future. Fundamentals of airline industry structure, airline economics, operations planning, safety, labor relations, airports and air traffic control, marketing, and competitive strategies, with an emphasis on the interrelationships among major industry stakeholders. Recent research findings of the MIT Global Airline Industry Program are showcased, including the impacts of congestion and delays, evolution of information technologies, changing human resource management practices, and competitive effects of new entrant airlines. Taught by faculty participants of the Global Airline Industry Program.

16.72 Air Traffic Control
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012-2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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
16.75J Airline Management
(Same subject as 1.234J)
Prereq: 16.71J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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

16.76| Logistical and Transportation Planning Methods
(Same subject as 1.203J, 6.281J, 15.073J, ESD.216J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.203J.
R. C. Larson, A. R. Odoni, A. I. Barnett

16.767 Introduction to Airline Transport Aircraft Systems and Automation (New)
Prereq: Permission of instructor
G (IAP)
3-2-1 [P/D/F]
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

16.781J Planning and Design of Airport Systems
(Same subject as 1.231J, ESD.224J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 1.231J.
R. de Neufville, A. R. Odoni

AEROSPACE SYSTEMS

16.810J Engineering Design and Rapid Prototyping
(Same subject as ESD.035J)
Prereq: 16.01, 16.02 or 2.001, 2.002 or permission of instructor
U (IAP)
2-4-0
Develops initial competency in engineering design by taking a holistic view. Conceiving, designing, manufacturing and testing a system component such as a complex structural part. Activities include hand sketching, CAD modeling, CAE analysis, CAM programming, and operation of CNC machining equipment. Focuses on the complementary roles of human creativity as well as the design process itself. Designs are executed by pairs of students who enter their products in a design competition. Enrollment may be limited.
O. de Weck

16.82 Flight Vehicle Engineering
Prereq: Permission of instructor
U (Spring)
3-3-6
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. Offered alternate spring and fall terms.
R. J. Hansman, M. Drela

16.821 Flight Vehicle Development
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (IAP, Spring)
2-10-6 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, J. How

16.831J Space Systems Development
(Same subject as 12.43J)
Prereq: Permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
2-10-6 Institute LAB
Students build a space system, focusing on refinement of sub-system designs and fabrication of full-scale prototypes. Sub-systems 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.
D. W. Miller, K. Cahoy, S. Seager

16.842 Fundamentals of Systems Engineering
Prereq: Permission of instructor
G (Fall)
2-0-4
General introduction to systems engineering using the classical V-model. Topics include stakeholder analysis, requirements definition, system architecture and concept generation, trade-space exploration and concept selection, human factors, design definition and optimization, system integration and interface management, system safety, verification and validation, and commissioning and operations. Discusses the trade-offs between performance, lifecycle...
cost and system operability. Readings based on systems engineering standards. Individual homework assignments apply concepts from class and contain both aeronautical and astronautical applications. Prepares students for the systems field exam in the Department of Aeronautics and Astronautics.

Staff

16.851 Satellite Engineering
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.

D. W. Miller, K. Cahoy, J. A. Hoffman

16.852J Integrating The Lean Enterprise
(Same subject as ESD.61J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Addresses some of the important issues involved with the planning, development, and implementation of lean enterprises. People, technology, process, and management dimensions of an effective lean manufacturing company are considered in a unified framework. Particular emphasis on the integration of these dimensions across the entire enterprise, including product development, production, and the extended supply chain. Analysis tools as well as future trends and directions are explored. A key component of this subject is a team project.

D. Nightingale

16.853 Introduction to Lean Six Sigma Methods
(Subject meets with 16.660J, ESD.62J)
Prereq: None
G (IAP)
1-1-0 [P/D/F]
See description under subject 16.660J.

A. L. Weigel, E. M. Murman

16.855J Enterprise Architecting
(Same subject as ESD.38J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.38J.

D. Nightingale, D. Rhodes

16.861 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject
(Offered under: 1.146, ESD.71)
(Subject meets with ESD.710)
Prereq: 1.145 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.71.

R. de Neufville

16.862 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 6.938, 10.816, 22.82, ESD.72)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.

G. Apostolakis

16.863J System Safety
(Same subject as ESD.863J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

16.866J Cost Estimation and Measurement Systems
(Same subject as ESD.361J)
Prereq: ESD.301 or a basic understanding of statistics and permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject ESD.361J.

R. Valerdi

16.882J Theory of System Architecture
(Same subject as ESD.340J)
Prereq: ESD.32J or permission of instructor
G (Fall)
4-2-6 H-LEVEL Grad Credit
See description under subject ESD.340J.

A. L. Weigel

16.885J Aircraft Systems Engineering
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-1-8 H-LEVEL Grad Credit
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

16.886J Air Transportation Systems Architecture
(Same subject as ESD.351J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-2-7 H-LEVEL Grad Credit
Addresses the architecture 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**

**16.888J Multidisciplinary System Design Optimization**  
(Same subject as ESD.77J)  
Prereq: 18.085 or permission of instructor  
G (Spring)  
3-1-8 H-LEVEL Grad Credit  
See description under subject ESD.77J.  
**O. de Weck, K. E. Willcox**

**16.89J Space Systems Engineering**  
(Same subject as ESD.352J)  
Prereq: 16.851, 16.892, or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
4-2-6 H-LEVEL Grad Credit  
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, D. W. Miller**

**16.891J Space Policy Seminar**  
(Same subject as ESD.129J)  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Explores current issues in space policy as well as the historical roots for the issues. Emphasis on critical policy discussion combined with serious technical analysis. Covers national security space policy, civil space policy, as well as commercial space policy. Issues explored include the GPS dilemma, the International Space Station choices, commercial launch from foreign countries, and the fate of satellite-based cellular systems.  
**A. L. Weigel**

**16.895J Engineering Apollo: The Moon Project as a Complex System**  
(Same subject as ESD.30J, STS.471J)  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
4-0-8 H-LEVEL Grad Credit  
See description under subject STS.471J.  
**L. R. Young, J. Tylko**

**COMPUTATION**

**16.90 Computational Methods in Aerospace Engineering**  
Prereq: 16.004 or permission of instructor;  
Coreq: 16.09 or 6.041  
U (Spring)  
3-0-9  
Introduction to computational techniques arising in aerospace engineering. Techniques include numerical integration of systems of ordinary differential equations; numerical discretization of partial differential equations; and probabilistic methods for quantifying the impact of variability. Specific emphasis will be given to finite volume methods in fluid mechanics, and energy and finite element methods in structural mechanics.  
**D. L. Darmofal, R. Radovitzky, Q. Wang**

**16.910J Introduction to Numerical Simulation**  
(Same subject as 2.096J, 6.336J)  
Prereq: 18.03 or 18.06  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 6.336J.  
**L. Daniel, J. K. White**

**16.920J Numerical Methods for Partial Differential Equations**  
(Same subject as 2.097J, 6.339J)  
Prereq: 18.03 or 18.06  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
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.  
**A. T. Patera, J. K. White, K. E. Willcox**

**16.930 Advanced Topics in Numerical Methods for Partial Differential Equations**  
Prereq: 16.920  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
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, D. L. Darmofal**

Prereq: 16.920, 6.431; or permission of instructor  
Acad Year 2011–2012: G (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9 H-LEVEL Grad Credit  
**Y. M. Marzouk, Q. Wang**
16.948 Advanced Special Subject in Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.949 Advanced Special Subject in Computation
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Consult D. L. Darmofal

OTHER GRADUATE SUBJECTS

16.ThG Graduate Thesis
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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. D. L. Darmofal

16.980 Advanced Special Project
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Study, original investigation, or lab project work by qualified students. Topics selected in consultation with instructor. Consult D. L. Darmofal

16.982 Advanced Special Subject
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

16.983 Advanced Special Subject
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Consult D. L. Darmofal

16.984 Seminar
Prereq: None
G (Fall, Spring)
2-0-0 [P/D/F]
Can be repeated for credit
Discussion of current interest topics by staff and guest speakers. Restricted to Course 16 students. D. L. Darmofal

16.985) Global Operations Leadership Seminar
(Same subject as 2.890J, 10.792J, 15.792J)
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
See description under subject 15.792). D. B. Rosenfield

16.5198 Advanced Special Subject in Mechanics and Physics of Fluids (16.198)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.5199 Advanced Special Subject in Mechanics and Physics of Fluids (16.199)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled fluids subjects. Consult E. H. Modiano

16.5298 Advanced Special Subject in Materials and Structures (16.298)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.5299 Advanced Special Subject in Materials and Structures (16.299)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled materials and structures subjects. Consult E. H. Modiano

16.5398 Advanced Special Subject in Information and Control (16.398)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.5399 Advanced Special Subject in Information and Control (16.399)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Consult E. H. Modiano

16.5498 Advanced Special Subject in Humans and Automation (16.498)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.5499 Advanced Special Subject in Humans and Automation (16.499)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Consult E. H. Modiano

Consult E. H. Modiano
16.5598 Advanced Special Subject in Propulsion and Energy Conversion (16.598)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.5599 Advanced Special Subject in Propulsion and Energy Conversion (16.599)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.
Consult E. H. Modiano

16.5798 Advanced Special Subject in Flight Transportation (16.798)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.5799 Advanced Special Subject in Flight Transportation (16.799)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.
Consult E. H. Modiano

16.5898 Advanced Special Subject in Aerospace Systems (16.898)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

16.5899 Advanced Special Subject in Aerospace Systems (16.899)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects.
Consult E. H. Modiano
### Bachelor of Science in Aerospace Engineering/Course 16-1
### Bachelor of Science in Aerospace Engineering with Information Technology/Course 16-2

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 1.00; 6.041; 18.03 or 18.034; and 16.001 in the Departmental Program]</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 16.622, 16.821, or 16.831/16.832 in the Departmental Program]</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M). See the Laboratory and Capstone section below for specific options.

**PLUS Departmental Program**

<table>
<thead>
<tr>
<th>Program</th>
<th>Subject Names</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Departmental Core (Required for students in both degree programs)</strong></td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>16.001 Unified Engineering I, 12, REST; Physics II (GIR), 18.03*, Chemistry (GIR)</td>
<td>16.002 Unified Engineering II, 12; Physics II (GIR), 18.03*, Chemistry (GIR)</td>
<td>16.003 Unified Engineering III, 12; 16.001, 16.002</td>
</tr>
<tr>
<td>16.004 Unified Engineering IV, 12; 16.001, 16.002</td>
<td>1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
<td>16.06 Principles of Automatic Control, 12; 16.004</td>
</tr>
<tr>
<td>16.07 Dynamics, 12; 16.004</td>
<td>16.09 Statistics and Probability, 12; Calculus II (GIR)</td>
<td>or 6.041 Probabilistic Systems Analysis, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td>or 18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td><strong>Professional Area Subjects</strong></td>
<td>at least 48</td>
<td></td>
</tr>
</tbody>
</table>

All students must take at least 48 units from among the subjects designated by the department as Professional Area Subjects. The program must include subjects from at least three professional areas. Students in Course 16-1 must take at least 24 units from the Professional Area Subjects in Aerospace Engineering. Students in Course 16-2 must take at least 36 units from among the Professional Area Subjects in Aerospace Information Technology.

**Aerospace Engineering, 16-1**

*Fluid Mechanics*
- 16.100 Aerodynamics, 12; 16.004

*Materials and Structures*
- 16.20 Structural Mechanics, 12; 16.004

*Propulsion*
- 16.50 Introduction to Propulsion Systems, 12; 16.004*

*Computational Tools*
- 16.90 Computational Methods in Aerospace Engineering, 12; 16.004*; 16.09*

**Aerospace Information Technology, 16-2**

*Estimation and Control*
- 16.30 Feedback Control Systems, 12; 16.06*

*Computer Systems*
- 6.111 Introductory Digital Systems Laboratory, 12, LAB; 16.004*
- 16.35 Real-Time Systems and Software, 12; 1.00*

*Communications Systems*
- 16.36 Communication Systems and Networks, 12; 16.004*, 16.09*

*Humans and Automation*
- 16.400 Human Factors Engineering, 12
- 16.410 Principles of Autonomy and Decision Making, 12; 1.00*
Laboratory and Capstone Subjects

One of the following two subjects:

- **16.82** Flight Vehicle Engineering, 12, CI-M; permission of instructor
- **16.83J** Space Systems Engineering, 12, CI-M; permission of instructor

Plus one of the following three sequences:

- **Experimental Projects**
  - **16.621** Experimental Projects I, 6; **16.06***
  - **16.622** Experimental Projects II, 12, LAB, CI-M; **16.621**
  or
- **Flight Vehicle Development**
  - **16.821** Flight Vehicle Development, 18, LAB, CI-M; permission of instructor
  or
- **Space Systems Development**
  - **16.831J** Space Systems Development, 18, LAB, CI-M; permission of instructor

Departmental Program Units That Also Satisfy the GIRs (36)

Unrestricted Electives (48)

Total Units Beyond the GIRs Required for SB Degree (198)

No subject can be counted both as part of the 17-subject GIRs and as part of the 198 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes

* Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Bachelor of Science in Engineering/Course 16-ENG

General Institute Requirements (GIRs)

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<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (can be satisfied from among 1.00, 18.03 or 18.034, and 16.001 in the Departmental Program)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (can be satisfied by 16.622, 16.821, or 16.831/16.832 in the Departmental Program)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M). See the Laboratory and Capstone section below for specific options.

PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics)

Departmental Core (Required for students in both degree programs)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.001 Unified Engineering I, 12; REST; Physics II (GIR), 18.03*; Chemistry (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>16.002 Unified Engineering II, 12; Physics II (GIR); 18.03*, Chemistry (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>16.003 Unified Engineering III, 12; 16.001, 16.002</td>
<td>12</td>
</tr>
<tr>
<td>16.004 Unified Engineering IV, 12; 16.001, 16.002</td>
<td>12</td>
</tr>
<tr>
<td>1.00 Introduction to Computers and Engineering Problem Solving, 12; REST; Calculus I (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>18.03 Differential Equations, 12; REST; Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>or 18.034 Differential Equations, 12; REST; Calculus II (GIR)</td>
<td>12</td>
</tr>
<tr>
<td>16.06 Principles of Automatic Control, 12; 16.004</td>
<td>12</td>
</tr>
<tr>
<td>or 16.07 Dynamics, 12; 16.004</td>
<td>12</td>
</tr>
</tbody>
</table>

Concentration Subjects

These electives define a concentrated area of study and must be chosen with the written approval of the AeroAstro Undergraduate Office. A minimum of 42 units of engineering topics and a minimum of 12 units of mathematics or science topics must be included in the 72 units of concentration electives. In all cases, the concentration subjects must be clearly related to the theme of the concentration.

Laboratory and Capstone Subjects

One of the following two subjects:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.82 Flight Vehicle Engineering, 12; CI-M; permission of instructor</td>
<td>12</td>
</tr>
<tr>
<td>16.83J Space Systems Engineering, 12; CI-M; permission of Instructor</td>
<td>12</td>
</tr>
</tbody>
</table>

Plus one of the following three sequences:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Projects</td>
<td>6</td>
</tr>
<tr>
<td>16.621 Experimental Projects I, 6; 16.06*</td>
<td>12</td>
</tr>
<tr>
<td>16.622 Experimental Projects II, 12, LAB, CI-M; 16.621; 6.041</td>
<td>12</td>
</tr>
<tr>
<td>or Flight Vehicle Development</td>
<td>18</td>
</tr>
<tr>
<td>16.821 Flight Vehicle Development, 18, LAB, CI-M; 16.82</td>
<td>18</td>
</tr>
<tr>
<td>or Space Systems Development</td>
<td>18</td>
</tr>
<tr>
<td>16.831J Space Systems Development, 18, LAB, CI-M; permission of instructor</td>
<td>18</td>
</tr>
</tbody>
</table>

Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
</tr>
</tbody>
</table>

Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree

No subject can be counted both as part of the 17-subject GIRs and as part of the 198 units required beyond the GIRs. Exceptions are department subjects that satisfy the CI-M requirement. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes

* Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
POLITICAL PHILOSOPHY / SOCIAL THEORY

17.000J Political Philosophy
(Same subject as 24.611J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor
Systematic examination of selected issues in political philosophy. Topic changes each year.
S. Haslanger, R. Langton

17.006 Feminist Thought
(Subject meets with 17.007J, 24.237J, WGS.301J)
Prereq: Permission of instructor, based on previous coursework
G (Spring)
3-0-9 H-LEVEL Grad Credit
17.007J Feminist Political Thought
(Same subject as 24.237J, WGS.301J)
(Subject meets with 17.006)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
See description under subject WGS.301J.
E. Wood

17.01J Justice
(Same subject as 24.04J)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 2); CI-H
See description under subject 24.04J.
L. Stanczyk

17.021J Philosophy of Law
(Same subject as 24.235J)
Prereq: One Philosophy subject or permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-E)
See description under subject 24.235J.
J. Markovits

17.03 Introduction to Political Thought
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
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.
L. Stanczyk

17.045J Power: Interpersonal, Organizational and Global Dimensions
(Same subject as 21A.245J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.245J.
S. Silbey

POLITICAL ECONOMY

17.100J Political Economy I: Theories of the State and the Economy
(Same subject as 14.781J, 15.678J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)
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

17.125 The Politics of Global Financial Relations
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
Explore effects of globalization of finance on international relations and domestic politics. Topics include international institutions and global governance; the multi-nationalization of production; effects of international capital markets on domestic politics; global finance and the developing world; and financial crises. Discussion of the interplay between politics and economics and the future of the nation-state.
D. Singer

17.135 Comparative Politics of Business-Government Relations
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)
Provides an in-depth comparative historical analysis of relations between business and government in a variety of economic, social, and political contexts. Focuses on selected developed and developing countries. Examines how government policy affects business practices, organization, and performance; and, conversely, how political activities by business affect the functioning and policy orientation of government.
B. Schneider

17.145 Political Economy of Technology and Development in Latin America
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
Presents a broad, historical overview of the political economy of development in Latin America, especially Mexico, Brazil, and Chile. Examines the ways in which these countries rely heavily on foreign technology transfer, especially through multinational corporations, but experience low levels of investment in R&D and education.
Addresses some of the pivotal theoretical and policy disputes over the appropriate mix of state and market, the optimum balance between foreign and domestic sources of capital and technology, and the trade-off between growth and equity.

B. Schneider

17.148 Political Economy of Globalization
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Analyzes the impact of trade and financial flows and regional integration on the domestic politics of advanced industrial states. Pressures for harmonization and convergence of domestic institutions and practices and the sources of national resistance to these are examined. Cases are drawn from both the advanced economies and developing countries.

S. Berger

17.156 Welfare and Capitalism in Western Europe
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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

17.176j Economic Development and Policy Analysis
(Same subject as 11.491j)
Prereq: 11.701
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 11.491j.

A. Amsden

17.178 Political Economy of Institutions and Development
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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
U (Spring)
3-0-9 HASS-S (HASS-E)

17.182 Sustainability: Political Economy, Science, and Policy
(Subject meets with 17.181)
Prereq: None
G (Spring)
3-0-9

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. Chouchi

17.184j Economic Institutions and Growth Policy Analysis
(Same subject as 11.486j, 14.778j)
Prereq: 11.203
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 11.486j.

A. Amsden, M. Piore

17.188j Labor and Politics
(Same subject as 11.414j)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9

Examines issues facing labor in today's global world through research and reading. Recent developments (globalization, liberalization, privatization) have created a mix of opportunities and risks for labor in most developing countries. On the one hand, these trends have encouraged foreign direct investment and the diffusion of global supply chains, which in turn, have promoted economic development and job growth for some groups of workers in some of these countries. On the other hand, globalization and liberalization have undermined social safety nets, eroded labor and environmental standards, and resulted in greater rates of poverty for other groups of workers in other developing countries. How do we explain these differences? What kinds of policies can be promoted to more evenly distribute the benefits of globalization? Subject seeks to address these two questions.

R. Locke

17.190j Economic Development and Policy Analysis, Part II
(Same subject as 11.492j)
Prereq: 11.491j
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 11.492j.

A. Amsden

17.195 Globalization
(Subject meets with 17.196)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

17.196 Globalization
(Subject meets with 17.195)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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

17.199j Working in a Global Economy
(Same subject as 21.f.098)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

Promotes understanding of the global economy through a combination of conceptual approach-
es and practical case studies. Combines a broad range of interactive classroom experiences, including student presentations and occasional guest speakers, with first-hand knowledge of how the global economy operates. Explores issues such as entrepreneurship and innovation, the rise of new global challengers, and cross-cultural communication in multinational organizations. Limited to 20; preference to students with experience abroad.
S. Berger, S. Sferza

A M E R I C A N  P O L I T I C S

17.20 Introduction to the American Political Process
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 4); CI-H
Studies American government, emphasizing the institutions of government and the representation of competing interests. Topics include the founding, constitutional interpretation, legislative processes, presidential power, public opinion and voting, group mobilization, political steering of the bureaucracy and the economy, and federalism.
Staff

17.200 Graduate Seminar in American Politics I
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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. Campbell

17.202 Graduate Seminar in American Politics II
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
C. Stewart

17.243 Media Politics
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

17.244 Media Politics
Prereq: None
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9
The mass media are crucial players in modern democratic government, but most people have only a fuzzy understanding of their role and influence. Subject examines why the media cover what they do; how their coverage influences the behavior of politicians and public officials; and how it shapes the attitudes of ordinary people. Focuses mainly on the US, but also includes some comparisons with other countries in both the developed and developing world.
Staff

17.249J Law and Society
(Same subject as 11.163J, 21A.219J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.219J.
S. Silbey

17.251 Congress and the American Political System I
(Subject meets with 17.252)
Prereq: 17.20 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

17.252 Congress and the American Political System I
(Subject meets with 17.251)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

17.262 Congress and the American Political System II
(Subject meets with 17.261)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
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.
A. Berinsky

17.263 Electoral Politics, Public Opinion, and Democracy
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
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. One subject in American Politics or relevant background required.
A. Berinsky

17.264 Electoral Politics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
Staff
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, A. Campbell

17.28j The War at Home: American Politics and Society in Wartime
(Same subject as 21H.213j)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
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

17.281 Public Opinion and Foreign Policy
(Subject meets with 17.282)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the nature of public opinion on foreign policy, the ability of the public to formulate reasoned and interconnected perspectives on the issues of the day, and the public’s influence on foreign policy decisions. Main focus is on the United States. The role of the media and international events in shaping public perspectives and public attitudes toward important issues such as internationalism and isolationism, the use of force, and trade are evaluated. Students taking graduate version are expected to complete additional assignments.

A. Berinsky

17.30j Making Public Policy
(Same subject as 11.002j)
Prereq: None
U (Fall)
4-0-8 HASS-S (HASS-D); CI-H
See description under subject 11.002j.
J. Layzer, A. Campbell

17.303j Methods of Policy Analysis
(Same subject as 11.003j)
Prereq: 11.002j, 17.30j, Coreq: 14.01
U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 11.003j.
Staff

17.307 American Public Policy for Washington Interns
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 HASS-S (HASS-E)
Examines US policy-making process, with special attention to making of policy for science and technology. Subject spans Spring and Fall terms. Spring term attends to origins and development of American policy-making 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

17.309j Science, Technology, and Public Policy
(Same subject as ESD.082J, STS.082J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
4-0-8 HASS-S (HASS-E); CI-H
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. Limited to 18.
K. Oye
17.310J Science, Technology, and Public Policy
(Same subject as ESD.103J, STS.482J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit

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 account of integration of uncertain technical information into public and private decision-making.
K. Oye

17.311 Politics, Race, and Science
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

Comparatively examines the historical and contemporary role of science in constructing knowledge about human differences and similarities in terms of race. Particular attention is paid to the social and political context of scientific inquiry and to its consequences for public policy. Topics include US “Jim Crow” segregation policy, US immigration policy, the US eugenics movement, and the international Human Genome Project.
M. Nobles

17.314j Labor Market Regulation and Career Mobility
(Same subject as 14.66$S$)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Examines the way in which workers organize to structure and regulate the labor market and how those efforts interact with (as cause and effect) career mobility. Particular focus on the contrast between union organization and government regulation and on the shift from mobilization around class to mobilization around race, sex and ethnicity. Contrast between unified systems of regulation (France, Spain, Latin America) and fragmented systems (United States).
Consult M. Piore

17.315 Health Policy
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
4-0-8 HASS-S (HASS-E)

Examines 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 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
4-0-8 HASS-S (HASS-E)

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

17.33 Building a Better World (New)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

Explores today’s key policy challenges, including state-building, economic development, environmental protection, corruption and the rule of law, the provision of basic public services, democratization, the strengthening civil society, and international security. Presents the problem for each topic, reviews potential solutions, discusses failed approaches, and identifies concrete successes. Examples drawn from around the world. Includes projects with a practical component.
C. Lawson, R. Locke

17.391J Human Rights in Theory and Practice
(Same subject as 11.164J)
(Subject meets with 11.497)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
2-0-10 HASS-S (HASS-E)

See description under subject 11.164J.
B. Rajagopal

17.393J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.801J, 11.021J)
(Subject meets with 1.811J, 11.630J, ESD.133J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

See description under subject 1.801J.
N. Ashford, C. Caldart

17.398J Energy Policy for a Sustainable Future
(Same subject as 11.369J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 11.369J.
J. D. Roab

INTERNATIONAL RELATIONS/SECURITY STUDIES

International Relations

17.40 American Foreign Policy: Past, Present, and Future
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-D 4); 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
17.405 Seminar on Politics and Conflicts in the Middle East
(Subject meets with 17.406)
Prereq: None
3-0-9 HASS-S (HASS-E)

17.406 Seminar on Politics and Conflicts in the Middle East
(Subject meets with 17.405)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Focuses on evolution of contemporary politics and economics. Subject divided into five parts: historical context of conflicts; domestic and regional politics; civil and cross-border conflicts; geostrategic challenges; conflict resolution and peace processes. Interactions and spillover effects explored, and alternative models of conflict(s) designed. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.

N. Choucri

17.407 Chinese Foreign Policy
Prereq: Permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)
Credit cannot also be received for 17.408

17.408 Chinese Foreign Policy
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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. Subjects meet together when offered concurrently.

M. T. Favel

17.410 Globalization, Migration, and International Relations
(Subject meets with 17.411)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

17.411 Globalization, Migration, and International Relations
(Subject meets with 17.410)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

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
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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.

M. T. Favel, V. Narang

17.42 Causes and Prevention of War
Prereq: None
U (Spring)
4-0-8 HASS-S (HASS-D 4); 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
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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

17.422 Field Seminar in International Political Economy
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Review of IPE field covering previous and core research focusing on dual national objectives in a global context, namely pursuit of power and pursuit of wealth. Surveys major paradigms of international political economy, including neoclassical economics, marxist economics, development and ecological economics, lateral property rights, international migration, and select issues in foreign economic policy in global context. Examines the evolution of international economic institutions and attendant political implications. Open to undergraduates by permission of instructor.

N. Choucri

17.424 International Political Economy of Advanced Industrial Societies
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

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 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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.

S. Van Evera

17.428 American Foreign Policy: Theory and Method
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

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

17.434 International Relations of East Asia
(Subject meets with 17.433)
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9

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
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9

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

17.440 Global Governance
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Research seminar explores the concept of governance at the international level, including the design and function of international institutions and organizations, the role of international law, the rise of transnational actors, and the relationship between domestic politics and international cooperation. Readings also include empirical studies of cooperation in a variety of issue areas, including the environment, human rights, economic affairs, and security.

D. Singer

17.441 International Politics and Climate Change
(Subject meets with 17.442)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

Examines how climate change has affected international politics and policy. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.

N. Choucri

17.442 International Politics and Climate Change
(Subject meets with 17.441)
Prereq: None
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9

Focuses on critical interconnections of international politics and climate change. Beginning with the 20th-century environmental and strategic legacies, examines politicization of the natural environment and the role of science in this process; types of conflicts and threats to security traced to climate change; and emergent global accords in response to mounting evidence of climate change. The course concludes by addressing the question of what is next for theory and policy. Students taking the graduate version complete additional assignments.

N. Choucri

17.444 Cyberpolitics in International Relations
(Subject meets with 17.448)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

Focuses on cyberspace and its implications for private and public, sub-national, national, and international actors and entities. Focuses on legacies of the 20th-century creation of cyberspace,
changes to the international system structure, and new modes of conflict and cooperation. Examines whether international relations theory accommodates cyberspace as a new venue of politics, and how cyberpolitics alters traditional international politics. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.

N. Choucri

Security Studies

17.468 Foundations of Security Studies
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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, Blaikney, von Clausewitz, and Huntington. Students write a seminar paper in which theoretical insights are systematically applied to a current security issue.

B. Posen

17.470 Homeland Security (New)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

Addresses a range of topics in homeland security, including the evolution of the Department of Homeland Security and its component agencies; the relationship between political appointees and civil servants; the inter-agency process on homeland security policy and operations; the role of Congress; budgeting for homeland security; managing risk; law enforcement “intelligence”; and technology development.

C. Lawson

17.473 The Politics of Nuclear Proliferation
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

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

17.475 Nuclear Forces and Missile Defenses
(Subject meets with STS.072j)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

17.476 Nuclear Forces and Missile Defenses
(Subject meets with STS.435j)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject STS.435j.

T. Postol

17.477 Technology and Policy of Weapons Systems
(Subject meets with STS.076j)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

See description under subject STS.076j.

T. Postol

17.478 Great Power Military Intervention
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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

17.482 US Military Power
(Subject meets with 17.483)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

17.483 US Military Power
(Subject meets with 17.482)
Prereq: Freshmen need permission of instructor
U (Spring)
3-0-9 HASS-S (HASS-E)

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
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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.

B. Posen

17.486 Japan and East Asian Security
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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

C O M P A R A T I V E  P O L I T I C S

17.50 Introduction to Comparative Politics
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 4); 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.
C. Lawson, M. Nobles

17.504 Ethnic Politics I
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit
17.506 Ethnic Politics II
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit
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. Designed as a year-long research workshop, but may also be taken in either term.
R. Petersen, M. Nobles

17.509 Social Movements in Comparative Perspective
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)
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 U.S. civil rights, poor peoples’, pro-life/pro-choice and gay/lesbian movements.
M. Nobles

17.515 Comparative Electoral Politics
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)
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
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
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

17.517 Participation in Public Life
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
Examines how and why people participate in public life and political affairs. Drawing on examples from around the world, students analyze the effects of social networks, community norms, and associational activities on the functioning of democracy, regime stability, state capacity, and international politics.
L. Tsai

17.523 Ethnic Conflict in World Politics
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
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

17.528 Civil Society, Social Capital, and the State in Comparative Perspective
Prereq: None
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9
Examines the growing body of research suggesting that social networks, community norms, and social organizations can have important effects on social welfare, political stability, economic development, and governmental performance. Cases drawn from various countries and focus on the effects of networks, norms, and organizations on outcomes ranging from local public goods provision and the performance of democracies to ethnic conflict and funding for terrorism.
L. Tsai
17.537 Politics and Policy in Contemporary Japan
(Subject meets with 17.538)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 H-LEVEL Grad Credit

17.538 Politics and Policy in Contemporary Japan
(Subject meets with 17.537)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Ref: Those approaches to broader trends in the study of contemporary Chinese politics; and

E. Steinfeld

17.540 Interdisciplinary Introduction to Contemporary Latin America
(Same subject as 21A.343O, 21F.084I)
Prereq: None
3-0-9 HASS-S (HASS-E)

Ref: Interdisciplinary introduction to contemporary Latin America, drawing on films, literature, press
accounts, and scholarly research. Topics include economic development, ethnic and racial identity,
religion, corruption, democracy, transitional justice, and the rule of law. Examples draw on a range of
countries, especially Mexico, Chile, and Brazil. Terms taught by Professor Nobles will cover the
English-speaking Caribbean; terms taught by Professor Lawson will focus more on Mexico. Requirements include class presenta-
tions and written essays.
C. Lawson, M. Nobles
patterns of investments in the region. Provides students with interdisciplinary approach to development in the Middle East. Open to undergraduates with permission of instructor.

N. Choucri

17.559 Comparative Security and Sustainability (Subject meets with 17.560) 
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall) 3-0-9 HASS-S (HASS-E) 
17.560 Comparative Security and Sustainability (Subject meets with 17.559) 
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall) 3-0-9 H-LEVEL Grad Credit

Focuses on comparative approaches to security and sustainability in national and international contexts, with special emphasis on constraints, options, strategies, and policy choice. Comparisons are undertaken in terms of levels and locations (countries and regions, localities); systems (social, economic, political, and technological); methods and models (analytical, empirical, historical); time frame (past, present, and future). Levels and locations include developing and industrial contexts encompassed in a global perspective. Emphasis on specific countries and coverage shaped by students’ interest and participation. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.

N. Choucri

17.561 European Politics 
Prereq: None 
U (Fall) 3-0-9 HASS-S (HASS-E)
Examines the organization of political power and the dynamics of political change in Britain, France, Germany, and Italy. 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 HASS-S (HASS-E)
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.

E. Eiran

17.571 Soviet and Post-Soviet Politics and Society: 1917 to the Present 
(=same subject as 21H.245J) 
Prereq: None 
U (Spring) 3-0-9 HASS-S (HASS-E); CI-H
See description under subject 21H.245J.

E. Wood

17.572 African Politics (New) 
Prereq: Permission of instructor 
G (Spring) 3-0-9 H-LEVEL Grad Credit
Introduces the major arguments, hypotheses and debates in the literature on African politics and development, with the goal of helping them 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.

D. Posner

17.582 Civil War 
Prereq: Permission of instructor 
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall) 3-0-9 H-LEVEL Grad Credit
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.

R. Petersen, F. Christia

17.584 Civil-Military Relations 
Prereq: Permission of instructor 
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall) 3-0-9 H-LEVEL Grad Credit
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

17.586 Warlords, Terrorists, and Militias: Theorizing on Violent Non-State Actors 
Prereq: Permission of instructor 
G (Spring) 3-0-9 H-LEVEL Grad Credit
Examines why non-state actors resort to violence, their means and tactics, and what can be done to counter that violence. Focuses on the production side of non-state violence, including the objectives and organization of insurgents, terrorists, militias and warlords, their mobilization strategies and support base, and how they coerce opponents. Also covers the response violence elicits from governments or other actors such as counterinsurgency or counterterrorism strategies.

F. Christia

17.588 Field Seminar in Comparative Politics 
Prereq: Permission of instructor 
Acad Year 2011–2012: G (Fall) 3-0-9 H-LEVEL Grad Credit
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.

B. Schneider

MODELS AND METHODS

17.800 Quantitative Research Methods I: Regression 
Prereq: Permission of instructor 
G (Fall) 4-0-8 H-LEVEL Grad Credit
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.

J. Hainmueller, T. Yamamoto

17.802 Quantitative Research Methods II: Advanced Empirical Tools 
Prereq: 17.800 or 17.871 
G (Spring) 4-0-8 H-LEVEL Grad Credit
Provides a survey of advanced empirical tools for political science and public policy research. Focuses on applied causal inference, i.e. statistical methods designed to address research questions that concern the impact of an institution,
The chief focus is the burgeoning literature in institutions from a rational choice perspective. An applied theory subject analyzing political sciences, international relations, and comparative politics. 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.

**17.810 Game Theory and Political Theory**
(Subject meets with 17.811)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit

**17.811 Game Theory and Political Theory**
(Subject meets with 17.810)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
4-0-8 HASS-S (HASS-E)

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.

**Staff**

**17.814 Collective Choice II**
Prereq: 17.812 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Focuses on the relationship between the behavioral models developed by formal theorists and the statistical models used in empirical estimation. The main questions are: How do researchers make the link between theory and the data? How do they generate and estimate statistical models that allow careful testing of the behavioral models? What constitutes a good test of a model? Questions studied through reading and discussion of articles that combine both empirical and theoretical analysis.

**Staff**

**17.850 Political Science Scope and Methods**
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduces principles of empirical and theoretical analysis in political science. Introduces students to major research questions and different ways of examining them.

A. Berinsky, L. Tsai

**17.869 Political Science Scope and Methods**
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

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.

L. Tsai

**17.871 Political Science Laboratory**
Prereq: 17.869 or permission of instructor
U (Spring)
3-6-6 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. Students participate in joint class projects and conduct individual projects. Does not count toward HASS Requirement. Enrollment limited; preference to Course 17 majors who have pre-registered.

C. Stewart
GENERAL SUBJECTS

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

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

Research opportunities in political science in theoretical and applied research. For further information, contact the departmental coordinator.

17.901 Political Science Internship and Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

17.902 Political Science Internship and Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
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.

T. Weiner

17.903 Community Service: Experience and Reflection
Prereq: None
U (Fall, IAP, Spring, Summer)
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 are 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

17.907 Reading Seminar in Social Science
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Reading and discussion of special topics in the fields of social science. Enrollment may be limited; priority to pre-registrants.

Staff

17.905–17.911 Reading Seminar in Social Science
Prereq: None
U (Fall, IAP, Spring, Summer)
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

17.921J Independent International Research Project
(Same subject as 21F.099J)
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Independent research for students who would like to pursue a research project during their stay abroad. Initiated with faculty advisor during the term prior to leaving, students are expected to conduct research during stay abroad and complete project after return to campus. The academic component involves close contact between the student and a faculty advisor, written work, and oral presentation.

S. Berger

17.954–17.960 Reading Seminar in Social Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 H-LEVEL Grad Credit

Workshop for research and writing of major research paper as part of pre-dissertation requirements. Restricted to doctoral students.

L. Tsai

17.THG Graduate Political Science Thesis
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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: 17.869, 17.871, or permission of instructor
U (Fall)
3-0-9

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. Includes substantial instruction and practice in writing with revision and oral presentations.

D. Singer

17.THU Undergraduate Political Science Thesis
Prereq: None
U (Fall, 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
### Bachelor of Science in Political Science/Course 17

#### General Institute Requirements (GIRs)

- **Science Requirement**: Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by subjects in the Departmental Program]
- **Restricted Electives in Science and Technology (REST) Requirement**: Laboratory Requirement
- **Total GIR Subjects Required for SB Degree**: 17

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Subjects&lt;sup&gt;(i)&lt;/sup&gt;</td>
<td>51</td>
</tr>
<tr>
<td>17.869 Political Science Scope and Methods, 12, HASS-S, CI-M</td>
<td></td>
</tr>
<tr>
<td>17.871 Political Science Laboratory, 15, LAB; 17.869*</td>
<td></td>
</tr>
<tr>
<td>17.971 Thesis Research Design Seminar, 12, CI-M; 17.869, 17.871, or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>17.971U Undergraduate Political Science Thesis (at least 12 units; additional units by special arrangement)</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>60–84</td>
</tr>
<tr>
<td>Political philosophy/social theory: one political science subject in the field of political philosophy/social theory (17.00–17.099)</td>
<td></td>
</tr>
<tr>
<td>American politics: one political science subject in the field of American politics (17.20–17.299)</td>
<td></td>
</tr>
<tr>
<td>Public policy: one political science subject in the field of public policy (17.30–17.399), or a subject in another field designated as fulfilling the public policy requirement</td>
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</tr>
<tr>
<td>International politics: one political science subject in the fields of international relations/security studies (17.40–17.499) or comparative politics (17.50–17.599)</td>
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</tr>
<tr>
<td>Plus three additional political science subjects representing a coherent plan of study. Specific subjects satisfying these criteria should be chosen in consultation with a faculty advisor.</td>
<td></td>
</tr>
</tbody>
</table>

#### Departmental Program Units That Also Satisfy the GIRs (30–36)

- **Unrestricted Electives**: 81–99

#### Total Units Beyond the GIRs Required for SB Degree

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

- Alternate prerequisites are listed in the subject description.
- Students typically enroll in subjects as follows: 17.869, fall term, junior year; 17.871, spring term, junior year; 17.971, fall term, senior year; 17.971U, spring term, senior year.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
18.01 Calculus
Prereq: None
U (Fall, Spring)
5-0-7 CALC I
Credit cannot also be received for 18.014, 18.01A, ES.1801, ES.181A


Fall: P. Seidel
Spring: Information: D. Vogan

18.01A Calculus
(Subject meets with CC.181A)
Prereq: Knowledge of differentiation and elementary integration
U (Fall; first half of term)
5-0-7 CALC I
Credit cannot also be received for 18.01, 18.014, ES.1801, ES.181A

Six-week review of one-variable calculus, emphasizing material not on the high-school AB syllabus: integration techniques and applications, improper integrals, infinite series, applications to other topics, such as probability and statistics, as time permits. Prerequisites: one year of high-school calculus or the equivalent, with a score of 4 or 5 on the AB Calculus test (or the AB portion of the BC test, or an equivalent score on a standard international exam), or equivalent college transfer credit, or a passing grade on the first half of the 18.01 advanced standing exam.

A. Postnikov

18.014 Calculus with Theory
Prereq: None
U (Fall)
5-0-7 CALC I
Credit cannot also be received for 18.01, 18.01A, ES.1801, ES.181A

Covers the same material as 18.01, but at a deeper and more rigorous level. Emphasizes careful reasoning and understanding of proofs. Assumes knowledge of elementary calculus. Topics: axioms for the real numbers; the Riemann integral; limits, theorems on continuous functions; derivatives of functions of one variable; the fundamental theorems of calculus; Taylor's theorem; infinite series, power series, rigorous treatment of the elementary functions.

C. Barwick

18.02 Calculus
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.023, 18.024, 18.02A, 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: J. McKernan
Spring: G. Staffilani

18.022 Calculus
Prereq: Calculus I (GIR)
U (Fall)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.023, 18.024, 18.02A, CC.1802, ES.1802, ES.182A

Covers the same material as 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.

P. Etingof

18.023 Calculus with Applications
Prereq: Calculus I (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.023, 18.024, 18.02A, CC.1802, ES.1802, ES.182A

Calculus of several variables, emphasizing applications. Vector algebra, partial differentiation, multiple integrals, and vector calculus. Asymptotic and numerical methods.

Information: M. X. Goemans

18.024 Calculus with Theory
Prereq: Calculus I (GIR), permission of Instructor
U (Spring)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.023, 18.024, 18.02A, CC.1802, ES.1802, ES.182A

Continues 18.014. Parallel to 18.02, but at a deeper level, emphasizing careful reasoning and understanding of proofs. Considerable emphasis on linear algebra and vector integral calculus.

C. Barwick
18.03 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
U (Fall, Spring)
5-0-7 REST
Credit cannot also be received for 18.034, 18.036, CC.1803, ES.1803
Study of ordinary differential equations (ODEs), including modeling physical systems. Solution of first-order ODEs by analytical, graphical, and numerical methods. Linear ODEs, primarily second order with constant coefficients. Complex numbers and exponentials. Inhomogeneous equations: polynomial, sinusoidal, and exponential inputs. Oscillations, damping, resonance. Fourier series inputs; resonant terms. Laplace transform methods; convolution and delta function. Matrix methods for first order linear systems: eigenvalues and eigenvectors, matrix exponentials, variation of parameters. Nonlinear autonomous systems: critical point analysis, phase plane diagrams, applications to modeling.
Fall: B. Brubaker
Spring: H. Miller

18.034 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
U (Spring)
3-0-7 REST
Credit cannot also be received for 18.03, 18.036, CC.1803, ES.1803
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.
Information: P. I. Etingof

18.036 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
5-0-7 REST
Credit cannot also be received for 18.03, 18.034, CC.1803, ES.1803
Information: H. R. Miller

18.04 Complex Variables with Applications
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Spring)
4-0-8
Credit cannot also be received for 18.075
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.
H. Cheng

18.05 Introduction to Probability and Statistics
Prereq: Calculus I (GIR)
U (Spring)
3-0-9 REST
Credit cannot also be received for 6.041, 18.440
Information: H. Miller

18.06 Linear Algebra
Prereq: Calculus II (GIR)
U (Fall, Spring)
4-0-8 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 MATLAB. Compared with 18.700, more emphasis on matrix algorithms and many applications.
Fall: A. Edelman
Spring: G. Strang

18.062J Mathematics for Computer Science
(Same subject as 6.042J)
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 REST
See description under subject 6.042J.
A. R. Meyer, T. Leighton

18.075 Methods for Scientists and Engineers
Prereq: Calculus II (GIR); 18.03
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

18.085 Computational Science and Engineering I
Prereq: Calculus II (GIR); 18.03 or 18.034
G (Fall, Spring, Summer)
3-0-9 H-LEVEL Grad Credit
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: G. Strang
Spring: P. Hand

18.086 Computational Science and Engineering II
Prereq: Calculus II (GIR); 18.03 or 18.034
G (Spring)
3-0-9 H-LEVEL Grad Credit
Information: G. Strang

18.089 Review of Mathematics
Prereq: Permission of instructor
G (Summer)
Units arranged
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: A. P. Mattuck
18.094 Teaching College-Level Science and Engineering
(Same subject as 1.95, 5.95, 6.982, 7.59, 8.395)
Prereq: None
6 (Fall)
2-0-2 [P/D/F]

See description under subject 5.95).

J. Rankin

18.095 Mathematics Lecture Series
Prereq: Calculus I (GIR)
U (IAP)
2-0-4 [P/D/F]

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: H. R. Miller

18.098 Independent Activities
Prereq: Permission of instructor
U (IAP)

Units arranged [P/D/F]

Can be repeated for credit

Studies or special individual reading arranged in consultation with individual faculty members and subject to departmental approval.

Information: H. R. Miller

18.099 Independent Activities
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: H. R. Miller

ANALYSIS

18.100A Real Analysis
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Fall, Spring)
3-0-9 (H except 18)
Credit cannot also be received for 18.100B, 18.100C

18.100B Real Analysis
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Fall, Spring)
3-0-9 (H except 18)
Credit cannot also be received for 18.100A, 18.100C

18.100C Real Analysis
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Fall, Spring)
4-0-11
Credit cannot also be received for 18.100A, 18.100B

Three options offered, each covering fundamentals of mathematical analysis: convergence of sequences and series, continuity, differentiability, Riemann integral, sequences and series of functions, uniformity, interchange of limit operations. Each option shows the utility of abstract concepts and teaches understanding and construction of proofs. Option A: Proofs and definitions are less abstract. Gives applications where possible. Concerned primarily with the real line. Option B: More demanding; for students with more mathematical maturity. Places more emphasis on point-set topology and n-space. Option C: 15-unit (4-0-11) variant of Option B, with further instruction and practice in written communication. Enrollment limited in Option C. Enrollment limited.

18.100A: Information: A. P. Mattuck
18.100B: Information: R. B. Melrose
18.100C: Information: H. R. Miller

18.101 Analysis and Manifolds
Prereq: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9 (H except 18)

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.

V. W. Guillemin

18.102 Introduction to Functional Analysis
Prereq: 18.100; 18.06, 18.700, or 18.701
U (Spring)
3-0-9 (H except 18)

Normed spaces, completeness, functionals, Hahn-Banach theorem, duality, operators.


R. B. Melrose

18.103 Fourier Analysis-Theory and Applications
Prereq: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9 (H except 18)

Roughly half the subject devoted to the theory of the Lebesgue integral with applications to probability, and half to Fourier series and Fourier integrals.

D. Jerison

18.104 Seminar in Analysis
Prereq: 18.100
U (Spring)
3-0-9

Students present and discuss material from books or journals. Several items will be based on the classic work: Polya and Szegö’s “Problems and Theorems from Analysis.” More recent work will also be used depending on each individual’s background. Instruction and practice in written and oral communication provided. Enrollment limited.

S. Helgason

18.112 Functions of a Complex Variable
Prereq: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9 (H except 18)


S. Helgason

18.116 Riemann Surfaces
Prereq: 18.112
G (Fall)
3-0-9 H-LEVEL Grad Credit

Riemann surfaces, uniformization, Riemann-Roch Theorem. Theory of elliptic functions and modular forms. Some applications, such as to number theory.

Information: T. S. Mrowka
18.117 Topics in Several Complex Variables
Prereq: 18.112, 18.965
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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 Kähler manifolds.
Information: R. B. Melrose

18.125 Real and Functional Analysis
Prereq: 18.100
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introductions to set theory and general topology as needed in analysis. Lebesgue’s integration theory. Introduction to functional analysis, Banach and Hilbert spaces.
Information: D. W. Stroock

18.135 Geometric Analysis
Prereq: 18.745 or 18.755
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
A quick description of Riemannian symmetric spaces. Spherical functions and Harish-Chandra’s c-function. Fourier transforms and Radon transforms on Riemannian symmetric spaces X. Applications to invariant differential equations, in particular the multitemporal wave equation on X. Eigenspace representations.
Information: S. Helgason

18.137 Topics in Geometric Partial Differential Equations
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
Information: R. B. Melrose

18.152 Introduction to Partial Differential Equations
Prereq: 18.100; 18.06, 18.700, or 18.701
U (Fall)
3-0-9 (H except 18)
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

18.155 Differential Analysis
Prereq: 18.102 or 18.103
G (Fall)
3-0-9 H-LEVEL Grad Credit
R. Melrose

18.156 Differential Analysis
Prereq: 18.155
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
V. Guillemin

18.157 Introduction to Microlocal Analysis
Prereq: 18.155
G (Spring)
3-0-9 H-LEVEL Grad Credit
V. Guillemin

18.158 Topics in Differential Equations
Prereq: 18.157
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
G. Staffilani

18.175 Theory of Probability
Prereq: 18.125
G (Spring)
3-0-9 H-LEVEL Grad Credit
Sums of random independent random variables, central limit phenomena, infinitely divisible laws, Levy processes, Brownian motion, conditioning, and martingales.
Information: S. Sheffield

18.177 Topics in Stochastic Processes
Prereq: 18.175
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
S. Sheffield

18.199 Graduate Analysis Seminar
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-21 H-LEVEL Grad Credit
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.
Information: R. B. Melrose

18.238 Geometry and Quantum Field Theory
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
A rigorous introduction designed for mathematicians into perturbative quantum field theory, using the language of functional integrals. Basics of classical field theory. Free quantum theories. Feynman diagrams. Renormalization theory. Local operators. Operator product expansion. Renormalization group equation. The goal is to discuss, using mathematical language, a number of basic notions and results of QFT that are necessary to understand talks and papers in QFT and string theory.
Information: P. I. Etingof

18.276 Mathematical Methods in Physics
Prereq: 18.745 or some familiarity with Lie theory
G (Spring)
3-0-9 H-LEVEL Grad Credit
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. Kac
A P P L I E D  M A T H E M A T I C S

18.303 Linear Partial Differential Equations: Analysis and Numerics
Prereq: 18.06 or 18.700
U (Fall) 3-0-9

Provides students with the basic analytical and computational tools of linear partial differential equations (PDEs) for practical applications in science 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. MATLAB is introduced and used in homework for simple examples.

S. G. Johnson

18.304 Undergraduate Seminar in Discrete Mathematics
Prereq: 18.310 or 18.310C; 18.06, 18.700, or 18.701; or permission of instructor
U (Fall, Spring) 3-0-9

Credit cannot also be received for 18.316

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.

Fall: O. Bernardi
Spring: R. Stanley

18.305 Advanced Analytic Methods in Science and Engineering
Prereq: 18.04, 18.075, or 18.112
G (Fall) 3-0-9 H-LEVEL Grad Credit

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 18.034; 18.04, 18.075, or 18.112
G (Spring) 3-0-9 H-LEVEL Grad Credit


R. R. Rosales

18.310 Principles of Applied Mathematics
Prereq: Calculus II (GIR)
U (Fall) 3-0-9

Study of illustrative topics in discrete applied mathematics, including sorting algorithms, 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

18.311 Principles of Applied Mathematics
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Spring) 3-0-9

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, caustics, lattices, dispersion and group velocity. Uses MATLAB computing environment.

R. R. Rosales

18.312 Algebraic Combinatorics
Prereq: 18.701 or 18.703
U (Spring) 3-0-9

Applications of algebra to combinatorics. Topics include walks in graphs, the Radon transform, groups acting on posets, Young tableaux, electrical networks.

R. Stanley

18.314 Combinatorial Analysis
Prereq: Calculus II (GIR); 18.06, 18.700, or 18.701
U (Fall) 3-0-9

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.

R. P. Stanley

18.315 Combinatorial Theory
Prereq: Permission of instructor
G (Fall) 3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Content varies from year to year.

J. Fox

18.316 Seminar in Combinatorics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring) 3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Credit cannot also be received for 18.304

Content varies from year to year. Readings from current research papers in combinatorics. Topics to be chosen and presented by the class.

Information: R. P. Stanley

18.318 Topics in Combinatorics
Prereq: Permission of instructor
G (Spring) 3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Topics vary from year to year. A. Postnikov

18.319 Combinatorics and Geometry
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring) 3-0-9 H-LEVEL Grad Credit

Connections between combinatorics and geometry (and algebra). Discussion of combinatorial
problems that arise in algebraic geometry, convex geometry, and algebraic topology. Topics include toric varieties, polytopes and fans, hyperplane arrangements, triangulations and tilings, matroids, topological combinatorics, Schubert calculus.

Information: A. Postnikov

18.325 Topics in Applied Mathematics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
Information: M. X. Goemans

18.330 Introduction to Numerical Analysis
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Spring)
3-0-9
L. Demanet

18.335j Introduction to Numerical Methods
(Same subject as 6.337j)
Prereq: 18.03 or 18.034; 18.06, 18.700, or 18.701
G (Fall)
3-0-9 H-LEVEL Grad Credit
Advanced introduction to numerical linear algebra and related numerical methods. Topics include direct and iterative methods for linear systems, eigenvalue and QR/SVD factorizations, stability and accuracy, floating-point arithmetic, sparse matrices, preconditioning, and the memory considerations underlying modern linear algebra software. Starting from iterative methods for linear systems, explores more general techniques for local and global nonlinear optimization, including quasi-Newton methods, trust regions, branch-and-bound, and multistart algorithms. Also addresses Chebyshev approximation and FFTs. MATLAB is introduced for problem sets.
S. G. Johnson

18.336 Numerical Methods for Partial Differential Equations
Prereq: 18.330, 18.335j, G (Spring)
3-0-9 H-LEVEL Grad Credit
Advanced introduction to applications and theory of numerical methods for solution of differential equations, especially of physically-arising partial differential equations, with emphasis on the fundamental ideas underlying various methods. Topics include finite differences, spectral methods, finite elements, well-posedness and stability, particle methods and lattice gases, boundary and nonlinear instabilities.
L. Demanet

18.337j Parallel Computing
(Same subject as 6.338j)
Prereq: 18.06, 18.700, or 18.701
G (Fall)
3-0-9 H-LEVEL Grad Credit
Advanced interdisciplinary introduction to modern scientific computing on parallel supercomputers. Numerical topics include dense and sparse linear algebra, N-body problems, and Fourier transforms. Geometrical topics include partitioning and mesh generation. Other topics include architectures and software systems with emphasis on understanding the realities and myths of what is possible on the world’s fastest machines.
A. Edelman

18.338 Eigenvalues of Random Matrices
Prereq: 18.701 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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 semi-circle and Marcenko-Pastur laws), free probability, random graphs, combinatorial methods, matrix statistics, stochastic operators, passage to the continuum limit, moment knowledge of MATLAB helpful, but not required.
A. Edelman

18.353j Nonlinear Dynamics I: Chaos
(Same subject as 2.050J, 12.006j)
Prereq: 18.03 or 18.034; Physics II (GIR)
U (Fall)
3-0-9
See description under subject 12.006j.
L. Chumakova

18.354j Nonlinear Dynamics II: Continuum Systems
(Same subject as 12.207j)
Prereq: 18.353 or permission of instructor
U (Spring)
3-0-9 (H except 18)
General mathematical principles of continuum systems. (1) From microscopic to macroscopic. Examples range from random walkers, to Newtonian mechanics, to option pricing. (2) Singular Perturbations. Examples include boundary layer theory, snowflakes and geophysical flows. (3) Instability. Generalize ideas from 18.353 to continuum systems. Examples from fluid mechanics, solid mechanics, astrophysics and biology. (4) Pattern formation and turbulence.
L. Bourouiba

18.355 Fluid Mechanics
Prereq: 18.354, 12.800, or 2.25
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Topics include the development of Navier-Stokes equations, ideal flows, boundary layers, lubrication theory, Stokes flows, and surface tension. Fundamental concepts illustrated through problems drawn from a variety of areas including geophysics, bifurcations and the dynamics of sport. Particular emphasis is given to the interplay between dimensional analysis, scaling arguments and rigorous theory. Course material supplemented by classroom and laboratory demonstrations.
Information: J. W. Bush

18.357 Interfacial Phenomena
Prereq: 18.354, 18.355, 12.800, or 2.25
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers fluid systems dominated by the influence of interfacial tension. The roles of curvature pressure and Marangoni stress are elucidated in a variety of fluid systems. Particular attention given to drops and bubbles, soap films and minimal surfaces, wetting phenomena, water-repellency, surfactants, Marangoni flows, capillary origami and contact line dynamics. Theoretical developments accompanied by classroom demonstrations. Highlights the role of surface tension in biology.
Information: J. W. Bush
18.369 Mathematical Methods in Nanophotonics
Prereq: 18.305 or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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

18.376j Wave Propagation
(Same subject as 1.138J, 2.062J)
Prereq: 2.003, 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 2.062J.

T. R. Akylas, R. R. Rosales

18.377J Nonlinear Dynamics and Waves
(Same subject as 1.685J, 2.034J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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.

T. R. Akylas, R. R. Rosales

18.384 Undergraduate Seminar in Physical Mathematics
Prereq: 18.311, 18.354, or permission of instructor
U (Fall)
3-0-9

The applied mathematics of continuous media and classical physics. Reading and presentation of papers from recent applied mathematics and physics literature. Topics and papers include fluid mechanics, solid mechanics, and biophysics. Instruction and practice in written and oral communication provided. Enrollment limited.

R. R. Rosales

18.385j Nonlinear Dynamics and Chaos
(Same subject as 2.036J)
Prereq: 18.03 or 18.034
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit


Information: R. R. Rosales

18.386j Advanced Nonlinear Dynamics and Chaos
Prereq: 18.385 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit


Information: R. R. Rosales

18.395 Group Theory with Applications to Physics
Prereq: 8.321
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Selection of topics from the theory of finite groups, Lie groups, and group representations, motivated by quantum mechanics and particle physics. 8.322 and 8.323 helpful.

Information: D. Z. Freedman

18.396j Supersymmetric Quantum Field Theories
(Same subject as 8.831J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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, I-loop renormalization, and gauge theories is essential.

D. Z. Freedman

18.398 Quantum Field Theories
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

For students who want to have a clear understanding of quantum field theories. Appropriate for students who have not taken such a subject as well as students who have but are not entirely comfortable with the basic concepts and techniques. The topics begin with classical mechanics and end with gauge field theories and the renormalization of the standard model.

Information: H. Cheng
THEORETICAL COMPUTER SCIENCE

18.400J Automata, Computability, and Complexity
(Same subject as 6.045J)
Prereq: 6.042
U (Spring)
4-0-8
See description under subject 6.045J.
S. Micali

18.404J Theory of Computation
(Same subject as 6.840J)
Prereq: 18.310 or 18.062J
G (Fall)
4-0-8 H-LEVEL Grad Credit (H except 18)
A more extensive and theoretical treatment of the material in 6.045/18.400, 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.
M. Sipser

18.405J Advanced Complexity Theory
(Same subject as 6.841J)
Prereq: 18.404
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Information: M. Sudan, J. Kelner

18.409 Topics in Theoretical Computer Science
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Study of areas of current interest in theoretical computer science. Topics vary from term to term.
J. Kelner

18.410J Design and Analysis of Algorithms
(Same subject as 6.046J)
Prereq: 6.006
U (Fall, Spring)
4-0-8
See description under subject 6.046J.
C. E. Leiserson, M. Goemans

18.415J Advanced Algorithms
(Same subject as 6.854J)
Prereq: 6.041, 6.042, or 18.440; 6.046
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
5-0-7 H-LEVEL Grad Credit
See description under subject 6.854J.
D. R. Karger

18.416J Randomized Algorithms
(Same subject as 6.856J)
Prereq: 6.854J, 6.041 or 6.042J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
5-0-7 H-LEVEL Grad Credit
See description under subject 6.856J.
D. R. Karger

18.417 Introduction to Computational Molecular Biology
Prereq: 6.01, 6.006, or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
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. A. Berger

18.418 Topics in Computational Molecular Biology
Prereq: 18.417, 6.047, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Covers current research topics in computational molecular biology. Recent research papers presented from leading conferences such as the SAGA International Conference on Computational Molecular Biology (RECOMB). Topics include original research (both theoretical and experimental) in comparative genomics, sequence and structure analysis, molecular evolution, proteomics, gene expression, transcriptional regulation, and biological networks. Recent research by course participants also covered. Participants will be expected to present either group or individual projects to the class.
B. Berger

18.424 Seminar in Information Theory
Prereq: 18.05, 18.440, or 6.041; 18.06, 18.700, or 18.701
U (Spring)
3-0-9
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

18.425J Cryptography and Cryptanalysis
(Same subject as 6.875J)
Prereq: 6.046J
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.875J.
S. Goldwasser, S. Micali

18.426J Advanced Topics in Cryptography
(Same subject as 6.876J)
Prereq: 6.875
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 6.876J.
S. Goldwasser, S. Micali

18.433 Combinatorial Optimization
Prereq: 18.06, 18.700, or 18.701
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 (H except 18)
Thorough treatment of linear programming and combinatorial optimization. Topics include matching theory, network flow, matroid optimization, and how to deal with NP-hard optimization problem. Prior exposure to discrete mathematics (such as 18.310) helpful.
M. X. Goemans

18.434 Seminar in Theoretical Computer Science
Prereq: 18.404, 18.410
U (Fall)
3-0-9
Topics vary from year to year. Students present and discuss the subject matter. Instruction and
practice in written and oral communication provided. Enrollment limited. 
Information: M. X. Goemans

18.435J Quantum Computation
(Same subject as 2.111J, 8.411J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

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, E. Farhi, S. Lloyd, P. Shor

18.436J Quantum Information Science
(Same subject as 6.443J, 8.371J)
Prereq: 18.435
G (Spring)
3-0-9 H-LEVEL Grad Credit

Examines quantum computation and quantum information. Topics include quantum circuits, quantum Fourier transform and search algorithms, the quantum operations formalism, quantum error correction, stabilizer and Calderbank-Shor-Steans codes, fault tolerant quantum computation, quantum data compression, entanglement, capacity of quantum channels, and proof of the security of quantum cryptography. Prior knowledge of quantum mechanics required.

I. Chuang

18.437J Distributed Algorithms
(Same subject as 6.852J)
Prereq: 6.046
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

See description under subject 6.852J.
N. A. Lynch

18.438 Advanced Combinatorial Optimization
Prereq: 18.433 or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

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

PROBABILITY AND STATISTICS

18.440 Probability and Random Variables
Prereq: Calculus II (GIR)
U (Fall, Spring)
3-0-9
Credit cannot also be received for 6.041, 18.05

Fall: S. Sheffield
Spring: J. A. Kelner

18.443 Statistics for Applications
Prereq: 18.440 or 6.041
U (Fall, Spring)
3-0-9 (H except 18)
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.

Fall: L. Wang
Spring: R. M. Dudley

18.445 Introduction to Stochastic Processes
Prereq: 18.440 or 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit

Information: L. Wang

18.446 Topics in Statistics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from term to term.
Information: R. M. Dudley

18.466 Mathematical Statistics
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Decision theory, estimation, confidence intervals, hypothesis testing. Introduces large sample theory. Asymptotic efficiency of estimates. Exponential families. Sequential analysis.

Information: L. Wang

Civil and Environmental Engineering: 1.151, 1.155, 1.202J, 1.203J, 1.205J

Electrical Engineering and Computer Science: 6.041, 6.231, 6.245, 6.262, 6.431, 6.432, and 6.435

Management: 15.034, 15.070, 15.075, and 15.098

Mathematics: 18.05, 18.175, 18.177, 18.440, 18.443, 18.445, and 18.465

See also: 2.830, 5.70, 5.72, 7.02, 8.044, 8.08, 10.816, 11.220, 11.221, 16.322, 22.38, HST.191, and MAS.622J.

LOGIC

18.504 Seminar in Logic
Prereq: 18.100; 18.06, 18.510, 18.700, or 18.701
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
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.

Information: B. Poonen

18.510 Introduction to Mathematical Logic and Set Theory
Prereq: None
U (Fall)
3-0-9

H. Cohn
18.511 Introduction to Computability and Undecidability
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9
Church’s thesis and models of computation. Elementary computability theory: enumeration and recursion theorems, the halting problem, relative computability, Turing degrees, and basic priority constructions. Post’s problem. Truth vs. provability, Gödel’s incompleteness theorem. Decidable and undecidable problems in number theory and other areas of mathematics. Information: B. Poonen

18.515 Mathematical Logic
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

ALGEBRA AND NUMBER THEORY

18.700 Linear Algebra
Prereq: Calculus II (GIR)
U (Fall)
3-0-9 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. T. Schedler

18.701 Algebra I
Prereq: 18.700, 18.100, or permission of instructor
U (Fall)
3-0-9
18.702 Algebra II
Prereq: 18.701
U (Spring)
3-0-9
More extensive and theoretical than the 18.700-18.703 sequence. Experience with proofs necessary. First term: group theory, geometry, and linear algebra. Second term: group representations, rings, ideals, fields, polynomial rings, modules, factorization, integers in quadratic number fields, field extensions, Galois theory. M. Artin

18.703 Modern Algebra
Prereq: Calculus II (GIR)
U (Fall)
3-0-9
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. V. G. Kac

18.704 Seminar in Algebra
Prereq: 18.702
U (Fall, Spring)
3-0-9
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. Fall: V. Kac Spring: S. Kleiman

18.705 Commutative Algebra
Prereq: 18.702
G (Fall)
3-0-9 H-LEVEL Grad Credit
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. S. Kleiman

18.706 Noncommutative Algebra
Prereq: 18.705
G (Spring)
3-0-9 H-LEVEL Grad Credit
Wedderburn theory, Morita equivalence, localization and Goldie’s theorem, central simple algebras and the Brauer group, maximal orders, representations, polynomial identity rings, invariant theory growth of algebras, Gelfand-Kirillov dimension. R. Bezrukavnikov

18.712 Introduction to Representation Theory
Prereq: 18.702 or 18.703
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9

18.721 Introduction to Algebraic Geometry
Prereq: 18.702, 18.901
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
Introduction to affine and projective algebraic geometry. Emphasis on basic examples of complex algebraic varieties, including algebraic curves. Information: M. Artin

18.725 Algebraic Geometry I
Prereq: None. Coreq: 18.705
G (Fall)
3-0-9 H-LEVEL Grad Credit
18.726 Algebraic Geometry II
Prereq: 18.725
G (Spring)
3-0-9 H-LEVEL Grad Credit
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. Fall: B. Poonen Spring: J. McKernan
18.727 Topics in Algebraic Geometry  
Prereq: 18.725  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Topics vary from year to year.  
Information: J. McKernan

18.735 Topics in Algebra  
Prereq: 18.705  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Topics vary from year to year.  
S. Kleiman

18.737 Algebraic Groups  
Prereq: 18.705  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
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 etale cohomology. Some results from algebraic geometry are stated without proof.  
Information: R. Bezrukavnikov

18.739 Theory of Invariants  
Prereq: 18.705  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Information: V. G. Kac

18.745 Introduction to Lie Algebras  
Prereq: 18.701 or 18.703  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
G. Lusztig

18.747 Infinite-dimensional Lie Algebras  
Prereq: 18.745  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Topics vary from year to year.  
P. I. Etingof

18.755 Introduction to Lie Groups  
Prereq: 18.100; 18.700 or 18.701  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
A general introduction to manifolds and Lie groups. The role of Lie groups in mathematics and physics. Exponential mapping. Correspondence with Lie algebras. Homogeneous spaces and transformation groups. Adjoint representation. Covering groups. Automorphism groups. Invariant differential forms and cohomology of Lie groups and homogeneous spaces. 18.101 recommended but not required.  
S. Helgason

18.757 Representations of Lie Groups  
Prereq: 18.745 or 18.755  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
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: S. Helgason

18.758 Representations of Lie Groups  
Prereq: 18.757  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Introduction to unitary representations of semisimple Lie groups: compact groups and the Borel-Weil theorem; parabolic induction; Zuckerman construction; unipotent representations.  
D. A. Vogan

18.769 Topics in Lie Theory  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Topics vary from year to year.  
Information: D. A. Vogan

18.781 Theory of Numbers  
Prereq: None  
U (Spring)  
3-0-9  
An elementary introduction to number theory with no algebraic prerequisites. Primes, congruences, quadratic reciprocity, diophantine equations, irrational numbers, continued fractions, partitions.  
A. Kumar

18.782 Introduction to Arithmetic Geometry  
Prereq: 18.702  
U (Fall)  
3-0-9  
Uses ideas from algebra to study rational points on plane conics and elliptic curves. Includes an introduction to p-adic numbers and a brief introduction to algebraic geometry.  
R. Bezrukavnikov

18.784 Seminar in Number Theory  
Prereq: 18.06, 18.100  
G (Spring)  
3-0-9  
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. Kim

18.785 Analytic Number Theory  
Prereq: 18.112  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Introduction to the analytic theory of automorphic forms. Constructing L-functions with analytic continuation and functional equation, spectral theory of automorphic forms, Eisenstein and Poincaré series, character sums, central values of L-functions and applications. Background in elementary number theory, e.g., 18.781, strongly recommended.  
B. B. Brubaker
18.786 Algebraic Number Theory
Prereq: 18.100; 18.702
G (Fall)
3-0-9 H-LEVEL Grad Credit
An introduction to algebraic number theory. Dedekind domains, unique factorization of prime ideals. Number fields, splitting of primes, class group. Lattice methods, finiteness of the class number, Dirichlet’s units theorem. Local fields, ramification, discriminants. Background in elementary number theory (e.g., 18.781) strongly recommended.
S. W. Shin

18.787 Topics in Number Theory
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
Information: J. McKernan

18.821 Project Laboratory in Mathematics
Prereq: Two mathematics subjects numbered 18.100 or above
U (Fall, Spring)
3-6-3 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.
Fall: J. Kim
Spring: T. Mrowka

TOPOLOGY AND GEOMETRY

18.901 Introduction to Topology
Prereq: 18.100 or permission of instructor
U (Fall, Spring)
3-0-9 (H except 18)
Introduces topology, covering topics fundamental to modern analysis and geometry. Topological spaces and continuous functions, connectedness, compactness, separation axioms, and selected further topics such as function spaces, embedding theorems, dimension theory, or covering spaces and the fundamental group.
Fall: J. R. Munkres
Spring: V. Vertesi

18.904 Seminar in Topology
Prereq: 18.901
U (Spring)
3-0-9
Topics vary from year to year and include the fundamental group and covering spaces. Time permitting, also covers the relationship between these objects and the theory of knots. Students present and discuss the subject matter. Instruction and practice in written and oral communication provided. Enrollment limited.
P. Seidel

18.905 Algebraic Topology I
Prereq: 18.701 or 18.703; 18.901
G (Fall)
3-0-9 H-LEVEL Grad Credit
Singular homology, CW complexes, universal coefficient and Künneth theorems, cohomology, cup products, Poincaré duality.
Information: P. Ozsvath

18.906 Algebraic Topology II
Prereq: 18.905
G (Spring)
3-0-9 H-LEVEL Grad Credit
Continues the introduction to algebraic topology from 18.905. Topics include basic homotopy theory, spectral sequences, characteristic classes, and cohomology operations.
M. J. Behrens

18.915 Graduate Topology Seminar
Prereq: 18.906
G (Fall)
3-0-9 H-LEVEL Grad Credit
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

18.917 Topics in Algebraic Topology
Prereq: 18.906
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
C. Barwick

18.937 Topics in Geometric Topology
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Content varies from year to year. Introduces new and significant developments in geometric topology.
T. Mrowka

18.950 Differential Geometry
Prereq: 18.100; 18.06, 18.700, or 18.701
U (Spring)
3-0-9 (H except 18)
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.
T. H. Colding

18.952 Theory of Differential Forms
Prereq: 18.701; 18.700 or 18.701
U (Spring)
3-0-9
Multilinear algebra: tensors and exterior forms. Differential forms on 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 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
Prereq: 18.700, 18.100, 18.102, or 18.103
G (Fall)
3-0-9 H-LEVEL Grad Credit
Differential forms, introduction to Lie groups, the DeRham theorem, Riemannian manifolds, curvature, the Hodge theory. 18.965 is a continuation of 18.963 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-Kähler theory, or smooth manifold topology. Prior exposure to calculus on manifolds, as in 18.952, is recommended.

T. H. Colding

18.969 Topics in Geometry
Prereq: 18.965
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Content varies from year to year.
Information: R. B. Melrose

18.979 Graduate Geometry Seminar
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
Information: R. B. Melrose

18.994 Seminar in Geometry
Prereq: 18.101, 18.102, 18.103, or 18.112
U (Spring)
3-0-9
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.
P. Ozsvath

18.995–18.998 Special Subject in Mathematics (18.995–18.998)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
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: H. R. Miller

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: B. Poonen, G. Staffilani

18.UR Undergraduate Research
Prereq: Permission of instructor
U (Fall, Spring)
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: H. R. Miller

18.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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.
Information: B. Poonen, G. Staffilani

18.CME Study at Cambridge University
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides credit for students studying at Cambridge University under the Cambridge-MIT Exchange program. Credit may be used to satisfy specific SB degree requirements. Consult with department and CME office.
H. R. Miller
Bachelor of Science in Mathematics/Course 18

<table>
<thead>
<tr>
<th>General Institute Requirements (GI�s)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (one subject can be satisfied by 18.03 or 18.034 in the Departmental Program)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td>Total GI� Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>One of the following two subjects: 18.03 or 18.034 Differential Equations, 12, REST; Calculus II (GIJR)</td>
<td>12</td>
</tr>
</tbody>
</table>

Restricted Electives
To satisfy the requirements that students take two CI-M subjects, students must take two of the following subjects: 18.104, 18.304, 18.384, 18.424, 18.434, 18.504, 18.704, 18.784, 18.821, 18.904, or 18.994 or one from the above list and one of the following subjects: 8.06, 14.33, 18.100C, or 18.310.

General Mathematics Option
Eight 12-unit subjects of different content, including at least six advanced subjects (first decimal digit one or higher). One of these eight subjects must be 18.06, 18.700, or 18.701.

Applied Mathematics Option
- 18.310 Principles of Applied Mathematics, 12, CI-M; Calculus II (GIJR)
- 18.311 Principles of Applied Mathematics, 12; Calculus II (GIJR), 18.03* One of the following two subjects:

Restricted Electives
To satisfy the requirements that students take two CI-M subjects, students must take two of the following subjects: 18.104, 18.304, 18.384, 18.424, 18.434, 18.504, 18.704, 18.784, 18.821, 18.904, or 18.994 or one from the above list and one of the following subjects: 8.06, 14.33, 18.100C, or 18.310.

General Mathematics Option
Eight 12-unit subjects of different content, including at least six advanced subjects (first decimal digit one or higher). One of these eight subjects must be 18.06, 18.700, or 18.701.

Applied Mathematics Option
- 18.310 Principles of Applied Mathematics, 12, CI-M; Calculus II (GIJR)
- 18.311 Principles of Applied Mathematics, 12; Calculus II (GIJR), 18.03* One of the following two subjects:

Restricted Electives
To satisfy the requirements that students take two CI-M subjects, students must take two of the following subjects: 18.104, 18.304, 18.384, 18.424, 18.434, 18.504, 18.704, 18.784, 18.821, 18.904, or 18.994 or one from the above list and one of the following subjects: 8.06, 14.33, 18.100C, or 18.310.

General Mathematics Option
Eight 12-unit subjects of different content, including at least six advanced subjects (first decimal digit one or higher). One of these eight subjects must be 18.06, 18.700, or 18.701.

Theoretical Mathematics Option
- 18.100 Real Analysis, 12; Calculus II (GIJR), 18.03* 18.701 Algebra I, 12; 18.700* 18.702 Algebra II, 12; 18.701 18.901 Introduction to Topology, 12; 18.100* One of the following subjects: 18.101 Analysis and Manifolds, 12; 18.100, 18.06* 18.102 Introduction to Functional Analysis, 12; 18.100, 18.06* 18.103 Fourier Analysis—Theory and Applications, 12; 18.100, 18.06* An undergraduate seminar from the following list: 18.104, 18.504, 18.704, 18.784, 18.904, 18.994 (12 units). Two additional Course 18 subjects of essentially different content, with the first decimal digit one or higher (24 units)

Departmental Program Units That Also Satisfy the GI�s | (12) |

Unrestricted Electives | 60 |
### Total Units Beyond the GIRs Required for SB Degree

<table>
<thead>
<tr>
<th>Units Required</th>
<th>180</th>
</tr>
</thead>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

- *Alternate prerequisites and corequisites are listed in the subject description.
- ** Students may substitute the more advanced subject 18.701 Algebra I.
- ***A list of acceptable subjects is available in Room 2-108 and on the Mathematics Department website.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Bachelor of Science in Mathematics with Computer Science/Course 18-C

General Institute Requirements (GiRs)  

<table>
<thead>
<tr>
<th>Subjects</th>
</tr>
</thead>
</table>
| Science Requirement                           | 6  
| Humanities, Arts, and Social Sciences Requirement | 8  
| Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 18.03, 18.034, 18.06, or 18.700 in the Departmental Program] | 2  
| Laboratory Requirement                        | 1  
| Total GIR Subjects Required for SB Degree     | 17  

Communication Requirement  

The program includes a Communication Requirement of 4 subjects:  
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and  
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program  

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

Required Subjects  

<table>
<thead>
<tr>
<th>Subject Names</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03 or 18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td>96</td>
</tr>
<tr>
<td>18.06 or 18.700 Linear Algebra, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.410 Design and Analysis of Algorithms, 12; 6.006*</td>
<td></td>
</tr>
<tr>
<td>6.01 Introduction to EECS I, 12, 1/2 LAB</td>
<td></td>
</tr>
<tr>
<td>6.006 Introduction to Algorithms, 12; 6.01, 18.062*</td>
<td></td>
</tr>
<tr>
<td>One subject from each of the following three groups:</td>
<td></td>
</tr>
<tr>
<td>18.064 Mathematics for Computer Science, 12; REST; Calculus I (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.310 Principles of Applied Mathematics, 12, CI-M; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.400 Automata, Computability, and Complexity, 12; 18.062</td>
<td></td>
</tr>
<tr>
<td>18.401 Theory of Computation, 1/2; 18.062*</td>
<td></td>
</tr>
<tr>
<td>6.005 Elements of Software Construction, 12; 6.01, 18.062*</td>
<td></td>
</tr>
<tr>
<td>6.033 Computer System Engineering, 12; 6.004</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives  

Four additional 12-unit subjects from Course 18 and one additional subject of at least 12 units from Course 6.

The Course 6 subject may be 6.02, 6.041, 6.17x, a Foundation or Header subject, or, with the permission of the Department of Mathematics, an advanced Course 6 subject. The overall program must consist of subjects of essentially different content, and must include at least five Course 18 subjects with a first decimal digit of 1 or higher.

To satisfy the requirements that students take two CI-M subjects, students must take two of the following subjects: 18.104, 18.304, 18.384, 18.424, 18.434, 18.504, 18.704, 18.784, 18.821, 18.904, or 18.994 or one from the above list and one of the following subjects: 6.073, 8.06, 14.33, 18.100C, or 18.310.

Departmental Program Units That Also Satisfy the GIRs  

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(24)</td>
</tr>
</tbody>
</table>

Unrestricted Electives  

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree  

<table>
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<tr>
<td>180</td>
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</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes  

*Alternate prerequisites and corequisites are listed in the subject description.  
(1) Recommended alternative.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
<table>
<thead>
<tr>
<th>COURSE 20</th>
<th>BIOLOGICAL ENGINEERING</th>
</tr>
</thead>
</table>

**20.002 Metakaryotic Biology and Epidemiology (New)**  
Prereq: None  
U (Fall)  
2-0-4 [P/D/F]  
Integration of biological stem cell hypotheses and mathematical models of age-specific mortality. Introduces amitotic metakaryotic stem cells that drive organogenesis and wound healing. Discusses topics such as the role of metakaryotic mutator fetal/juvenile phenotype in generation of preneoplastic lesions and lethal tumors, and non-canonical metakaryotic genome organization, replication and segregation in human tissues, tumors and tumor-derived cell cultures. Studies the relationship to age-specific cancer and other disease rates observed in human populations.  
*W. Thilly*

**20.020 Introduction to Biological Engineering Design Using Synthetic Biology**  
(Subject meets with 20.385)  
Prereq: None  
U (Spring)  
3-3-3  
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*

**20.109 Laboratory Fundamentals in Biological Engineering**  
Prereq: Biology (GIR), Chemistry (GIR), 6.00, 18.03; 20.110 or 20.111  
U (Fall, Spring)  
2-8-5 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. Enrollment limited; priority to Course 20 majors.  
*Fell: A. Belcher, N. Kuldell, N. Tedford, K. D. Wittrup*  
*Spring: J. Niles, A. Stachowiak, R. Weiss*

**20.104J Environmental Cancer Risks, Prevention, and Therapy**  
(Same subject as 1.081J, ESD.053J)  
Prereq: Biology (GIR), Chemistry (GIR)  
U (Spring)  
3-0-9  
Considers potentially important risk factors for common cancers in the general environment and the workplace: air-, food- and water-borne chemicals; subclinical infections; and diet and lifestyle choices. Includes an analysis of the history of cancer mortality rates in predominantly European- and African-American cohorts. Examines metakaryotic cancer stem cells as targets for both pathogenic environmental risk factors and drugs that prevent the growth of or kill preneoplastic and/or neoplastic stem cells.  
*W. Thilly, R. McCunney*  

**20.110J Thermodynamics of Biomolecular Systems**  
(Same subject as 2.772J)  
Prereq: Calculus II (GIR), Chemistry (GIR)  
U (Fall)  
5-0-7 REST  
Credit cannot also be received for 7.10  
*E. Alm, K. Hamad-Schifferli*
20.111J Physical Chemistry of Biomolecular Systems
(Same subject as 7.10J)
Prereq: Calculus II (GIR), Chemistry (GIR), Physics I (GIR); Coreq: Physics II (GIR)
U (Spring)
5-0-7
See description under subject 7.10J.
E. Alm, M. Bathe

20.200 Biological Engineering Seminar
Prereq: Open only to BE graduate students, or by permission of instructor
G (Fall, Spring)
1-0-2 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Weekly one-hour seminars covering graduate student research and presentations by invited speakers.
J. S. Wishnok

20.201 Mechanisms of Drug Actions
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Chemical and biological analysis of the metabolism and distribution of drugs and chemicals in animals and humans, and the mechanisms by which they cause therapeutic and toxic responses. Examines pharmacokinetics, metabolism, pharmacodynamics, toxicity and pharmacogenetics as foundations for drug development. Includes case studies and literature discussions of specific drugs, drug classes, and therapeutic targets.
P. C. Dedon, S. R. Tannenbaum

Prereq: Permission of instructor
G (Spring; first half of term)
1-1-4 H-LEVEL Grad Credit
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.
J. G. Fox, B. Marini, M. Whary

20.213 DNA Damage and Genomic Instability
Prereq: 5.07, 7.05, permission of instructor
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Focuses on the biochemistry and molecular mechanisms of DNA replication and DNA repair. Analyzes the chemistry of DNA damaging events, and continues with analysis of the mutagenic and toxic consequences of modifications to DNA structure. Also presents the contrasting perspective that normal DNA processing leads to mutations. Moves from analysis and discussion of key DNA repair pathways to connections between DNA repair and human diseases. Discussion of current literature and in depth discussions of the chemistry and biochemistry of DNA metabolism form the foundation of the subject.
B. P. Engelward

20.215 Macropidemiology, Population Genetics, and Stem Cell Biology of Human Cancers
(Subject meets with 20.102)
Prereq: Calculus II (GIR), 1.00
G (Fall)
3-0-15 H-LEVEL Grad Credit
Studies the logic and technology needed to discover genetic and environmental causes and accelerating factors for common human cancers. Includes an introduction to metakaryotic stem cell biology. Examines regulatory genes that control the cell cycle, survival and apoptosis. Discovers genetic and environmental causes of cancer and develops diagnostic strategies for its early detection. Includes an introduction to the use of large, organized historical public health databases using quantitative carcinogenesis cascade computer models. Means to test hypotheses that certain genes carry mutations conferring risk for common cancers via genetic analyses in large human cohorts.
W. G. Thilly

20.219 Selected Topics in Toxicology
Prereq: Permission of Instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Detailed discussion of selected topics of current interest. Classwork in various areas not covered by regular subjects.
Staff

20.305J Principles of Synthetic Biology (New)
(Same subject as 6.580J)
(Subject meets with 20.405)
Prereq: None
U (Fall)
3-0-9
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

20.309J Instrumentation and Measurement for Biological Systems
(Same subject as 2.673J, MAS.402J)
(Subject meets with 20.409)
Prereq: Biology (GIR), Physics II (GIR), 6.00, 18.03; 2.001, 20.310, or 6.02; or permission of instructor; Coreq: 20.330
U (Fall)
3-6-3
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 electromagnetic probes (atomic force microscopy, optical traps, MEMS devices). Application of statistics, probability, signal and noise analysis, and Fourier techniques to experimental data. Final design project emphasizes utilization of principles underlying biological instrumentation. Preference to juniors and seniors.
Fall: S. Manalis, P. T. So, S. Wasserman
Spring: E. Boyden, S. Wasserman, M. F. Yanik

20.310J Molecular, Cellular, and Tissue Biomechanics
(Subject meets with 20.409)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Spring)
4-0-8
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.
Fall: R. D. Kamm
Spring: R. D. Kamm, A. J. Grodzinsky
20.320 Analysis of Biomolecular and Cellular Systems  
Prereq: 20.110, 18.03, 6.00; Coreq: 5.07  
U (Fall)  
4-0-8  
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, E. Fraenkel

20.330J Fields, Forces and Flows in Biological Systems  
(Same subject as 2.793, 6.023J)  
Prereq: 2.005, 6.021, 20.320 or permission of instructor  
U (Spring)  
4-0-8  
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, N. Tedford

20.340J Materials for Biomedical Applications  
(Same subject as 3.051J)  
(Subject meets with 3.962J, 20.462J)  
Prereq: Chemistry (GIR), Biology (GIR), 3.034, 3.012 or 3.046; or permission of instructor  
Acad Year 2011–2012: U (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9  
See description under subject 3.051J.  
D. Irvine

20.342 Molecular Structure of Biological Materials  
(Subject meets with 20.442)  
Prereq: 5.07 or 7.05; permission of instructor  
U (Fall)  
3-0-9  
Basic molecular structural principles of biological materials. Molecular structures of various materials of biological origin, including collagen, silk, bone, protein adhesives, GFP, self-assembling peptides. Molecular design of new biological materials for nanotechnology, biocomputing and regenerative medicine. Graduate students are expected to complete additional coursework.  
S. Zhang

20.345J Bioinstrumentation Project Lab  
(Same subject as 6.123J)  
Prereq: Biology (GIR), and 2.004 or 6.003; or 20.309; or permission of instructor  
U (Spring)  
2-7-3  
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.  
E. Boyden, S. F. Nagle, S. Wasserman, M. F. Yanik

20.360J Tissue Engineering for Analysis, Prevention, and Treatment of Human Disease  
(Same subject as 10.499J)  
Prereq: 5.07 or 7.05; 7.03; 18.03; 20.110 or 5.60  
U (Spring)  
3-0-6  
Analysis of fundamental processes in tissue engineering with an emphasis on use of comparative animal models and in vitro tissue engineered models to understand human disease and develop therapies for human disease and for regenerating human tissues and organs. Using representative examples of metabolic tissue (e.g., liver) and connective tissue (e.g., bone). Design principles and engineering approaches (e.g., use of synthetic materials) for controlling receptor-mediated processes such as cell migration, growth, and differentiation. Mass transfer limitations in design of devices for cell encapsulation and in scaffold-guided regeneration. Guided organization of multicellular structures. Current clinical prospects.  
Staff

20.361J Molecular and Engineering Aspects of Biotechnology  
(Same subject as 7.37J, 10.441J)  
Prereq: 2.005, 3.012, 5.60, 20.110, or 20.111; 7.06; or permission of instructor  
U (Spring)  
4-0-8  
See description under subject 7.37J.  
H. Lodish, D. Lauffenburger

20.363J Biomaterials Science and Engineering (New)  
(Same subject as 3.055J)  
(Subject meets with 3.963J, 20.463J)  
Prereq: 3.034, 20.110, or permission of instructor  
U (Fall)  
3-0-9  
See description under subject 3.055J.  
D. Irvine, K. Ribbeck

20.370J Cellular Biophysics  
(Same subject as 2.791J, 6.021J)  
(Subject meets with 2.794J, 6.521J, 20.470J, HST.541J)  
Prereq: Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110, 20.111, or permission of instructor  
U (Fall)  
5-2-5  
See description under subject 6.021J.  
D. M. Freeman, J. Han, J. Voldman, M. F. Yanik

20.371J Quantitative Systems Physiology  
(Same subject as 2.792J, 6.022J, HST.542J)  
(Subject meets with 2.796J, 6.522J, 20.471J)  
Prereq: Physics II (GIR), 18.03, or permission of instructor  
U (Spring)  
4-2-6  
See description under subject 6.022J.  
R. G. Mark, C. M. Stultz

20.380 Biological Engineering Design  
Prereq: 7.06, 20.309  
U (Spring)  
5-0-7  
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.  
F. White, K. Ribbeck
20.385 Understanding Current Research in Synthetic Biology
(Subject meets with 20.020)
Prereq: 20.109, 20.320; or permission of instructor
U (Spring)
3-3-3
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.
N. Kuldell

20.390 Foundations of Computational and Systems Biology
Prereq: 7.05 or 5.07; or Biology (GIR) and 6.001; or permission of instructor
U (Spring)
3-0-9
Introduction to computational biology emphasizing the fundamentals of nucleic acid and protein sequence and structural analysis, as well as the analysis of complex biological systems. Principles and methods used for sequence alignment, motif finding, expression array analysis, structural modeling, structure prediction and network modeling. Techniques include dynamic programming, Markov models, clustering techniques, and energy minimization approaches. Exposure to currently emerging research areas. Designed for advanced undergraduates and graduate students with strong backgrounds in either molecular biology or computer science. Some foundational material covering basic programming skills, probability and statistics is provided for students with non-quantitative backgrounds.
C. Burge, A. Keating, E. Fraenkel

20.405 Principles of Synthetic Biology (New)
(Subject meets with 6.580J, 20.305J)
Prereq: None
G (Fall)
3-0-9
See description under subject 20.305J.
R. Weiss

20.409 Biological Engineering II: Instrumentation and Measurement
(Subject meets with 2.673J, 20.309J, MAS.402J)
Prereq: 18.03
G (Fall, Spring)
2-7-3
Sensing and measurement aimed at quantitative molecular/cell/tissue analysis in terms of genetic, biochemical, and biophysical properties. Methods include light and fluorescence microscopies, and electro-mechanical probes (atomic force microscopy, laser and magnetic traps, MEMS devices). Application of statistics, probability and noise analysis to experimental data. Limited to 5 graduate students.
S. Manalis, P. T. So, S. Wasserman

20.410 Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.798J, 3.971J, 6.524J, 10.537J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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. Van Vliet

20.411J Cell-Matrix Mechanics
(Same subject as 2.785J, 3.97J, HST.523J)
Prereq: 2.001, Chemistry (GIR), Biology (GIR); or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.785J.
I. V. Yannas, M. Spector

20.415 Physical Biology
Prereq: Permission of instructor
G (Spring)
3-0-9
Develops and applies principles of probability, statistics and physics to biological systems at the molecular, cellular and tissue levels. Applies information theory, statistical mechanics and transition-state theory to equilibrium and non-equilibrium biological systems. Focuses on sequence conservation and evolution, protein-protein/-DNA interactions, and cytoskeletal dynamics mediating cell division, migration, and morphogenesis. Presents quantitative experimental techniques to measure protein dynamics in living cells; techniques include fluorescence correlation and cross-correlation spectroscopy, particle-tracking, and image-based correlation.
M. Bathe

20.416J Evaluating Current Research in Molecular and Cellular Biophysics
(Same subject as 7.74J)
Prereq: None
G (Fall)
2-0-4
Focuses on the current state of research in molecular and cellular biophysics. Bi-weekly meetings include lectures by distinct biophysics faculty on specific topics in molecular and cellular biophysics followed by in-depth discussion of relevant literature. Provides broad exposure to diverse areas of biophysics research, with an emphasis on reading and evaluating scientific literature critically.
M. Bathe, J. Gore

20.420J Biomolecular Kinetics and Cellular Dynamics
(Same subject as 10.538J)
Prereq: 7.05, 7.06, 18.03
G (Fall)
3-0-9 H-LEVEL Grad Credit
Fundamental analysis of biological rate processes using approaches from biomolecular reaction kinetics and dynamical systems engineering. Topics include binding and hybridization interactions, enzyme reactions, metabolic cycles, gene regulation, receptor/ligand trafficking systems, intra- and intercellular signaling, and cell population dynamics.
K. D. Wittrup, B. Tidor

20.430J Fields, Forces, and Flows in Biological Systems
(Same subject as 2.795J, 6.561J, 10.539J, HST.544J)
Prereq: 6.013, 2.005, 10.302, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.

M. Bathe, A. J. Grodzinsky

20.440 Analysis of Biological Networks
Prereq: Permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Conceptual and experimental approaches to analyzing complex biological networks and systems, from molecules to human populations, focusing on human pathophysiology and disease. Moving from single component analysis to pathways and networks, combines didactic lectures with in-depth analysis of current literature. Emphasizes the chemistry and biochemistry of underlying biological processes. Topics include linking genes/SNPs to disease, defining pathways, analysis of pathways in vivo, systems-level analysis, and applications of network biology. First half of term focuses on fundamental biological processes and tools/analyses needed by biological engineers, and the second half elaborates on these fundamentals by covering complex biological processes. Students acquire skills in the fundamentals of grant preparation using an NIH format and make an oral presentation.

P. C. Dedon, B. Engelward

20.441J Biomaterials: Tissue Interactions
(Subject meets with 2.79J, 3.96J, HST.522J)
Prereq: Chemistry (GIR), Biology (GIR), Physics I (GIR); or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Principles of materials science and cell biology underlying the design of medical implants, artificial organs, and matrices for tissue engineering. Methods for biomaterials surface characterization and analysis of protein adsorption on biomaterials. Molecular and cellular interactions with biomaterials are analyzed in terms of unit cell processes, such as matrix synthesis, degradation, and contraction. Mechanisms underlying wound healing and tissue remodeling following implantation in various organs. Tissue and organ regeneration. 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

20.442 Molecular Structure of Biological Materials
(Subject meets with 20.342)
Prereq: 5.07 or 7.05; permission of instructor
G (Fall)
3-0-9
See description under subject 20.342. Graduate students are expected to complete additional coursework.

S. Zhang

20.445J Methods and Problems in Microbiology
(Same subject as 1.86J, 7.492J)
Prereq: Permission of instructor or Coreq: 7.493
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 7.492J.

L. Samson, M. Polz

20.446J Microbial Genetics and Evolution
(Same subject as 1.87J, 7.493J)
Prereq: 7.03, 7.05, 7.28 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 7.493J.

A. D. Grossman, M. Polz, E. Alm

20.450 Molecular and Cellular Pathophysiology
Prereq: 20.420, 20.440; or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Fundamentals of tissue and organ response to injury are examined from a molecular and cellular perspective. Special emphasis on disease states that bridge infection, inflammation, immunity, and cancer. Systems approach to pathophysiology includes lectures, critical evaluation of recent scientific papers, and student projects and presentations.

J. C. Niles, K. Ribbeck

20.451J Design of Medical Devices and Implants
(Subject meets with 2.782J, 3.961J, HST.524J)
Prereq: Chemistry (GIR), Biology (GIR), Physics I (GIR); or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.782J.

I. V. Yannas, M. Spector

20.452J Principles of Neuroengineering
(Same subject as 9.422J, MAS.881J)
Prereq: 8.03, 6.003, 9.01; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.881J.

E. S. Boyden, III

20.454J Neurotechnology Ventures
(Same subject as 9.455J, 15.128J, MAS.883J)
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
See description under subject MAS.883J.

E. S. Boyden, R. Ellis-Behnke, J. Bonsen

20.462J Molecular Principles of Biomaterials
(Subject meets with 3.962J)
Prereq: 3.051J, 20.340J
G (Spring)
3-0-9 H-LEVEL Grad Credit
Analysis and design at a molecular scale of materials used in contact with biological systems, including biotechnology and biomedical engineering. Topics include molecular interactions between bio- and synthetic molecules and surfaces; design, synthesis, and processing approaches for materials that control cell functions; and application of state-of-the-art materials science to problems in tissue engineering, drug delivery, biosensors, and cell-guiding surfaces.

Staff

20.463J Biomaterials Science and Engineering (New)
(Subject meets with 3.963J)
Prereq: 3.034, 20.110, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.963J.

D. Irvine, K. Ribbeck

20.470J Cellular Biophysics
(Subject meets with 2.794J, 6.521J, HST.541J)
Prereq: Physics II (GIR); 18.03, 6.002, 6.003, 6.017, 10.301, 20.110, or permission of instructor
G (Fall)
5-2-5 H-LEVEL Grad Credit
See description under subject 6.521J.

D. M. Freeman, J. Han
20.471J Quantitative Physiology: Organ Transport Systems
(Same subject as 2.796J, 6.522J)
(Subject meets with 2.792J, 6.022J, 20.371J, HST.542J)
Prereq: 2.006 or 6.013; 6.021
G (Spring)
4-2-6 H-LEVEL Grad Credit
See description under subject 6.522J).
R. G. Mark, C. M. Stultz

20.472J Neuroimaging Cells and Circuits
(Same subject as 9.472J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9
See description under subject 9.472J.
A. Jasanoff, P. T. So

20.482J Foundations of Algorithms and Computational Techniques in Systems Biology
(Same subject as 6.581J)
(Subject meets with 6.503)
Prereq: 6.021, 6.034, 6.046, 6.336, 7.911, 18.417, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.581J.
A. Jasanoff, P. T. So

20.483J Noninvasive Imaging in Biology and Medicine
(Same subject as 9.173J, 22.56J, HST.561J)
Prereq: 18.03, 8.03, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.56J.
A. Jasanoff

20.486J Case Studies and Strategies in Drug Discovery and Development
(Same subject as 7.549J, 15.137J, HST.916J)
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
The stages in drug discovery and development begin with target identification and end with the submission of preclinical and clinical data to the regulatory authorities. Following identification of a lead compound, there is optimization of structures for pharmaceutical properties, bioavailability, and safety. Subject relies on actual cases presented by the scientist(s) involved in discovery and drug development. A major goal is to analyze the cases and determine how the discovery and development process might be influenced by new and future technologies.
S. R. Tannenbaum, A. J. Sinskey, A. Wood

20.487J Optical Microscopy and Spectroscopy for Biology and Medicine
(Same subject as 2.715J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9
See description under subject 2.715J.
P. T. So, C. Sheppard

20.490J Foundations of Computational and Systems Biology
(Same subject as 7.911J)
(Subject meets with 7.36)
Prereq: Biology (GIR); 7.05 or 5.07; 1.00, 1.001, or 6.00; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 7.36.
C. Burge, A. Keating, E. Fraenkel

20.507J Biological Chemistry I
(Same subject as 5.071J)
Prereq: 5.12
U (Fall)
5-0-7 REST
See description under subject 5.07J.
J. Essigmann, J. Stubbe

20.554J Frontiers in Chemical Biology
(Same subject as 5.54J, 7.540J)
Prereq: 5.13, 5.07, 7.06, permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 5.54J.
B. Imperiali

20.901 Special Topics in Toxicology and Environmental Health
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Program of study to be arranged by the student and a BE faculty member, leading to the writing of a substantive paper. Minimum of 12 units required.
Staff

20.902 Independent Study in Biological Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
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 12 units required.
Staff

20.920 Practical Work Experience
Prereq: None
U (Fall, IAP, Spring, Summer)
0-1-0 [P/D/F]
For Course 20 students participating in off-campus work experiences in biological engineering. Before registering for this subject, students must have an employment offer from a company or organization and must identify a BE 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 undergraduate office.
Staff

20.950 Research Problems in Biological Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Directed research in the fields of bioengineering and environmental health. Open only to BE students.
Staff

20.951 Thesis Proposal
Prereq: Permission of instructor
G (Fall, Spring, Summer)
0-24-0 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
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 H-LEVEL Grad Credit
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.EPW UPOP IAP Workshop**  
Engineering School-Wide Elective Subject  
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 22.EPW)  
Prereq: None  
U (IAP)  
3-0-0 [P/D/F]  
See description under subject 2.EPW.  
S. Luperfoy

Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Opportunity for individual or group study of biological engineering not otherwise included in the curriculum. To be arranged by the student and a faculty member.  
Staff

**20.S952 Special Topics in Biological Engineering (20.952)**  
Prereq: Permission of instructor  
G (Fall, IAP, Spring)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
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, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
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.UR Undergraduate Research Opportunities**  
Prereq: None  
U (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

**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.  
S. Manalis

**20.URN Undergraduate Research**  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
0-1-0  
Can be repeated for credit  
Staff
# Bachelor of Science in Biological Engineering/Course 20

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**: 17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Course 20 Program

### Required Core Subjects

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
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<tbody>
<tr>
<td>18.03 Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>20.110J Thermodynamics of Biomolecular Systems</td>
<td>12</td>
</tr>
<tr>
<td>or 20.111J Physical Chemistry of Biomolecular Systems</td>
<td>12</td>
</tr>
<tr>
<td>5.12 Organic Chemistry</td>
<td>12</td>
</tr>
<tr>
<td>20.109J Laboratory Fundamentals in Biological Engineering</td>
<td>15</td>
</tr>
<tr>
<td>7.05 Genetics</td>
<td>12</td>
</tr>
<tr>
<td>7.01J Introduction to Computer Science and Programming</td>
<td>12</td>
</tr>
<tr>
<td>7.05J General Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>7.06 Cell Biology</td>
<td>12</td>
</tr>
<tr>
<td>20.310J Molecular, Cellular, and Tissue Biomechanics</td>
<td>12</td>
</tr>
<tr>
<td>20.320J Analysis of Biomolecular and Cellular Systems</td>
<td>12</td>
</tr>
<tr>
<td>20.330J Fields, Forces, and Flows in Biological Systems</td>
<td>12</td>
</tr>
<tr>
<td>20.380J Biological Engineering Design</td>
<td>12</td>
</tr>
</tbody>
</table>

### Restricted Electives (Tracks TBD)

- 21–24

### Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>(36)</td>
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### Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
</tr>
</tbody>
</table>

### Total Units Beyond the GIRs Required for SB Degree

No subject can be counted both as part of the 17-subject GIRs and as part of the 192 units required beyond the GIRs. Every subject in the student’s Departmental Program will count toward one or the other, but not both.

## Notes

* Alternate prerequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
To register for individual research or thesis in a specific humanities section, see the end of the section’s subject listing.

21.THT Humanities Pre-Thesis Tutorial
Prereq: As specified for particular field
U (Fall, Spring)
1-0-5
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.
Consult D. K. Fitzgerald

21.THU Undergraduate Thesis in Humanities
Prereq: 21.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 most students in Course 21 and those doing 21-E and 21-S degrees.
Consult D. K. Fitzgerald

21.UR Research in Humanities
Prereq: None
U (Fall, Spring)
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 D. K. Fitzgerald

Bachelor of Science in Humanities/Course 21

General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Distribution subjects can be satisfied by subjects in the Departmental Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Total GIR Subjects Required for SB Degree

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication Requirement</td>
<td>17</td>
</tr>
</tbody>
</table>

German
Eight elective subjects in the field (which may include a pre-thesis and a thesis), plus a four-subject cluster

To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take 21F.406 and 21F.407. Registration for 21F.406 and 21F.407 must be simultaneous with one of 21F.409, 21F.410, 21F.412, 21F.414, 21F.415, 21F.416, or 21F.420.

Major Departures
The restricted electives for the major departure fields are determined in consultation with the faculty advisor in the chosen field. Major departures are available in American Studies, Ancient and Medieval Studies, Asian and Asian Diaspora Studies, Latin American and Latino Studies, Russian and Eurasian Studies, Theater Arts, and Women’s and Gender Studies.

Each major departure program must include two Communication Intensive major subjects, usually chosen from the subjects designated as CI-M for major programs in adjacent disciplines.

Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>126–162</td>
</tr>
</tbody>
</table>

Notes
(1) Only one subject used to meet the distribution element of the Humanities, Arts, and Social Sciences Requirement may be counted toward the humanities component of these degree programs.
(2) The cluster is usually formed within a single second discipline of the humanities, arts, or social sciences. In special cases, it may draw together subjects from different disciplines to form a coherent grouping.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
### Bachelor of Science in Humanities and Engineering/Course 21E, Bachelor of Science in Humanities and Science/Course 21S

#### General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [all but two Humanities,</td>
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</tr>
<tr>
<td>Arts, and Social Sciences Distribution subjects can be satisfied by subjects</td>
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<tr>
<td>in the Departmental Program</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M). Students must designate CI-M subjects by petitioning the Subcommittee on the Communication Requirement. Each 21E and 21S program must include two CI-M subjects. Normally, students are expected to complete one CI-M from each area of study, usually chosen from the subjects designated as CI-M for the full major.

#### PLUS Departmental Program

**Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).**

**Restricted Electives**

For the humanities component, one of the following (further details may be obtained from the descriptions of programs in specific fields and the relevant field office):

**American Studies**(2) 81–102

Seven elective subjects (including two in history and two in literature), a pre-thesis tutorial, and a thesis. Students may submit a request to the American Studies faculty advisor to substitute two classes in lieu of the pre-thesis and thesis.

**Ancient and Medieval Studies**(2) 81–102

Seven elective subjects (should follow the general structure of the Ancient and Medieval Studies Minor Program), a pre-thesis tutorial, and a thesis.

**Anthropology** 102–108

Nine subjects including 21A.100 or 21A.109, 21A.510, and 21A.512. An honors thesis may be done at the invitation and approval of faculty.

**Asian and Asian Diaspora Studies**(2) 81–102

Seven elective subjects (should follow the general structure of the Asian and Asian Diaspora Studies Minor program), a pre-thesis tutorial, and a thesis.

**Comparative Media Studies** 81–102

Eight CMS subjects, including 21L.011 or CMS.100, one mid-tier subject (CMS.400, CMS.403, CMS.405, or CMS.407), one capstone subject (21L.706 or 21L.753), and five CMS electives. A pre-thesis tutorial (CMS.ThT) and thesis (CMS.ThU) may be substituted for one CMS elective.

**Foreign Languages and Literatures (in French, German, or Spanish)** 81–102

Nine elective subjects, which may include a pre-thesis and thesis, subject to faculty approval.

**History** 81–102

Seven elective subjects, a pre-thesis tutorial, and a thesis.

**Latin American and Latino Studies**(2) 81–102

Introduction to Latin American Studies (21F.084J/17.55J/21A.430J) plus six elective subjects (including study in at least two disciplines and some work in Spanish or Portuguese language), a pre-thesis tutorial and a thesis.

**Literature** 96

Eight elective subjects (including two seminars and subjects in three historical periods or thematic complexes).

**Music** 96

Four subjects (21M.301, 21M.302, 21M.500, and one of the following: 21M.220, 21M.235, 21M.250, or 21M.260), two terms of performance subjects, electives in two categories (usually theory/composition and history/literature), and a third elective in any category (theory/composition, history/literature, or two terms of performance).

**Russian and Eurasian Studies**(2) 81–102

Seven elective subjects (including Russian language requirement), a pre-thesis tutorial, and a thesis.
Science, Technology, and Society (STS)  
Eight subjects (including at least one STS Tier I subject, at least one Tier II subject, and STS.091), plus a pre-thesis tutorial and a thesis.  
96–114

Theater Arts  
Eight subjects (including Script Analysis, Theater Practicum, and Stagecraft), a pre-thesis tutorial, and a thesis.  
90–108

Women’s and Gender Studies  
Seven subjects (including WGS.101 Introduction to Women’s and Gender Studies), a pre-thesis tutorial, and a thesis. Students may submit a request to the Women’s and Gender Studies director to substitute two classes in lieu of the thesis and pre-thesis.  
81–102

Writing: Creative  
Seven subjects centered in creative or expository writing (one of these subjects is normally at the introductory level, one may be chosen from a related field), a pre-thesis tutorial, and a thesis.  
93–102

Writing: Digital Media  
Three subjects in digital media (21W.764, 21W.765J, and 21W.785), a C-I-M subject in writing, and three related subjects from another department.  
93–102

Writing: Science Writing  
Six subjects in writing (including 21W.777, 21W.778, 21W.792, a subject in basic exposition, and a subject in digital media), one approved science, technology, and society subject, a pre-thesis tutorial, and a thesis.  
96–102

And for the engineering/science component, one of the following:

For 21E  
Six elective subjects restricted to one of the engineering curricula and approved by a faculty member in the field.  
54–72

For 21S  
Six elective subjects restricted to one of the science curricula and approved by a faculty member in the field.  
54–72

Departmental Program Units That Also Satisfy the GIRs  
Unrestricted Electives  
(54–72)  
54–103

Total Units Beyond the GIRs Required for SB Degree  
180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes on 21E and 21S

1. As a matter of general Course 21 policy, subjects used to meet the General Institute Science Requirement, the REST Requirement, and the Laboratory Requirement may not be included in the six-subject Engineering or Science component of 21E or 21S degrees. Only one subject being used to meet the distribution element of the Humanities, Arts, and Social Sciences Requirement may be counted toward the humanities component of these degree programs.

2. American Studies, Ancient and Medieval Studies, Asian and Asian Diaspora Studies, Latin American and Latino Studies, Russian and Eurasian Studies, Theater Arts, and Women’s and Gender Studies are also available as full majors with the Dean of the School of Humanities, Arts, and Social Sciences.

3. Russian language subjects are not offered at MIT, but may be taken at Harvard University or Wellesley College through cross-registration.

4. When possible, the subject satisfying the Institute Laboratory Requirement and one of the subjects satisfying the REST Requirement should be selected from this same curriculum, in addition to the regular requirement.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
The anthropology subjects described below are grouped within seven areas: Introductory, Social Anthropology, Technology in Cultural Context, Areal and Historical Studies, Advanced Undergraduate, Special Subjects and Topics, and Graduate Subjects and Topics.

**UNDERGRADUATE SUBJECTS**

**Introductory**

**21A.100 Introduction to Anthropology**
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 4)

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.109 How Culture Works**
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-D 4); CI-H

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 experience, such as gender, ethnicity, language, politics, economics, and art.

M. Buyandelger

**21A.113J The Supernatural in Music, Literature and Culture**
(Same subject as 21L.013J, 21M.013J)
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-D 3); CI-H

See description under subject 21M.013J.

C. Shadle, J. Howe, M. Fuller

**21A.114J Black Matters: Introduction to Black Studies**
(Same subject as 24.912J, 21H.106J, 21L.008J, 21W.741J, WGS.190J)
Prereq: None
U (Spring)
3-0-9 HASS-A, HASS-H (HASS-D 4); CI-H

See description under subject 24.912J.

A. Braithwaite, M. DeGraff

**Social Anthropology**

**21A.210 Magic, Science, and Religion (New)**
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

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.215 Disease and Health: Culture, Society, and Ethics**
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 4); CI-H

Examines how medicine is practiced cross-culturally, with particular emphasis on Western biomedicine. Analyzes medical practice as a cultural system, focusing on the human, as opposed to the biological, side of things. Also considers how people in different cultures think of disease, health, body, and mind. Enrollment limited.

J. Jackson

**21A.216J Dilemmas in Biomedical Ethics: Playing God or Doing Good?**
(Same subject as WGS.271J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

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

**21A.218J Identity and Difference**
(Same subject as WGS.170J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E); CI-H

Examines several theoretical perspectives on human identity and focuses on processes of creating categories of acceptable and deviant identities; how identities are formed, how behaviors are labelled, and how people enter deviant roles and worlds; and responses to differences and strategies for coping with these responses. Describes how identity and difference are inescapably linked. Enrollment limited.

J. Jackson

**21A.219J Law and Society**
(Same subject as 11.163J, 17.249J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)

Studies legal reasoning, types of law and legal systems, and relationship of law to social class and social change. Emphasis on the profession and practice of law including legal education, stratification within the bar, and the politics of legal services. Investigation of emerging issues.
in the relationship between institutions of law and science.

S. Silbey

21A.225J Violence, Human Rights, and Justice
(Same subject as WGS.270J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)

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

21A.229 Introduction to Disability in Local and Global Contexts (New)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)

Challenges common assumptions of what disability is. Considers broader questions through the lens of disability, about international development, human rights, citizenship, identity, and community formation. Students read diverse texts, such as human rights documents, ethnographies, autobiographies, and social theory. Discusses whether a universal disability experience exists, as well as issues and tensions involved in writing about and representing disability.

M. Friedner

21A.226 Ethnic and National Identity
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-D 4); CI-H

An introduction to the cross-cultural study of ethnic and national identity. Students explore the history of nationalism, focusing on ideologies about the nation-state, and look at the ways gender, religious and racial identities intersect with ethnic and national ones. Ethnic conflict is examined, along with the emergence of social movements based on identity, in particular indigenous rights movements and the ways culture can become highly politicized. Finally, students discuss the effects of globalization, migration, and transnational institutions. Enrollment limited.

J. Jackson

21A.228 Practicum in Global Health and Development (New)
Prereq: None
U (Spring)
3-3-6 HASS-S (HASS-E)

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.

E. C. James

21A.235 American Dream: Exploring Class in the US
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

Americans have historically preferred to think of the United States in classless terms, as a land of economic opportunity equally open to all. Yet, social class remains a central fault line in the US. Subject 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

21A.236 What is Capitalism? (New)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)

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.

C. Walley

21A.242J The Science of Race, Sex, and Gender
(New)
(Same subject as WGS.225J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

See description under subject WGS.225J.

A. Sur, S. Helmreich

21A.245J Power: Interpersonal, Organizational and Global Dimensions
(Same subject as 17.045J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

Using examples from anthropology and sociology alongside classical and contemporary social theory, subject explores the nature of dominant and subordinate relationships, types of legitimate authority, and practices of resistance. Examines how we are influenced in subtle ways by the people around us, who makes controlling decisions in the family, how people get ahead at work, and whether democracies, in fact, reflect the will of the people.

S. Silbey

21A.252 Memory, Culture, and Forgetting
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

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
Anthropology

21A.253 Religion, Violence, and Media
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

 Approaches to the socio-cultural study of religion. Provides conceptual tools for analyzing the resilience and diversity of religious experience in the face of large socio-economic and political change. Traces the connections between contemporary religious resurgence and violence, displacement, globalization, economic insecurity, and ethnic and national identity. Cases include Catholic conversion via mass media in the Philippines; a rise in witchcraft in post-apartheid South Africa; underground Protestantism in the atheistic Soviet Union; “spiritual shopping” in the United States.

M. Buyandelger

21A.265 Food and Culture
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)

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.

H. Paxson

21A.270 Anthropology through Speculative Fiction
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

Examines how anthropology and speculative fiction (SF) each explore ideas about culture and society, technology, morality, and life in “other” worlds. Investigates this convergence of interest through analysis of SF in print, film, and other media. Covers traditional and contemporary anthropological themes, including first contact; gift exchange; gender, marriage, and kinship; law, morality, and cultural relativism; religion; race and embodiment; politics, violence, and war; medicine, healing, and consciousness; technology and environment.

E. C. James, S. Helmreich

21A.275 Fun and Games: Cross-Cultural Perspectives
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

Considers 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.290 Cross-Cultural Investigations: Practical and Conceptual Issues (New)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

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.

H. Paxson

Language and Technology

21A.262 Language and Technology
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

Introductory exploration of documentary film theory and production, focusing on documentaries about science, engineering, and related fields. Students engage in digital video production as well as social and media analysis of science documentaries. Readings drawn from social studies of science as well as from documentary film theory. Uses documentary video making as a tool to explore the worlds of science and engineering, as well as a tool for thinking analytically about media itself and the social worlds in which science is embedded. Class includes a lab component devoted to digital video production in addition to class time. Enrollment limited.

C. Walley, C. Boebel

21A.330 Reproductive Politics and Technologies
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

Examines through comparative case studies how cultural, moral, and political values give meaning to human reproductive events and inform people’s uses of medical technologies. Focuses on how technological mediations of fertility, pregnancy and birth (e.g., contraception, abortion, in vitro fertilization, prenatal testing, etc.) offer opportunities for the formation of gender and kinship, the reproduction of social inequalities, and the implementation of national population and international development agendas. Considers how bioethical evaluation of reproductive technologies might take into account the motivations and experiences of actual users.

H. Paxson

21A.335J Language and Technology
(Same subject as 24.913J, STS.070J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E); CI-H

Examines cultural impact of communication technologies, from basic literacy to cell phones, and computer-based social networks on patterns of verbal interaction. Introduces theories and methods of linguistic anthropology pertinent to technologies that make it possible for people to communicate across distances in space and time. Students develop their own research projects exploring the cultural dimensions of technologically enhanced communication. Enrollment limited.

G. Jones

21A.339J DV Lab: Documenting Science through Video and New Media
(Same subject as STS.064J)
Prereq: None
U (Fall)
3-3-6 HASS-S (HASS-E)

Introductory exploration of documentary film theory and production, focusing on documentaries about science, engineering, and related fields. Students engage in digital video production as well as social and media analysis of science documentaries. Readings drawn from social studies of science as well as from documentary film theory. Uses documentary video making as a tool to explore the worlds of science and engineering, as well as a tool for thinking analytically about media itself and the social worlds in which science is embedded. Class includes a lab component devoted to digital video production in addition to class time. Enrollment limited.

C. Walley, C. Boebel

21A.340J Technology and Culture
(Same subject as STS.075J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)

Examines 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.

K. Downes

21A.341J Energy Decisions, Markets, and Policies
(Same subject as 11.161J, 14.43J, 15.031J)
Prereq: 14.01 or permission of instructor
U (Spring)
3-0-9 HASS-S (HASS-E)

See description under subject 15.031J.
D. Lessard, R. Schmalensee

21A.342 Environmental Struggles
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

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.344J Drugs, Politics, and Culture
(Same subject as STS.062J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)

Examines the relationship between drugs, politics, and society in cross-cultural perspective; use of mind-altering and habit-forming substances by “traditional societies”; the development of a global trade in sugar, opium, and cocaine with the rise of capitalism; and the development of a global trade in sugar, opium, substances by “traditional societies”; the politics, and society in cross-cultural perspective.

21A.345 The Politics of International Development
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-D 4)

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 national parks in Indonesia.
C. Walley

21A.349J Advanced DV Lab: Documenting Science through Video and New Media (New)
(Same subject as STS.068J)
Prereq: 21A.339) or permission of instructor
U (Fall)
3-3-6 HASS-S (HASS-E)

Advanced exploration of documentary film theory and production that offers a social scientific perspective on documentaries about science, engineering, and related fields. Student work focuses on final digital video projects. Discussion and readings tailored to the questions and issues raised by specific student projects; labs focus on the technical skills required to complete more advanced work. Enrollment limited.
C. Walley, C. Boebel

21A.350J Cultures of Computing
(Same subject as STS.086J, WGS.276J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

Examines 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 commoditization 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.
S. Helmreich

21A.355J The Anthropology of Biology
(Same subject as STS.060J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)

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 as bioterrorism, genetic modification, and cloning. Offers an anthropological inquiry into how the substances and explanations of biology—ecological, organismic, 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.360J The Anthropology of Sound
(Same subject as STS.065J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

Credit cannot also be received for CMS.407

Examines the ways humans experience sound and how perceptions and technologies of sound emerge from cultural, economic, and historical worlds. Consider how the sound/noise boundary has been imagined, created, and modeled across sociocultural and scientific contexts. Learn how environmental, linguistic, and musical sounds are construed cross-culturally as well as the rise of telephony, architectural acoustics, sound recording, and the globalized travel of these technologies. Questions of sound ownership, property, authorship, and copyright in the digital age are also addressed.
S. Helmreich

21A.370J Art, Craft, Science
(Same subject as STS.074J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)

Examines how people learn, practice, and evaluate traditional and contemporary craft techniques. Social science theories of design,
embody, 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.

H. Paxson

21A.385 Becoming Experts
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
Examines how people acquire the skills necessary to perform expert activities, using apprenticeship as a subject and method for anthropological research. Case studies cover theories of learning and their application in a wide range of domains, from medical imaging, lawyering, and navigating a warship to capoeira, dance, and jazz piano. Students conduct ethnographic and experiential activities, generating original data for analysis.

G. Jones

21A.390J People and Other Animals
(Same subject as 21H.380J)
(Subject meets with 21A.835J, 21H.980J)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
2-0-10 HASS-S (HASS-E)
See description under subject 21H.380J.

H. Ritvo

21A.430J Introduction to Latin American Studies
(Same subject as 17.55J, 21F.084J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 4); CI-H
See description under subject 17.55J.

C. Lawson, M. Nobles

21A.470J Gender and Representation of Asian Women
(Same subject as WGS.274J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
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.475 Cultures and Political Economies of East Asia (New)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
Explores diverse cultures and political economies in East Asian countries, such as China, Japan, Korea, and Mongolia, with additional examples from the surrounding regions of South and Southeast Asia. Examines the different ways people in these regions experience and make sense of globalization, capitalism, neoliberalism, economic development, and modernization. Readings include 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 how mining is creating new economic and cultural dilemmas in Mongolia.

M. Buyandelger

21A.510 Seminar in Anthropological Theory
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS-S (HASS-E)
Focuses on core issues and approaches in anthropological theory and method. Studies theoretical frameworks for the analysis and integration of material from other subjects in cultural anthropology. Reading and discussion of classics of anthropological theory and contemporary critiques. Students prepare and present analyses of texts. Preference to Anthropology majors and minors.

J. Jackson

21A.512 Seminar in Ethnography and Fieldwork
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-S (HASS-E)
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.

G. Jones

Other Undergraduate Subjects

21A.650–21A.652 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 fieldwork 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. HASS credit awarded only by individual petition to the Subcommittee on the HASS Requirement; minimum of 9 units required for HASS credit.

Consult Program Head

21A.S61–21A.S64 Special Subject in Anthropology
Prereq: None
U (Fall, IAP, Spring, 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
21A.750J Social Theory and Analysis
(Same subject as STS.250J)
Prereq: None
G (Fall)
3-0-9
Major theorists and theoretical schools since the late 19th century. Marx, Weber, Durkheim, Bourdieu, Levi-Strauss, Geertz, Foucault, Gramsci, and others. Key terms, concepts, and debates.
M. Fischer

21A.760J Qualitative Research Methods
(Same subject as 15.349J)
Prereq: None
G (Spring)
3-6-3
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.
G. Jones

21A.790J Ethics of Intervention: Anthropological Approaches
(Same subject as 11.238J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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

21A.795 Seminar in Readings on Law and Society
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores the historical and contemporary literature, theoretical and empirical, tracking the roles of law in society as a common yet distinctive aspect of everyday life. Focuses on law as a social institution, a system, and as a feature of popular culture. Highlights the relationship between the internal logic of legal devices and economic, political, and social processes and change. Emphasizes law as a practical resource, a mechanism for handling a wide range of unspecified social issues, problems, and conflicts, and at the same time, as a set of limited although shared representations and aspirations.
S. Silbey

21A.800J Environmental Conflict and Social Change
(Same subject as STS.320J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.820J Ethnography
(Same subject as STS.360J)
Prereq: Permission of instructor; Coreq: 21A.750J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject STS.360J.
M. Fischer

21A.830J History and Anthropology of Medicine and Biology
(Same subject as STS.330J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject STS.330J.
D. Jones, S. Helmreich

21A.835J People and Other Animals
(Same subject as 21H.980J)
(Subject meets with 21A.390J, 21H.380J)
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
0-2-10
See description under subject 21H.380J.
H. Ritvo
21A.840J Food and Power  
(Same subject as STS.429J)  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject STS.429J.  
H. Paxson

21A.861 Methods for Graduate Research in the Social Sciences  
(Subject meets with 15.347)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Foundations of good empirical research in the social sciences. Introduction to the basic assumptions and underlying logic of both quantitative and qualitative methodologies. Explores a variety of approaches to research design, evaluates the products of empirical research, and practices several common techniques. Students develop a framework for their own research project.  
R. Fernandez

21A.900J Monitoring the Rights of Native Peoples  
(Same subject as 11.498J)  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-4-5  
Participation in the process of examining and assessing human rights. Students research the situation of indigenous peoples in a country scheduled for the United Nations Universal Periodic Review, write a comprehensive assessment, and submit a brief to the UPR Working Group. When funds allow, students will visit the country in question and/or attend a UPR session in Geneva. Topics include indigenous peoples and states, the politics of human rights, development and environmental politics, and indigenous organizing.  
J. Howe

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.997–21A.999 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.S91–21A.S94 Special Graduate Subject in Anthropology  
Prereq: None  
G (Fall, IAP, Spring, Summer)  
Units arranged  
Seminar or lecture on a topic in anthropology that is not covered in the regular curriculum.  
Staff
# Bachelor of Science in Anthropology/Course 21A

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement (three subjects may be satisfied by subjects in the Departmental Program)</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**: 17

## Communication Requirement

The program includes a Communication Requirement of 4 subjects: 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and 2 subjects designated as Communication Intensive in the Major (CI-M).

## PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

### Required Subjects

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21A.100 Introduction to Anthropology, 12, HASS-S†</td>
<td>12</td>
</tr>
<tr>
<td>21A.109 How Culture Works, 12, HASS-S†</td>
<td>12</td>
</tr>
<tr>
<td>21A.510 Seminar in Anthropological Theory, 12, HASS-S, CI-M *</td>
<td>12</td>
</tr>
<tr>
<td>21A.512 Seminar in Ethnography and Fieldwork, 12, HASS-S, CI-M *</td>
<td>12</td>
</tr>
</tbody>
</table>

**Total Units Beyond the GIRs Required for SB Degree**: 180

*No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

### Notes

*Prerequisites and corequisites are listed in the subject description.

† Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Special note for students who entered MIT prior to Fall 2010: A variety of literature subjects given in the original language, as well as some that are taught in English, may be counted toward the HASS-D requirement. In addition, students may substitute one language subject at Level III or IV (i.e., 21F.303 or 21F.304) for one HASS-D subject. The two remaining HASS-Ds may be chosen from any two of the five HASS-D categories.

For subjects in English Language Studies, see 21F.211–21F.240.

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 do work in comparative studies. A significant number of subjects also allow students to study works from a single foreign country.

21F.010 Introduction to European and Latin American Fiction
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-D 1); 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

21F.011 Topics in Indian Popular Culture
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E); 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

21F.019 Communicating Across Cultures
(Subject meets with 21F.021)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E); CI-H
21F.021 Communicating Across Cultures
(Subject meets with 21F.019)
Prereq: None
G (Spring)
3-0-9
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

21F.022J International Women’s Voices
(Same subject as 21L.522J, WGS.141J)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 1); CI-H
See description under subject 21L.522J.
M. Resnick

21F.023 Women’s Voices: An International Perspective
Prereq: None
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9
Introduces students to fictional works by contemporary women writers. Subject’s international perspective emphasizes the extent to which each author’s work reflects her distinct cultural heritage and to what extent, if any, we can identify a female voice that transcends national boundaries. Interpretive perspectives, including sociohistorical, psychoanalytic, and feminist criticism. Authors include: Mariama Bâ, Isabel Allende, Hong Kingston, Toni Morrison, Alifa Rijaat, Nawal Al-Saadawi, Yang Jiang, Anita Desai, and Sawako Ariyoshi. Taught in English.
M. Resnick

21F.024J The Linguistic Study of Bilingualism
(Same subject as 24.906J)
Prereq: 24.900
U (Fall)
3-0-9 HASS-S (HASS-E); CI-H
See description under subject 24.906J.
S. Flynn

21F.027J Asia in the Modern World: Images and Representations
(Same subject as 21H.250J)
(Subject meets with 21F.590)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 5); CI-H
Studies how visual images shape the identity of peoples, cultures, and events in Asia. Uses prototype digital projects as case studies to introduce the conceptual and practical issues involved in “visualizing cultures.” Projects look at American, Chinese, and Japanese graphics depicting contacts between Asia and the West
in the 19th and early 20th centuries. Taught in English. Enrollment limited.
S. Miyagawa, J. Dower

21F.029J Exploring Identity through Asian American Literature
(Subject meets with 21L.029J)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 4); CI-H
Explores a range of topics related to Asian American identity and cultural politics through discussion of literature (fiction and nonfiction). Topics include immigration, assimilation, cultural or biracial identity, affirmative action, Asian Americans in the workplace, and interracial dating and marriage. Examines cultural debates surrounding various identity labels, including “banana,” “AZN,” and “FOB.” Taught in English.
E. Teng

21F.030J East Asian Culture: From Zen to Pop
(Subject meets with WGS.236J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
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

21F.036 Advertising and Popular Culture: East Asian Perspectives
(Subject meets with 21F.190, CMS.888)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
Examines modern advertising culture in East Asia and India with an emphasis on post-socialist China. Topics include the rise of transnational advertising agencies in East Asia since the 1980s; advertising and identity formation; the production of brand culture and its impact on youth culture; music marketing; the new paradigm of neo neo-tribes; media and advertising; and mobile culture and branding. Includes case studies of advertising campaigns and lab sessions on how to brand products. Taught in English. Students taking graduate version complete additional assignments.
J. Wang

21F.038 The Cultural Politics of Contemporary China
(Subject meets with 21F.194)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
Introduction to the study of modern and contemporary China and its context in the Chinese-speaking world. Themes include debates over “Cultural China” and “Chineseness”; state and (flexible) citizenship, and contemporary Mao Zedong fever; gender and the politics of pornography; the consumer revolution, leisure, and popular culture; ethnic minorities, globalization, and local responses. Students watch documentaries and feature films, and read essays that highlight dramatic moments in the transformation of Chinese societies in East Asia. Taught in English.
J. Wang

21F.039 Japanese Popular Culture
(Subject meets with 21F.591)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
Examines Japanese popular culture as a way of understanding the changing character of media, capitalism, fan communities, and cultural differences. Topics include manga (comic books), hip-hop and other popular music in Japan, anime (Japanese animated films) and feature films, sports (sumo, soccer, baseball), and online communication. Emphasizes contemporary popular culture and theories of gender, sexuality, race, and the workings of power in global culture industries. Several films screened outside of regular class meeting times. Taught in English.
E. Teng

21F.040 A Passage to India: Introduction to Modern Indian Culture and Society
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
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.
S. Banerjee

21F.043J Introduction to Asian American Studies: Historical and Contemporary Issues
(Subject meets with 21H.107J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 5); CI-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.
E. Teng

21F.044J Classics of Chinese Literature in Translation
(Subject meets with 21F.195)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
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

21F.046 Modern Chinese Fiction and Cinema
(Subject meets with 21F.192)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E); 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

21F.052 French Film Classics  
Prereq: None  
Acad Year 2011–2012: U (Fall)  
Acad Year 2012–2013: Not offered  
2-2-8 HASS-H (HASS-E)  
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 screenwriter, 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.  
E. B. Turk

21F.055 Media in Weimar and Nazi Germany  
Prereq: None  
Acad Year 2011–2012: U (Spring)  
Acad Year 2012–2013: Not offered  
2-2-8 HASS-H (HASS-E); 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

21F.059 Paradigms of European Thought and Culture  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Spring)  
3-0-9 HASS-H (HASS-D 2); 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.  
Staff

21F.060 Topics in Media and Cultural Studies  
Prereq: Permission of instructor  
Acad Year 2011–2012: U (Fall)  
Acad Year 2012–2013: Not offered  
3-0-9 HASS-H (HASS-E)  
Can be repeated for credit with permission of instructor  
In-depth study of leading theories and research in media and cultural studies from a comparative perspective. Focuses on a particular group of theorists, range of media, movement, theme, critical or theoretical issue, or analytic approach. Considers international dimensions of media and cultural studies. Taught in English.  
C. Vo

21F.063 Anime: Transnational Media and Culture  
(Subject meets with 21F.596)  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Fall)  
3-0-9 HASS-H (HASS-E)  
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

21F.064 Introduction to Japanese Culture  
(Subject meets with 21F.592)  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-H (HASS-D 4); 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.  
Fall: S. Miyagawa  
Spring: I. Condry

21F.065 Japanese Literature and Cinema  
(Subject meets with 21F.593)  
Prereq: None  
Acad Year 2011–2012: U (Fall)  
Acad Year 2012–2013: Not offered  
3-0-9 HASS-H (HASS-E); 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.  
I. Condry

21F.068J The Invention of French Theory: A History of Transatlantic Intellectual Life since 1945 (New)  
(Same subject as WGS.234J)  
Prereq: None  
U (Spring)  
3-0-9 HASS-H (HASS-E)  
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

21F.069J Race and Gender in Asian America  
(Same subject as 21H.312J, WGS.237J)  
Prereq: None  
U (Spring)  
3-0-9 HASS-H (HASS-E)  
Interdisciplinary examination of the intersection of race, gender, and class in Asian American culture from the mid-19th century to the present. Topics include media images of Asian American men and women, feminism and gender roles, women and labor issues, transnational migration, and interracial marriage. Writers may include Maxine Hong Kingston, Eric Liu, Chang-rae Lee, Jessica Hagedorn, Jhumpa Lahiri, and Shirley Geok-lin Lim. Filmmakers may include Mira Nair, Ang Lee, Wayne Wang, and Gurinder Chadha. Taught in English.  
C. Vo
21F.071 Freedom of Expression in Contemporary Europe (New)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)
Explores contemporary European identities through the lenses of conflicts and debates on freedom of expression in a globalized world. Examines European history and law, rights and anti-discrimination policies, privacy as a political ideal, art and censorship, sexual consent, religious values, pornography, offense in a digital age, etc. Specific focus on France and the United Kingdom. Taught in English.
B. Perreau

21F.074 Topics in Portuguese Popular Culture (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
Can be repeated for credit
Provides an overview of Portuguese history and culture through a variety of material, such as popular fiction, music, television, and cinema. Explores major themes and their representations in relation to current social and political issues. Taught in English.
Staff

21F.075 The Global Chinese: Chinese Migration, 1567–Present (New)
(Same subject as 21H.253)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
Examines Chinese migration in historical and comparative perspective, beginning in 1567 with the lifting of the imperial ban on private maritime trade. Covers Chinese migration to locations such as Southeast Asia, Hawaii, North America, Latin America and the Caribbean, Australia, Europe, India and Africa. Also considers Han Chinese internal migration to frontier regions like Taiwan. Topics include the varied roles of Chinese migrants in colonial, settler and frontier societies, the coolie trade, Chinese exclusion movements, transnational networks, marital and chain migration, immigrant community formation, women’s roles, second-generation “roots seeking”, the new migration, and the reciprocal relationship between contemporary Chinese migration to Africa and African migration to China. Critically examines the degree to which this transnational migration has produced a “Global Chinese” identity. Taught in English.
E. Teng

21F.076] Globalization: The Good, the Bad and the In-Between
(Same subject as 21L.020)
U (Fall)
3-0-6 HASS-H (HASS-D 4); CI-H
See description under subject 21L.020).
M. Resnick

21F.084] Introduction to Latin American Studies
(Same subject as 17.55), 21A.430)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 4); CI-H
See description under subject 17.55).
C. Lawson, M. Nobles

21F.098 Working in a Global Economy
(Same subject as 17.199)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 17.199).
S. Berger, S. Sferza

21F.099] Independent International Research Project
(Same subject as 17.921)
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
See description under subject 17.921).
S. Berger

CHINESE

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in Chinese. All first-year foreign language subjects are also offered for graduate credit.

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. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076).

Undergraduate Language Subjects

21F.101 Chinese I (Regular)
(Same subject as 21L.101, 21L.171)
Prereq: None
U (Fall, IAP)
4-0-8 HASS-H (HASS-E)
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 21F.151.
J. Zhang

21F.171 Chinese I (Regular)—Globalization
(Same subject as 21L.101, 21L.151)
Prereq: None. Coreq: 21F.076]
U (Fall)
4-0-5 HASS-H (HASS-E)
In conjunction with 21F.076, covers same material as 21L.101. See description under 21L.101. Students cannot receive credit without simultaneous completion of 21F.076).
J. Zhang

21F.102 Chinese II (Regular)
(Same subject as 21L.152)
Prereq: 21F.101, 21F.171, or permission of instructor
U (Spring)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.142
Continuation of 21F.101. For full description, see 21F.102. For graduate credit see 21F.152.
M. Liang

21F.142 Intermediate Chinese I: Very Fast Track (New)
(Subject meets with 21F.162)
Prereq: 21F.101, 21F.171, or placement test; permission of instructor
U (Spring; first half of term)
4-0-5 HASS-H (HASS-E)
Credit cannot also be received for 21F.142
Students enhance their skills in speaking, listening, reading and writing. Extension of basic grammar. Includes vocabulary and Chinese character building. Coordinated weekly small group conversation sessions. Intended to cover the equivalent of 21F.101 in half the time as well as to introduce concepts in 21F.103. Students taking the graduate version complete additional assignments. Limited to 12.
J. Zhang
21F.103 Chinese III (Regular)
(Subject meets with 21F.173)
Prereq: 21F.102 or permission of instructor
U (Fall)
4-0-8 HASS-H (HASS-L)
Credit cannot also be received for 21F.143

Continuing instruction in spoken and written Chinese, with particular emphasis on consolidating basic conversational skills and improving reading confidence and depth. Lab work required.
T. Chen, M. Liang

21F.173 Chinese III (Regular)—Globalization
(Subject meets with 21F.103)
Prereq: 21F.102 or permission of instructor; Coreq: 21F.076J
U (Fall)
4-0-5 HASS-H (HASS-E)

In conjunction with 21F.076J, covers same material as 21F.103. See description under 21F.103. Students cannot receive credit without simultaneous completion of 21F.076J.
T. Chen, M. Liang

21F.143 Intermediate Chinese II: Very Fast Track (New)
(Subject meets with 21F.163)
Prereq: 21F.142, or placement test; permission of instructor
U (Spring; second half of term)
4-0-8 HASS-H (HASS-L)
Credit cannot also be received for 21F.103

Students further develop their skills in speaking, listening, reading and writing. Includes continued vocabulary and character building. Coordinated weekly small group conversation sessions. Intended to cover the same material as 21F.103 in half the time as well as introduce concepts in 21F.104. Limited to 12.
J. Zhang

21F.104 Chinese IV (Regular)
Prereq: 21F.103, 21F.173, or permission of instructor
U (Spring)
4-0-8 HASS-H (HASS-L)

Continuation of 21F.103. For full description, see 21F.103.
T. Chen

21F.105 Chinese V (Regular): Discovering Chinese Cultures and Societies
(Subject meets with 21F.175)
Prereq: 21F.104 or permission of instructor
U (Fall)
3-0-9 HASS-H (HASS-E)

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.
T. Chen

21F.175 Chinese V (Regular)—Globalization
(Subject meets with 21F.105)
Prereq: 21F.104 or permission of instructor; Coreq: 21F.076J
U (Fall)
3-0-6 HASS-H (HASS-E)

In conjunction with 21F.076J, covers same material as 21F.105. See description under 21F.105. Students cannot receive credit without simultaneous completion of 21F.076J.
T. Chen

21F.106 Chinese VI (Regular): Discovering Chinese Cultures and Societies
Prereq: 21F.105, 21F.175, or permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-E)

Continuation of 21F.105. For full description see 21F.105.
J. Zhang

21F.107 Chinese I (Streamlined)
(Subject meets with 21F.157, 21F.181)
Prereq: 21F.108 or placement test and permission of instructor
U (Fall)
3-0-9 HASS-H (HASS-E)

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 21F.157.
M. Liang

21F.108 Chinese II (Streamlined)
(Subject meets with 21F.158)
Prereq: 21F.107 or 21F.181; or placement test and permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-E)

The second term streamlined sequence; continuation of 21F.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 21F.158.
M. Liang

21F.109 Chinese III (Streamlined)
(Subject meets with 21F.183)
Prereq: 21F.108; or placement test and permission of instructor
U (Fall)
3-0-9 HASS-H (HASS-L)

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.
J. Zhang

21F.181 Chinese I (Streamlined)—Globalization
(Subject meets with 21F.107, 21F.157)
Prereq: Placement test and permission of instructor; Coreq: 21F.076J
U (Fall)
3-0-6 HASS-H (HASS-E)

In conjunction with 21F.076J, covers same material as 21F.107. See description under 21F.107. Students cannot receive credit without simultaneous completion of 21F.076J.
M. Liang

21F.183 Chinese III (Streamlined)—Globalization
(Subject meets with 21F.109)
Prereq: Placement test and permission of instructor; Coreq: 21F.076J
U (Fall)
3-0-6 HASS-H (HASS-E)

In conjunction with 21F.076J, covers same material as 21F.109. See description under 21F.109. Students cannot receive credit without simultaneous completion of 21F.076J.
J. Zhang
21F.110 Chinese IV (Streamlined)
Prereq: 21F.109 or 21F.183; or placement test and permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-L)

Intermediate level subject in streamlined sequence; continuation of 21F.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.
T. Chen

21F.113 Chinese V (Streamlined)
(Subject meets with 21F.185)
Prereq: 21F.110; or placement test and permission of instructor
U (Fall)
3-0-9 HASS-H (HASS-E)

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.
Staff

21F.185 Chinese V (Streamlined)—Globalization
(Subject meets with 21F.113)
Prereq: 21F.110 or placement test and permission of instructor; Coreq: 21F.076
U (Fall)
3-0-6 HASS-H (HASS-E)

In conjunction with 21F.076, covers same material as 21F.113. See description under 21F.113. Students cannot receive credit without simultaneous completion of 21F.076.
Staff

Graduate Language Subjects

21F.152 Chinese II (Regular)
(Subject meets with 21F.102)
Prereq: 21F.151 or permission of instructor
G (Spring)
4-0-5

See description under subject 21F.102.
M. Liang

21F.157 Chinese I (Streamlined)
(Subject meets with 21F.107, 21F.181)
Prereq: Placement test and permission of instructor
G (Fall)
3-0-6

See description under subject 21F.107.
M. Liang

21F.158 Chinese II (Streamlined)
(Subject meets with 21F.108)
Prereq: 21F.157; or placement test and permission of instructor
G (Spring)
3-0-6

See description under subject 21F.108.
M. Liang

21F.162 Intermediate Chinese I: Very Fast Track (New)
(Subject meets with 21F.142)
Prereq: 21F.151, or placement test; permission of instructor
G (Spring; first half of term)
4-0-5

Students enhance their skills in speaking, listening, reading and writing. Extension of basic grammar. Includes vocabulary and Chinese character building. Coordinated weekly small group conversation sessions. Intended to cover the equivalent of 21F.152 in half the time as well as introduce concepts in 21F.103. Students taking the graduate version complete additional assignments. Students cannot also receive credit for 21F.152. Limited to 12.
J. Zhang

21F.163 Intermediate Chinese II: Very Fast Track (New)
(Subject meets with 21F.143)
Prereq: 21F.162, or placement test; permission of instructor
G (Spring; second half of term)
4-0-5

Student further develop their skills in speaking, listening, reading and writing. Includes continued vocabulary and Chinese character building. Coordinated weekly small group conversation sessions. Intended to cover the same material as 21F.103 in half the time as well as introduce concepts in 21F.104. Limited to 12.
J. Zhang

Chinese Language Option Subjects

21F.190 Advertising and Popular Culture: East Asian Perspectives
(Subject meets with 21F.036, CMS.888)
Prereq: 21F.104, 21F.110, or permission of instructor
U (Fall)
3-0-10 HASS-H (HASS-E)

See description under subject 21F.036. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
J. Wang

21F.192 Modern Chinese Fiction and Cinema
(Subject meets with 21F.046)
Prereq: 21F.104, 21F.110, or permission of instructor
U (Spring)
3-0-10 HASS-H (HASS-E); CI-H

See description under subject 21F.046. Taught in English with a project that requires research in Chinese. Enrollment limited; preference to Chinese minors.
J. Wang

21F.193 East Asian Culture: From Zen to Pop
(Subject meets with 21F.030J, WGS.236J)
Prereq: 21F.104, 21F.110, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-10 HASS-H (HASS-E)

See description under subject 21F.030J. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
E. Teng

21F.194 The Cultural Politics of Contemporary China
(Subject meets with 21F.038)
Prereq: 21F.104, 21F.110, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-10 HASS-H (HASS-E)

See description under subject 21F.038. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
J. Wang
21F.195 Classics of Chinese Literature in Translation
(Subject meets with 21F.044J, 21L.044J, WGS.235J)
Prereq: 21F.104, 21F.110, or permission of instructor
U (Fall)
3-0-10 HASS-H (HASS-E)
See description under subject 21F.044J. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
E. Teng

21F.199 Chinese Youths and Web Culture
Prereq: 21F.113, permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-E)
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


ENGLISH LANGUAGE STUDIES (ELS)

Undergraduate Subjects

21F.218 Workshop in Strategies for Effective Teaching (ELS)
(Subject meets with 21F.217)
Prereq: None
U (IAP)
1-0-2
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. Graduate TAs have priority.
A. C. Kemp

21F.220 Workshop in Written Expression (ELS)
(Subject meets with 21F.219)
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-0-9 HASS-H (HASS-E)
Can be repeated for credit
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.
Fall: P. Brennecke
Spring: A. C. Kemp

21F.222 Expository Writing for Bilingual Students
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-0-9 HASS-H (HASS-E); 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. Undergraduates only. Enrollment limited.
Fall: A. C. Kemp, K. Barker
Spring: K. Barker

21F.223 Listening, Speaking and Pronunciation (ELS)
(Subject meets with 21F.224)
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-0-9 HASS-H (HASS-E)
Can be repeated for credit
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. No listeners.
Fall: P. Brennecke, A. C. Kemp, K. Barker
Spring: A. C. Kemp

21F.226 Advanced Workshop in Writing for Science and Engineering (ELS)
(Subject meets with 21F.225)
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-0-9 HASS-H (HASS-E); CI-H
Can be repeated for credit
See description under subject 21F.225. Enrollment limited; no listeners.
J. Dunphy

21F.228 Advanced Workshop in Writing for Social Sciences and Architecture (ELS)
(Subject meets with 21F.227)
Prereq: Placement test and permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-E); CI-H
Can be repeated for credit with permission of instructor
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. 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. Listeners not allowed. Enrollment limited.
P. Brennecke

21F.233 Advanced Speaking and Critical Listening Skills (ELS)
(Subject meets with 21F.232)
Prereq: Placement test and permission of instructor in all cases
U (Fall, Spring)
3-3-6 HASS-H (HASS-E)
Can be repeated for credit with permission of instructor
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. No listeners.
Fall: J. Dunphy
Spring: P. Brennecke
Graduate Subjects

21F.217 Workshop in Strategies for Effective Teaching (ELS)
(Subject meets with 21F.218)
Prereq: None
G (IAP)
1-0-2
See description under subject 21F.218.
A. C. Kemp

21F.219 Workshop in Written Expression (ELS)
(Subject meets with 21F.220)
Prereq: Placement test and permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit
See description under subject 21F.220.
Fall: P. Brennecke
Spring: A. C. Kemp

21F.224 Listening, Speaking, and Pronunciation (ELS)
(Subject meets with 21F.223)
Prereq: Placement test and permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit
See description under subject 21F.223.
Fall: P. Brennecke, A. C. Kemp, K. Barker
Spring: A. C. Kemp

21F.225 Advanced Workshop in Writing for Science and Engineering (ELS)
(Subject meets with 21F.226)
Prereq: Placement test and permission of instructor
G (Fall, Spring)
3-0-9
Can be repeated for credit
See description under subject 21F.226.
Fall: J. Dunphy
Spring: J. Dunphy

21F.227 Advanced Workshop in Writing for Social Sciences and Architecture (ELS)
(Subject meets with 21F.228)
Prereq: Placement test and permission of instructor
G (Spring)
3-0-9
Can be repeated for credit with permission of instructor
See description under subject 21F.228. Listeners not allowed.
P. Brennecke

21F.232 Advanced Speaking and Critical Listening Skills (ELS)
(Subject meets with 21F.233)
Prereq: Placement test and permission of instructor in all cases
G (Fall, Spring)
3-3-6
Can be repeated for credit with permission of instructor
See description under subject 21F.233. Listeners not allowed.
Fall: J. Dunphy
Spring: P. Brennecke

FRENCH

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in French. All first-year foreign language subjects are also offered for graduate credit.

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. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076.

Fundamental Language Subjects

21F.301 French I
(Subject meets with 21F.351)
Prereq: None
U (Fall, IAP, Spring)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.371
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 21F.351. Meets with 21F.371 when offered concurrently.
Fall: L. Rezvani, S. Ravillon
Spring: L. Rezvani

21F.371 French I—Globalization
Prereq: None. Coreq: 21F.076
U (Fall)
4-0-5 HASS-H (HASS-E)
Credit cannot also be received for 21F.301
In conjunction with 21F.076, covers same material as 21F.301. See description under 21F.301. Students cannot receive credit without simultaneous completion of 21F.076. Meets with 21F.301 and 21F.351 when offered concurrently.
L. Rezvani

21F.302 French II
(Subject meets with 21F.352)
Prereq: 21F.301, 21F.371, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.372
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 21F.352. Meets with 21F.372 when offered concurrently.
C. Culot

21F.372 French II—Globalization
Prereq: 21F.301 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H (HASS-E)
Credit cannot also be received for 21F.302
In conjunction with 21F.076, covers same material as 21F.302. See description under 21F.302. Students cannot receive credit without simultaneous completion of 21F.076. Meets with 21F.302 and 21F.352 when offered concurrently.
C. Culot
FOREIGN LANGUAGES AND LITERATURES

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Uses developed linguistic skills for improving the overall quality of writing and oral fluency. Uses literary texts, films, and the Internet. Students cannot receive credit without simultaneous completion of 21F.076L. Meets with 21F.304 when offered concurrently.  
S. Ravillon

21F.306 French: Communication Intensive I
Prereq: Permission of instructor; Coreq: 21F.308, 21F.310, 21F.311, 21F.312, 21F.315, 21F.320, 21F.325, 21F.345, or 21F.346  
U (Fall, Spring)  
3-0-0

21F.307 French: Communication Intensive II
Prereq: Permission of instructor; Coreq: 21F.308, 21F.310, 21F.311, 21F.312, 21F.315, 21F.320, 21F.325, 21F.345, or 21F.346  
U (Fall, Spring)  
3-0-0

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. 21F.307 builds on writing and speaking skills acquired in 21F.306. Conducted entirely in French. Preference to French majors.  
Staff

Intermediate Subjects in Language, Literature, and Culture

These subjects (21F.308–21F.315) are designed for students who have completed French IV or its equivalent. They serve as a transition between language study and more advanced subjects in literature and cultures. Although each subject has a different emphasis, all provide students with additional practice in reading, speaking, and writing.  

Students may take several subjects from these offerings. Native speakers of French who have studied French literature at a high school level must seek the instructor’s approval for admission to any of these subjects.

21F.308 Writing (Like the) French
Prereq: 21F.304, 21F.374, or permission of instructor  
U (Fall)  
3-0-9 HASS-H (HASS-E)

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

21F.310 French Conversation: Intensive Practice
Prereq: 21F.304, 21F.374, or permission of instructor  
U (Spring)  
3-0-9 HASS-H (HASS-E)

Training in oral expression including communicative 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.  
S. Ravillon

21F.311 Introduction to French Culture
Prereq: 21F.304, 21F.374, or permission of instructor  
U (Fall)  
3-0-9 HASS-H (HASS-D 1)

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.  
E. B. Turk

21F.312 Basic Themes in French Literature and Culture
Prereq: 21F.304, 21F.374, or permission of instructor  
Acad Year 2011–2012: U (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9 HASS-H (HASS-E)

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.  
P. Perreau

21F.314 Topics in Interculturalism: France (Study Abroad)
Prereq: 21F.304 or 21F.374; permission of instructor  
U (IAP)  
3-0-3

Offers intercultural experience through a cultural and intellectual immersion in France. Advanced language skill-building through readings, lectures, conversations, writing, and a variety
of real-world activities. Conducted in French. Limited to 12 via lottery.

S. Levet

21F.315 Cross-cultural Perspectives on Contemporary French Society
Prereq: 21F.304, 21F.374, or permission of instructor
U (Fall)
3-0-9 HASS-H (HASS-E)

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.

S. Levet

Advanced Subjects in Literature and Culture

Students are required to take at least one intermediate subject before enrolling in advanced subjects. Otherwise they must obtain permission of instructor.

21F.320 Introduction to French Literature
Prereq: 21F.304, 21F.374, or permission of instructor
Acad Year 2011−2012: Not offered
Acad Year 2012−2013: U (Spring)
3-0-9 HASS-H (HASS-E)

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.

Staff

21F.325J New Culture of Gender: Queer France (New)
(Same subject as WGS.233J)
Prereq: One intermediate subject in French
Acad Year 2011−2012: U (Fall)
Acad Year 2012−2013: Not offered
3-0-9 HASS-H (HASS-E)
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 Garréta, Abdellah Taïa, Anne Scott, and Nina Bouraoui. Taught in French.

B. Perreau

21F.345 Contemporary French Theater: Traditions and New Trends
Prereq: 21F.304 or 21F.374
Acad Year 2011−2012: Not offered
Acad Year 2012−2013: U (Fall)
3-0-9 HASS-H (HASS-E)

Studies major plays of the past six decades, with emphasis on recent works and trends. Attention to the influence of the Theater of the Absurd, the political events of 1968, the intellectual avant-garde, and mass-audience entertainment. Dramatists include Ionesco, Beckett, Genet, Arrabal, Sarrate, Cixous, Duras, Koltès, Reza, Visniec, Ndiaye, Schmitt, Grumberg, Balasko. Taught in French.

E. B. Turk

21F.346 Topics in Modern French Literature and Culture
Prereq: One intermediate subject in French
Acad Year 2011−2012: U (Spring)
Acad Year 2012−2013: Not offered
3-0-9 HASS-H (HASS-E)
Can be repeated for credit with permission of instructor

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. Taught in French.

Staff

Graduate Language Subjects

21F.351 French I
(Subject meets with 21F.301)
Prereq: None
G (Fall, IAP, Spring)
4-0-5

See description under subject 21F.301.

Fall: L. Rezvani, S. Ravillon
Spring: L. Rezvani

21F.352 French II
(Subject meets with 21F.302)
Prereq: 21F.351
G (Fall, Spring)
4-0-5

See description under subject 21F.302.

C. Culot

For French Literature and Culture subjects offered in English, see 21F.052, 21F.068J, and 21F.071.

German

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in German. All first-year foreign language subjects are also offered for graduate credit.

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. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076.

Fundamental Language Subjects

21F.401 German I
(Subject meets with 21F.451)
Prereq: None
U (Fall, IAP, Spring)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.471

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.
as well as short prose and poetry (Dürrenmatt, Böll, 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. Meets with 21F.473 when offered concurrently.  
Fall: E. Crocker, D. Jaeger  
Spring: D. Jaeger

**21F.473 German III—Globalization**  
Prereq: 21F.402 or permission of instructor;  
Coreq: 21F.076j  
U (Fall)  
4-0-5 HASS-H (HASS-E)  
Credit cannot also be received for 21F.403

In conjunction with 21F.076j, covers same material as 21F.403. See description under 21F.403. Students cannot receive credit without simultaneous completion of 21F.076j. Meets with 21F.403 when offered concurrently.  
Fall: E. Crocker, D. Jaeger  
Spring: D. Jaeger

**21F.402 German II**  
(Subject meets with 21F.452)  
Prereq: 21F.401, 21F.471, or permission of instructor  
U (Fall, Spring)  
4-0-8 HASS-H (HASS-E)  
Credit cannot also be received for 21F.472

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 21F.452. Meets with 21F.472 when offered concurrently.  
P. Weise

**21F.472 German II—Globalization**  
Prereq: 21F.401 or permission of instructor;  
Coreq: 21F.076j  
U (Fall)  
4-0-5 HASS-H (HASS-E)  
Credit cannot also be received for 21F.402

In conjunction with 21F.076j, covers same material as 21F.402. See description under 21F.402. Students cannot receive credit without simultaneous completion of 21F.076j. Meets with 21F.402 when offered concurrently.  
P. Weise

**21F.403 German III**  
Prereq: 21F.402, 21F.472, or permission of instructor  
U (Fall, Spring)  
4-0-8 HASS-H (HASS-L)  
Credit cannot also be received for 21F.473

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, Böll, 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. Meets with 21F.473 when offered concurrently.  
P. Weise

**21F.404 German IV**  
Prereq: 21F.403, 21F.473, or permission of instructor  
Coreq: 21F.076j  
U (Fall, Spring)  
4-0-8 HASS-H (HASS-L)  
Credit cannot also be received for 21F.474

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. Meets with 21F.474 when offered concurrently.  
P. Weise

**21F.406 German: Communication Intensive I**  
Prereq: Permission of instructor; Coreq: 21F.409, 21F.410, 21F.412, 21F.414, 21F.415, 21F.416, or 21F.420  
U (Fall, Spring)  
3-0-0

**21F.407 German: Communication Intensive II**  
Prereq: Permission of instructor; Coreq: 21F.409, 21F.410, 21F.412, 21F.414, 21F.415, 21F.416, or 21F.420  
U (Fall, Spring)  
3-0-0

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. 21F.407 builds on writing and speaking skills acquired in 21F.406. Conducted entirely in German. Preference to German majors.  
Staff

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**Intermediate Subjects in Language, Literature, and Culture**

**21F.409 Opening the Text: Performing in German**  
Prereq: 21F.403 or 21F.473  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Spring)  
3-0-0 HASS-H (HASS-E)

Students refine their language skills via performing (story telling, 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

**21F.410 Professional Communication in German**  
Prereq: 21F.404 or 21F.474  
Acad Year 2011–2012: U (Spring)  
Acad Year 2012–2013: Not offered  
3-0-0 HASS-H (HASS-E)

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 on-line material. Taught in German.

E. Crocker

21F.412 Texts, Topics, and Times in German Literature
Prereq: 21F.404 or 21F.474; permission of instructor
U (Fall)
3-0-9 HASS-H (HASS-E)
Can be repeated for credit with permission of instructor
Explores representative and influential works from the late 19th century to the present through literary texts (prose, drama, poetry), radio plays, art, film, and architecture. Introduces different forms of aesthetic analysis and interpretation. Provides the opportunity to discuss, orally and in writing, cultural, ethical, and social issues on a stylistically sophisticated level. 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, Dürrenmatt, Süskind, and W.G. Sebald. Topics and authors vary from term to term. Taught in German.

D. Jaeger

Advanced Subjects in Language, Literature, and Culture

21F.414 German Culture, Media, and Society
Prereq: 21F.404 or 21F.474
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
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

21F.415 Germany and its European Context
Prereq: 21F.404 or 21F.474
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
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

21F.416 20th- and 21st-Century German Literature
Prereq: 21F.404 or 21F.474
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)
Can be repeated for credit with permission of instructor
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. Taught in German.

Staff

21F.420 Visual Histories: German Cinema 1945 to Present
Prereq: 21F.404, 21F.474, or permission of instructor
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
2-2-8 HASS-H (HASS-E)
Studies the history, aesthetics, and cultural contexts of German film since the end of World War II. Explores films of “New German Cinema” by Fassbinder, Wenders, Herzog, and others, and investigates the film tradition of East Germany and the internationalization of German cinema since the 1980s. Special thematic focus on the representation of history in film. Taught in German.

K. Fendt

21F.422 Advanced Practicum in German (Study Abroad)
Prereq: 21F.404, 21F.474, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (IAP)
5-0-4 HASS-H (HASS-E)
Offers cross-cultural learning and advanced intensive practice in oral and written communication in German through explorations of contemporary cultural, political, and societal issues. Topics include current demographic changes and the role of minorities, strategies for dealing with Germany’s past, the connections between architecture and politics, and German corporate culture and globalization. Students participate in interviews, workshops and group discussions with local writers, artists, students and young professionals in corporate settings. Includes project-based assignments, such as cultural explorations, multi-media projects, and professional case-studies. Conducted in German. Limited to 20.

K. Fendt

Graduate Language Subjects

21F.451 German I
(Subject meets with 21F.401)
Prereq: None
G (Fall, IAP, Spring)
4-0-5
See description under subject 21F.401.

Fall: P. Weise
Spring: D. Jaeger

21F.452 German II
(Subject meets with 21F.402)
Prereq: 21F.451 or permission of instructor
G (Fall, Spring)
4-0-5
See description under subject 21F.402.

E. Crocker

For German Literature and Culture subjects offered in English, see 21F.055 and 21F.059.
ITALIAN

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in Italian. All first-year foreign language subjects are also offered for graduate credit.

Fundamental Language Subjects

21F.601 Italian I
(Subject meets with 21F.651)
Prereq: None
U (IAP)
4-0-8 HASS-H (HASS-E)
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 materials. Limited to 12.

Y. Nagaya

21F.651 Italian I
(Subject meets with 21F.601)
Prereq: None
G (IAP)
4-0-5
See description under subject 21F.601.

Staff

JAPANESE

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in Japanese. All first-year foreign language subjects are also offered for graduate credit.

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. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076J.

Fundamental Language Subjects

21F.501 Japanese I
(Subject meets with 21F.551)
Prereq: None
U (Fall, IAP)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.571
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 21F.551. Meets with 21F.571 when offered concurrently.

Y. Nagaya

21F.571 Japanese I—Globalization
Prereq: None. Coreq: 21F.076J
U (Fall)
4-0-5 HASS-H (HASS-E)
Credit cannot also be received for 21F.501
In conjunction with 21F.076J, covers same material as 21F.501. See description under 21F.501. Students cannot receive credit without simultaneous completion of 21F.076J. Meets with 21F.501 and 21F.551 when offered concurrently.

Y. Nagaya

21F.502 Japanese II
(Subject meets with 21F.552)
Prereq: 21F.501 or 21F.571; or placement test and permission of instructor
U (Spring)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.562
Enhancement of the four basic skills. Extension of basic grammar. Vocabulary and kanji (Chinese characters) building. Lab work required. For graduate credit see 21F.552.

Y. Nagaya

21F.562 Intermediate Japanese I: Very Fast Track
(Subject meets with 21F.555)
Prereq: 21F.501, 21F.571, or placement test; permission of instructor
U (Spring; first half of term)
4-0-5 HASS-H (HASS-E)
Credit cannot also be received for 21F.502
Students enhance their skills in speaking, listening, reading and writing. Extension of basic grammar. Includes vocabulary and kanji (Chinese characters) building. Covers the equivalent of 21F.502 and part of 21F.503 in half the time. Students taking the graduate version complete additional assignments. Limited to 12.

Y. Nagaya

21F.503 Japanese III
(Subject meets with 21F.573)
Prereq: 21F.502 or 21F.562; or placement test and permission of instructor
U (Fall)
4-0-8 HASS-H (HASS-L)
Credit cannot also be received for 21F.563
Students further develop their skills in speaking, listening, reading and writing. Involves continued vocabulary and kanji building. Coordinated language lab.

Y. Nagaya

21F.573 Japanese III—Globalization
(Subject meets with 21F.503)
Prereq: 21F.502 or 21F.562; or placement test and permission of instructor; Coreq: 21F.076J
U (Fall)
4-0-5 HASS-H (HASS-E)
In conjunction with 21F.076J, covers same material as 21F.503. Students further develop their skills in speaking, listening, reading and writing. Includes continued vocabulary and kanji building. Coordinated language lab. Students cannot receive credit without simultaneous completion of 21F.076J.

Y. Nagaya

21F.563 Intermediate Japanese II: Very Fast Track
(Subject meets with 21F.556)
Prereq: 21F.562, or placement test; permission of instructor
U (Spring; second half of term)
4-0-8 HASS-H (HASS-L)
Credit cannot also be received for 21F.503
Students further develop their skills in speaking, listening, reading and writing. Includes continued vocabulary and kanji building. Covers the same material as 21F.503 and much of 21F.504 in half the time. Limited to 12.

Y. Nagaya

21F.504 Japanese IV
Prereq: 21F.503 or 21F.573; or placement test and permission of instructor
U (Spring)
4-0-8 HASS-H (HASS-L)
Review and expansion of basic skills. Emphasis on application of basic grammar and vocabulary in various situations. Lab work required.

Y. Nagaya
S. Miyagawa

21F.575 Japanese V—Globalization
(Subject meets with 21F.505)
Prereq: 21F.504; or placement test and permission of instructor
U (Fall)
4-0-8 HASS-H (HASS-E)

In conjunction with 21F.076, covers same material as 21F.505. See description under 21F.505. Students cannot receive credit without simultaneous completion of 21F.076.
M. Ikeda-Lamm

21F.506 Japanese VI
Prereq: 21F.505 or 21F.575; or placement test and permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-E)

Continuation of 21F.505. Further development of reading, writing, and oral communication skills. Requires completion of basic grammar and further instruction in vocabulary and expression. Variety of cultural elements studied through readings, video, and discussion. Lab work required.
Y. Sakurai

Advanced Subjects

21F.514 Linguistic Theory and Japanese Language
(Subject meets with 24.946)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-6 HASS-H (HASS-E)

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. Meets with graduate subject 24.946, but assignments differ. Assumes familiarity with linguistic theory.
S. Miyagawa

Graduate Language Subjects

21F.551 Japanese I
(Subject meets with 21F.501)
Prereq: None
G (Fall, IAP)
4-0-5
See description under subject 21F.501.
Y. Nagaya

21F.552 Intermediate Japanese II: Very Fast Track
(Subject meets with 21F.562)
Prereq: 21F.551 or placement test; permission of instructor
G (Spring; first half of term)
4-0-5
Continuation of 21F.551. Students enhance their skills in speaking, listening, reading, and writing. Extension of basic grammar. Includes vocabulary and kanji (Chinese characters) building. Covers the equivalent of 21F.552 and part of 21F.503 in half the time. Students cannot also receive credit for 21F.552. Students taking the graduate version complete additional assignments. Limited to 12.
Y. Nagaya

21F.555 Intermediate Japanese I: Very Fast Track
(Subject meets with 21F.561)
Prereq: 21F.551 or placement test; permission of instructor
G (Spring)
4-0-5
Continuation of 21F.551. Students enhance their skills in speaking, listening, reading, and writing. Extension of basic grammar. Includes vocabulary and kanji (Chinese characters) building. Covers the equivalent of 21F.552 and part of 21F.503 in half the time. Students cannot also receive credit for 21F.552. Students taking the graduate version complete additional assignments. Limited to 12.
Y. Nagaya

21F.556 Intermediate Japanese II: Very Fast Track
(Subject meets with 21F.563)
Prereq: 21F.555; or placement test; permission of instructor
G (Spring; second half of term)
4-0-5
Continuation of 21F.555. Students further develop their skills in speaking, listening, reading, and writing. Includes continued vocabulary and kanji (Chinese characters) building. Covers the same material as 21F.503 and much of 21F.504 in half the time. Students taking graduate version complete additional assignments. Limited to 12.
Y. Nagaya

Japanese Language Option Subjects

21F.590 Asia in the Modern World: Images and Representations
(Subject meets with 21F.027, 21H.250J)
Prereq: 21F.504 or permission of instructor
G (Spring)
3-0-10 HASS-H (HASS-D 5); CI-H
See description under subject 21F.027. Preference to Japanese minors.
S. Miyagawa, J. Dower

21F.591 Japanese Popular Culture
(Subject meets with 21F.039)
Prereq: 21F.504 or permission of instructor
U (Fall)
3-0-10 HASS-H (HASS-E)
See description under subject 21F.039. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.
I. Condry

21F.592 Introduction to Japanese Culture
(Subject meets with 21F.064)
Prereq: 21F.504 or permission of instructor
U (Fall, Spring)
3-0-10 HASS-H (HASS-D 4); CI-H
See description under subject 21F.064. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.
Fall: S. Miyagawa
Spring: I. Condry

21F.593 Japanese Literature and Cinema
(Subject meets with 21F.065)
Prereq: 21F.504 or permission of instructor
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-10 HASS-H (HASS-E); CI-H
See description under subject 21F.065. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.
I. Condry

21F.596 Anime: Transnational Media and Culture
(Subject meets with 21F.063)
Prereq: 21F.504 or permission of instructor
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-10 HASS-H (HASS-E)
See description under subject 21F.063. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.
I. Condry
### PORTUGUESE

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in Portuguese. All first-year foreign language subjects are also offered for graduate credit.

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.

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#### Fundamental Language Subjects

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Prerequisites/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>21F.801</td>
<td>Portuguese I</td>
<td>Prereq: None</td>
</tr>
<tr>
<td></td>
<td>(Subject meets with 21F.851)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4-0-8 HASS-H (HASS-E)</td>
<td>Introduction to the language and culture of the Portuguese-speaking world, with special</td>
</tr>
</tbody>
</table>
|             |                                                  | 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. Students taking graduate version complete additional assignments. Enrollment in each subject limited to 18.  
  N. Dominique | |
| 21F.802     | Portuguese II                                    | Prereq: 21F.801 or permission of instructor  
  U (Spring)  | 4-0-8 HASS-H (HASS-E)                            | Continuation of 21F.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. Students taking graduate version complete additional assignments. Enrollment in 21F.802 limited to 18; enrollment in 21F.852 limited.  
  N. Dominique | |
| 21F.803     | Portuguese III                                   | Prereq: 21F.802, 21F.880, or permission of instructor  
  U (IAP)      | 4-0-8 HASS-H (HASS-L)                            | 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 | |
| 21F.804     | Portuguese IV                                    | Prereq: 21F.803 or permission of instructor  
  U (Spring)  | 4-0-8 HASS-H (HASS-L)                            | 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

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<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Prerequisites/Comments</th>
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| 21F.820     | Topics in Modern Portuguese Literature and Culture (New) | Prereq: 21F.804 or permission of instructor  
  U (Fall)    | 3-0-9 HASS-H (HASS-E)                            | 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. Taught in Portuguese.  
  Staff | |

#### Graduate Language Subjects

<table>
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<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Prerequisites/Comments</th>
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<tbody>
<tr>
<td>21F.851</td>
<td>Portuguese I</td>
<td>Prereq: None</td>
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<td>(Subject meets with 21F.801)</td>
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<td>4-0-5 G (Fall)</td>
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</table>
| 21F.852     | Portuguese II                                    | Prereq: 21F.851 or permission of instructor  
  G (Spring) | 4-0-5                                             | Continuation of 21F.851. See description under subject 21F.802.  
  N. Dominique | |
| 21F.855     | Accelerated Introductory Portuguese for Spanish Speakers | Prereq: 21F.704 or permission of instructor  
  G (Fall)   | 4-0-5                                             | For Portuguese Literature and Culture subjects offered in English, see 21F.074.  
  N. Dominique | |
SPANISH

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in Spanish. All first-year foreign language subjects are also offered for graduate credit.

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. The 9-unit Globalization subjects cover the same material as their 12-unit counterparts, but they may only be taken in conjunction with 21F.076).

Fundamental Language Subjects

21F.701 Spanish I
(Subject meets with 21F.751)
Prereq: None
U (Fall, IAP, Spring)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.771
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 21F.751. Meets with 21F.771 when offered concurrently.
M. Ehrsam, R. Rey Agudo

21F.717 Spanish I—Globalization
(Subject meets with 21F.783)
Prereq: None. Coreq: 21F.076
U (Fall)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.701
In conjunction with 21F.076, covers same material as 21F.701. See description under 21F.701. Students cannot receive credit without simultaneous completion of 21F.076. Meets with 21F.701 and 21F.751 when offered concurrently.
M. Ehrsam, R. Rey Agudo

21F.702 Spanish II
(Subject meets with 21F.752)
Prereq: 21F.701, 21F.771, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.772, 21F.782
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 21F.752. Meets with 21F.772 when offered concurrently.
L. Soto, M. Ehrsam

21F.772 Spanish II—Globalization
Prereq: 21F.701 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H (HASS-E)
Credit cannot also be received for 21F.702, 21F.782
In conjunction with 21F.076, covers same material as 21F.702. See description under 21F.702. Students cannot receive credit without simultaneous completion of 21F.076. Meets with 21F.702 and 21F.752 when offered concurrently.
L. Soto, M. Ehrsam

21F.782 Spanish II (Study Abroad)
(Subject meets with 21F.783)
Prereq: 21F.701, 21F.771, or permission of instructor
U (IAP)
4-0-8 HASS-H (HASS-E)
Credit cannot also be received for 21F.702, 21F.772
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. Trips outside of Madrid allow students to experience Spanish culture and history. Opportunities to visit Spanish companies and research labs. Enrollment limited; lottery subject.
L. Soto

21F.703 Spanish III
Prereq: 21F.702, 21F.772, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-H (HASS-L)
Credit cannot also be received for 21F.773
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. Meets with 21F.773 when offered concurrently.
L. Soto, C. Pérez

21F.773 Spanish III—Globalization
Prereq: 21F.702 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H (HASS-E)
Credit cannot also be received for 21F.703
In conjunction with 21F.076, covers same material as 21F.703. See description under 21F.703. Students cannot receive credit without simultaneous completion of 21F.076. Meets with 21F.703 when offered concurrently.
L. Soto, C. Pérez

21F.704 Spanish IV
Prereq: 21F.703, 21F.773, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-H (HASS-L)
Credit cannot also be received for 21F.774
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. Meets with 21F.774 when offered concurrently.
M. Ribas Groeger, R. Rey Agudo

21F.774 Spanish IV—Globalization
Prereq: 21F.703 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H (HASS-E)
Credit cannot also be received for 21F.704
In conjunction with 21F.076, covers same material as 21F.704. See description under 21F.704. Students cannot receive credit without simultaneous completion of 21F.076. Meets with 21F.704 when offered concurrently.
M. Ribas Groeger, R. Rey Agudo

21F.708 Spanish: Communication Intensive I
Prereq: Permission of instructor; Coreq: 21F.716, 21F.717, 21F.721, 21F.730, 21F.731, 21F.735, 21F.738, or 21F.740
U (Fall, Spring)
3-0-0

21F.709 Spanish: Communication Intensive II
Prereq: Permission of instructor; Coreq: 21F.716, 21F.717, 21F.721, 21F.730, 21F.731, 21F.735, 21F.738, or 21F.740
U (Fall, Spring)
3-0-0

Intensive tutorial in writing and speaking for majors. Provides students with enhanced linguistic and cultural fluency for academic or real-world purposes. 21F.709 builds on writing and speak-
Intermediate Subjects in Language, Literature, and Culture

These subjects (21F.711–21F.714) are designed for students who have completed Spanish IV or its equivalent. They serve as a transition between language study and more advanced subjects in literature and culture. Although each subject has a different emphasis, all provide students with additional practice in reading, speaking, and writing.

All students are required to take an intermediate-level subject before enrolling in 21F.716 and above. Students may take several subjects from these offerings. Native speakers of Spanish who have studied Hispanic literature at a high school level must seek the instructor’s approval for admission to any of these subjects.

21F.711 Advanced Spanish Conversation and Composition: Perspectives on Technology and Culture
Prereq: 21F.704, 21F.774, or permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-E)

Subject designed as a logical complement to Advanced Reading and Writing in Spanish. Unlike 21F.713, which focuses primarily on literary language, subject focuses on expository and journalistic writing that examines the social and cultural impact of science and technology in Hispanic societies. Topics considered include: 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 communication 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.
M. Ribas Groeger

21F.712 Spanish Conversation and Composition
(Subject meets with 21F.792)
Prereq: 21F.704, 21F.774, or permission of instructor
U (Fall)
3-0-9 HASS-H (HASS-E)

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.
M. Ribas Groeger

21F.713 Advanced Communication in Spanish: Film, Visual Arts, and Fiction
Prereq: 21F.704, 21F.774, or permission of instructor
U (Fall, Spring)
3-0-9 HASS-H (HASS-E)

Students continue to refine their speaking, reading, and writing skills through study of contemporary visual arts (images in museums, political propaganda, websites, etc.), short literary texts, and films from all corners of the Hispanic world. Develops analytical skills and vocabulary appropriate for understanding and discussing these media in their historical context. Interactive format with frequent work in small groups. Essays receive both peer and instructor review before final submission. Taught in Spanish.
E. Garrels

21F.714 Spanish for Bilingual Students
Prereq: Fluency in a Spanish dialect
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

Designed for students of Hispanic descent and raised in the US. Expands oral and written skills through the study of grammar and increased contact with standard Spanish. Studies recent fiction and poetry as well as specific historical, social, economic, and political aspects of Mexican-American, Puerto Rican, Cuban and other Hispanic/Latino cultures. Taught in Spanish.
M. Resnick

Advanced Subjects in Literature and Culture

All students are strongly advised to take an intermediate-level subject before enrolling in an advanced subject. Otherwise students are required to obtain permission of the advanced subject’s instructor.

21F.716 Introduction to Contemporary Hispanic Literature and Film
Prereq: One intermediate subject in Spanish or permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-D 1)

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 literary and cultural issues in the Spanish-speaking world. Conducted entirely in Spanish. Emphasis on active participation of students in class discussion.
E. Garrels

21F.721 The Novelist as Witness: Science and Imagination in 20th-Century Spain
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)

Studies the complex relationship between science, medicine and the imagination in 20th-century Spain. Students read fiction by Spanish authors who use the scientist/physician as a catalyst for social, educational and political critique. The ethical conflicts and debates surrounding science and science policy, especially in medicine, will be examined as background for authors writing within and against their historical moments. Also discusses how writers, using the figure of the physician, explored the challenges to the human spirit of discovery posed by the Church, Franco, and Spain’s mythic past. Authors include Pío Baroja, Luis Martín-Santos, Miguel Delibes, Nuria Amat, and Eduardo Mendoza. Conducted in Spanish. Limited to 25.
M. Resnick
Graduate Language Subjects

21F.750 Spanish I
(Subject meets with 21F.701)
Prereq: None
G (Fall, IAP, Spring)
4-0-5
See description under subject 21F.701.
*E. Garrels*

21F.752 Spanish II
(Subject meets with 21F.702)
Prereq: 21F.751 or permission of instructor
G (Fall, Spring)
4-0-5
See description under subject 21F.702.
*L. Soto, M. Ehrsam*

21F.783 Spanish II (Study Abroad)
(Subject meets with 21F.782)
Prereq: 21F.751 or permission of instructor
G (IAP)
4-0-5
See description under subject 21F.782.
*L. Soto*

For Spanish Literature and Culture subjects taught in English, see 21F.010 and 21F.084J.

SPECIAL TOPICS

21F.911 Independent Study
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Advanced work in foreign 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; to count toward HASS Requirement, 9 units are required. Exceptional 9-unit projects occasionally approved.
*Consult Foreign Languages and Literatures Headquarters*

21F.730 Hispanic America: One Hundred Years of Literature and Film
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
Explores artistic achievement in a culture that over the past century has engaged in constant and intense imaginative self-renewal. Studies film, narrative (e.g., Márquez's *One Hundred Years of Solitude*), and poetry. Conducted in Spanish.
*E. Garrels*

21F.735 Advanced Topics in Hispanic Literature and Film
Prereq: One intermediate Spanish subject or permission of instructor
U (Fall)
4-0-8 HASS-H (HASS-E)
Can be repeated for credit with permission of instructor
Close study of a theme, a grouping of authors, or a historical period not covered in depth in other subjects. Taught in Spanish.
*E. Garrels*

21F.738 Literature and Social Conflict: Perspectives on Modern Spain
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)
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 Pérez Galdós, Pardo Bazán, Unamuno, Ortega y Gasset, Salinas, Lorca, La Pasionaria, and Falcón. Taught in Spanish.
*C. Ramos*

(Same subject as 21L.640J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)
See description under subject 21L.640J.
*M. Resnick*

21F.751 Spanish I
(Subject meets with 21F.701)
Prereq: None
G (Fall, IAP, Spring)
4-0-5
See description under subject 21F.701.
*M. Ehrsam, R. Rey Agudo*

21F.752 Spanish II
(Subject meets with 21F.702)
Prereq: 21F.751 or permission of instructor
G (Fall, Spring)
4-0-5
See description under subject 21F.702.
*L. Soto, M. Ehrsam*

21F.783 Spanish II (Study Abroad)
(Subject meets with 21F.782)
Prereq: 21F.751 or permission of instructor
G (IAP)
4-0-5
See description under subject 21F.782.
*L. Soto*

For individual research in Foreign Languages and Literatures, register for 21F.UR or 21F.URG.
For Foreign Languages and Literatures pre-thesis tutorial, register for 21F.ThT. For undergraduate thesis, register for 21F.ThU. Descriptions of these subjects can be found in the beginning of this section under 21.UR, 21.URG, 21.ThT, and 21.ThU. For individual research in Foreign Languages and Literatures, register for 21F.UR or 21F.URG. For Foreign Languages and Literatures pre-thesis tutorial, register for 21F.ThT. For undergraduate thesis, register for 21F.ThU. Descriptions of these subjects can be found in the beginning of this section under 21.UR, 21.URG, 21.ThT, and 21.ThU.

21F.911 Independent Study
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Advanced work in foreign 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; to count toward HASS Requirement, 9 units are required. Exceptional 9-unit projects occasionally approved.
*Consult Foreign Languages and Literatures Headquarters*
Bachelor of Science in Foreign Languages and Literatures/Course 21F

General Institute Requirements (GIRs) (17 subjects required)
Science Requirement (6)
Humanities, Arts, and Social Sciences Requirement (8)
Restricted Electives in Science and Technology (REST) Requirement (2)
Laboratory Requirement (1)

Communication Requirement (4 subjects)
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program Units That Also Satisfy the GIRs (36 units)

Program 1: French Studies
Prerequisite subjects: 21F.301, 21F.302
Required Subjects (42 units)
21F.304 French IV, 12, HASS-H, 21F.307*

To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take 21F.306 and 21F.307. Registration for 21F.306 and 21F.307 must be simultaneous with one of the following: 21F.308, 21F.310, 21F.311, 21F.312, 21F.315, 21F.320, 21F.325, 21F.345, or 21F.346.

Restricted Electives (90 units)
A coherent program of 8 subjects beyond French II from the French curriculum, which may include a pre-thesis tutorial and a thesis.

Program 2: Spanish Studies
Prerequisite subjects: 21F.701, 21F.702
Required Subjects (42 units)
21F.704 Spanish IV, 12, HASS-H, 21F.709*

To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take 21F.708 and 21F.709. Registration for 21F.708 and 21F.709 must be simultaneous with one of the following range of subjects: 21F.716, 21F.717, 21F.721, 21F.730, 21F.731, 21F.735, 21F.736, 21F.738, or 21F.740.

Restricted Electives (90 units)
A coherent program of 8 subjects beyond Spanish II from the Spanish curriculum, which may include a pre-thesis tutorial and a thesis.

Departmental Program Units That Also Satisfy the GIRs (56 units)

Unrestricted Electives (48 units)

Total Units Beyond the GIRs Required for SB Degree (180 units)
No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

Notes
* Alternate prerequisites and corequisites are listed in the subject description.
† Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
INTRODUCTORY

21H.001 How to Stage a Revolution
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 5); 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. Goal is 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.

A. Bahr, W. Broadhead, E. Goldberg

21H.007J Empire: Introduction to Ancient and Medieval Studies
(Same subject as 21L.014J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E); CI-H
Interdisciplinary and comparative investigation of the Roman empire of Augustus, the Frankish empire of Charlemagne, and the English empire in the age of the Hundred Years’ War. Focuses on how large, multi-ethnic empires were created, sustained, legitimated, and contested through conquest, government, literature, art, and economic organization. Students examine several different types of evidence, read across a variety of disciplines, and develop skills to identify continuities and changes in ancient and medieval societies.

A. Bohr, W. Broadhead, E. Goldberg

21H.009 The World Since 1400 (21H.912)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-D 5)
Surveys the social, economic, and political evolution of societies and cultures from 1400 to the present. Studies the increasing interaction between communities as the barrier of distance succumbed to both curiosity and new transport technologies. Explores the rise to world dominance of Western Europe and the United States, as well as the great divergence in material, political, and technological development between Western Europe and East Asia after 1750 and its impact on the rest of the world. Examines a series of evolving relationships: human beings and their physical environment; religious and political systems; and sub-groups within communities as sorted by race, class, and gender. Introduces historical and other interpretive methodologies using both primary and secondary source materials.

Staff

21H.101 American History to 1865
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
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.

P. Maier

21H.102 American History since 1865
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 5); CI-H
Examines the history of American politics, economics, and society from the Civil War to the present. Use of secondary accounts and primary documents such as court cases, letters and diaries, photographs, and films to examine some of the key issues in the development of modern America: industrialization and urbanization, US emergence as a global power, growth of consumer culture, and the development of the civil rights movement.

Staff

21H.106J Black Matters: Introduction to Black Studies
(Same subject as 24.912J, 21A.114J, 21L.008J, 21W.741J, WGS.190J)
Prereq: None
U (Spring)
3-0-9 HASS-A, HASS-H (HASS-D 4); CI-H
See description under subject 24.912J.

A. Braithwaite, M. DeGraff

21H.107J Introduction to Asian American Studies: Historical and Contemporary Issues
(Same subject as 21F.043J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 5); CI-H
See description under subject 21F.043J.

E. Teng

21H.130 The Ancient World: Greece (21H.301)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 5); 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, Macedonia, and Hellenism. Emphasis on use of primary sources in translation.

S. Ostrow

21H.132 The Ancient World: Rome (21H.302)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 5); CI-H
History of Rome from its humble beginnings to the 5th century AD 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.

W. Broadhead
HISTORY

21H.133 The Medieval World: 200–1500 (21H.306)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

Surveys the history of Europe, Byzantium, and the Islamic World between 200 and 1500. Topics include the late Roman Empire and the “barbarian” invasions; the emergence of Christianity and Islam; the formation of the Carolingian, Byzantine, and Islamic empires; the Vikings and Mongols; castles, knights, and “feudalism”; medieval warfare and the crusades; religious thinkers, reformers, and heretics; the experience of women and Jews; the rise of cities and trade; the Black Death and the fall of Constantinople.

E. Goldberg

21H.134J Medieval Economic History in Comparative Perspective (21H.416)
(Same subject as 14.70J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 5); 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.140 The Renaissance: 1300–1600 (21H.311)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)

European history from the 14th through the 16th century. Consideration of political, social, artistic, and scientific developments during this period of transition to the modern world. Examines the connections between Renaissance Humanism and the Protestant and Catholic reform movements of the 16th century. Studies works by Petrarch, Machiavelli, Brunelleschi, Leonardo, Erasmus, More, Luther, and Montaigne.

J. Ravel

21H.142 The Age of Reason: Europe in the 18th and the 19th Centuries (21H.433)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 5); CI-H

Considers the ways in which social theorists, institutional reformers, and political revolutionaries in this period seized upon insights developed in the natural sciences and mathematics to change themselves and the society in which they lived. Students study trials, art, literature and music to understand developments in Europe and its colonies in these two centuries. Covers works by Newton, Locke, Voltaire, Rousseau, Marx, and Darwin.

J. Ravel

21H.151 Traditional China: Earliest Times to 1644 (21H.501)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Surveys China from its origins to 1644. Examines how traditional China originated and exported a civilization of universal meaning and persistent influence, including ideologies (universal emperorship, Confucianism, Daoism), technologies (writing, bureaucracy, gunpowder), and culture (tea-drinking, poetry, noodles). Explains how this unique civilization and the Chinese state at its center developed, considers its patterns, and assesses its impact.

C. Leighton

21H.152 Modern China: 1644 to the Present (21H.502)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

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.

C. Leighton

21H.154 Pre-modern Japan: Earliest times to 1868 (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Surveys Japanese history from the origin myths to the fall of Tokugawa shogunate in 1868. Highlights key themes, including the rise of a court-centered state, interactions with the broader world, and the rise and fall of the warrior class. Examines the continuities as well as diversity in pre-modern Japanese culture, spirituality, and everyday life.

H. Nagahara

21H.155 Modern Japan: 1868 to Present (New)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

Surveys Japanese history from the Meiji Restoration in 1868 to the present. 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 rise and fall of an economic superpower in the postwar era. Explores the local and global nature of modernity in Japan.

H. Nagahara

21H.160 Islam, the Middle East, and the West (21H.601)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 5)

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, Safavid, and Mughal expansion and the flourishing of European powers; European competition with and colonization of Middle Eastern societies, and Middle Eastern responses including Arab nationalism and the popularity of Islamic movements.

Staff

21H.161 The Middle East in the Twentieth Century (21H.615)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E); CI-H

Surveys major political, socio-economic, and cultural changes in the Middle East after 1900. Investigates the demise of the Ottoman and Qajar dynasties, the rise of new nations and nationalist identities, and the development of modern states and societies. Examines contemporary issues in historical perspective: the Arab-Israeli conflict, the Gulf War, oil and regional security, the impact of the Iranian revolution, and Islamic movements. Heavy emphasis on primary sources, such as novels and historical documents. Enrollment limited.

Staff
21H.171 Latin America: Revolution, Dictatorship, and Democracy, 1850 to Present (21H.802)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
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., indigenism, feminism, and the varieties of religion in Latin America.

J. Ravel

INTERMEDIATE

21H.185 Introduction to Environmental History (21H.421)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-D 5); CI-H
Focusing primarily on the period since 1500, explores the influence of climate, topography, plants, animals, and microorganisms on human history and the reciprocal influence of people on the environment. Topics include the European encounter with the Americas, the impact of modern technology, and the historical roots of the current environmental crisis.

H. Ritvo

21H.204j The Civil War and Reconstruction (21H.205)
(Same subject as STS.029j)
(Subject meets with STS.423)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
Anti-slavery and the intensification of sectionalism in the 1850s; the secession crisis; political and military developments in the Civil War years; key technological innovations (including medicine); why the North won; and the political, economic, and social legacies of the conflict.

M. R. Smith

21H.205j The Civil War and the Emergence of Modern America: 1861–1890 (New number 21H.204d)
(Same subject as STS.027j)
(Subject meets with STS.427)
Prereq: Permission of instructor
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)
See description under subject STS.027j.

M. R. Smith

21H.209 America in Depression and War (21H.126)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
The Great Depression and World War II permanently changed American politics and society. Topics include: the Great Crash, the New Deal, Roosevelt, the home front, the Normandy Invasion, and the atomic bomb. Explores those events through film, posters, newspapers, and other historical documents.

M. Jacobs

21H.211 The United States in the Nuclear Age: Politics, Culture, and Society Since 1941 (21H.131)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
American experience at home and abroad from Pearl Harbor to the end of the Cold War. Topics include: America’s role as global superpower, foreign and domestic anticommunism, social movements of left and right, urbanization, and popular culture.

M. Jacobs

21H.213j The War at Home: American Politics and Society in Wartime (21H.222)
(Same subject as 17.28j)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 17.28j.

A. Berinsky, C. Capozzola

21H.214 War and American Society (21H.223)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
Throughout American history, the experience of war has shaped the ways that Americans think about themselves, their fellow citizens, and the meanings of American citizenship. Examines how Americans have told the stories of modern war in multiple forms such as history, literature, film, and popular culture from the First World War to the war in Iraq, and interprets media representations in terms of changing ideas about American identity.

C. Capozzola

21H.217j American Urban History I (21H.231)
(Same subject as 11.013j)
Prereq: None
U (Spring)
2-0-7 HASS-H (HASS-E)
See description under subject 11.013j.

R. M. Fogelson

21H.218j American Urban History II (21H.232)
(Same subject as 11.014j)
Prereq: None
U (Fall)
2-0-7 HASS-H (HASS-E)
See description under subject 11.014j.

R. M. Fogelson

21H.220j Metropolis: A Comparative History of New York City (21H.235)
(Same subject as 11.150j)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
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| Riots, Strikes, and Conspiracies in American History (21H.104)  
(21H.104)
(Same subject as 11.015J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 5); CI-H

Readings and discussions focusing on a series of short-term events that shed light on American politics, culture, and social organization. Events studied include the Boston Tea Party of 1773; the crisis at Boston over the case of Anthony Burns, an escaped slave, in 1854; the Pullman strike of 1891; and the student uprisings at Columbia University in 1968. Emphasis on finding ways to make sense of these complicated, highly traumatic events, and on using them to understand larger processes of change in American history.

P. Maier, R. M. Fogelson

21H.227| Constitutional Law in US History (21H.224)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)

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 (21H.105)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 5); 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. DuBois, 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.

Staff

21H.229| The Black Radical Tradition in America (21H.117)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

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.233J| The Ancient City (21H.405)
(Same subject as 11.012J)
Prereq: None
Acad Year 2012–2013: U (Spring)
Acad Year 2011–2012: Not offered
3-0-9 HASS-H (HASS-E)

Explores the complex relationship of the Vikings with the medieval world. 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 monastic chronicles, archaeology, coin hoards, stone inscriptions, and sagas.

E. Goldberg

21H.236J| The Vikings (21H.308)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Explores the complex relationship of the Vikings with the medieval world. 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 monastic chronicles, archaeology, coin hoards, stone inscriptions, and sagas.

E. Goldberg
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.

E. Wood

21H.250J Asia in the Modern World: Images and Representations (21H.917)
(Same subject as 21F.027j)
(Subject meets with 21F.590)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 5); CI-H
See description under subject 21F.027j.
S. Miyagawa, J. Dower

21H.253J The Global Chinese: Chinese Migration, 1567-Present (New)
(Same subject as 21F.075j)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
See description under subject 21F.075j.
E. Teng

21H.262 Palestine and the Arab-Israeli Conflict (21H.631)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
Traces the history of the Palestinian-Israeli and later larger Arab-Israeli conflict from the 19th century up to the present. Explores the role of ideology, political actors, social history, economic and infrastructural problems, and regional and international interaction, as well as prospects for peace in the 21st century. Examines the related historiographical debates, especially those focusing on the Arab-Israeli Wars of 1948 and 1967, and the two intifadas.
Staff

21H.285J Making the Modern World: The Industrial Revolution in Global Perspective (21H.913)
(Same subject as STS.025j)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
See description under subject STS.025j.
M. R. Smith

SEMINARS

21H.310J Migration and Immigration in US History (21H.221)
(Same subject as 11.019j)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
Examines the history of the United States as a "nation of immigrants" within a broader global context. Considers migration from the mid-19th century to the present through case studies of such places as New York's Lower East Side, South Texas, Florida, and San Francisco's Chinatown. Examines the role of memory, media, and popular culture in shaping ideas about migration. Includes optional field trip to New York City.
C. Capozzola

21H.312J Race and Gender in Asian America (21H.153)
(Same subject as 21F.069j, WGS.237j)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
See description under subject 21F.069j.
C. Vo

21H.315 American Consumer Culture (21H.206)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
2-0-7 HASS-H (HASS-E)
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.
M. Jacobs

21H.318 The Energy Crisis: Past and Present (21H.207)
Prereq: None
U (Fall)
2-0-10 HASS-H (HASS-E)
Explores how Americans have confronted energy challenges since the 1970s. Primary areas of concern include the supply of energy and the environmental consequences of its use. Examines topics such as nuclear power, environmentalism, oil shortages, global warming, alternative energies, and Middle East foreign policy.
M. Jacobs

21H.320J Gender and the Law in US History (21H.225)
(Same subject as WGS.161j)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
Examines 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 for both women and men 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.321J Downtown (21H.234)
(Same subject as 11.026j)
(Subject meets with 11.339)
Prereq: None
U (Spring)
2-0-7 HASS-H (HASS-E)
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. Meets with graduate subject 11.339, but assignments differ.
R. M. Fogelson

21H.322 Christianity in America (21H.115)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
C. Wilder
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. Taught in seminar format with emphasis on class participation.

W. Broadhead

21H.333 Early Christianity (21H.303)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

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.334 Charlemagne: Emperor of Europe (21H.309)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Investigates the life, reign, and world of the medieval emperor Charlemagne (768–814). Focuses on the central question of how Charlemagne forged the first medieval empire out of the diverse peoples and territories of Europe, not only through warfare and military might, but also through Christianity and the Church, educational and cultural reforms, government and law, art and architecture, and a fundamental reorganization of the economy and society. Considers the enduring contributions of Charlemagne to the formation of Europe as well as the shortcomings and failures of his empire.

E. Goldberg

21H.343 From Print to Digital: Technologies of the Word, 1450–Present (21H.418)
(Subject meets with CMS.880)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)

Explores the impact of new technology on the recording and distribution of words at three different times: the invention of the printing press ca. 1450; the adaptation of electricity to communication technology in the 19th century (telegraph, telephone, phonograph); and the emergence of digital media today. Assignments include essays and online projects.

J. Ravel

21H.351J Shanghai and China’s Modernization (21H.515)
(Same subject as 11.153J)
Prereq: None
U (Spring)
2-0-10 HASS-H (HASS-E)

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.

C. Leighton

21H.380J People and Other Animals (21H.909)
(Same subject as 21A.390J)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
2-0-10 HASS-S (HASS-E)

Historical exploration of the ways that people have interacted with their closest animal relatives, for example: hunting, domestication of livestock, worship of animal gods, 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.385J The Ghetto: From Venice to Harlem (21H.916)
(Same subject as 11.152J)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
2-0-10 HASS-S (HASS-E)

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 Seminar in Historical Methods (21H.931)
Prereq: Two History subjects or permission of instructor
U (Spring)
2-0-10 HASS-H (HASS-E)

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. Introduction to 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 weekly two-page response papers and an original research paper (including a proposal, bibliography, first draft, and final version, based on primary sources) in conjunction with a formal oral presentation. Open to all students interested in history.

E. Wood

21H.391 Undergraduate Independent Study (21H.932)
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. HASS credit awarded only by individual petition to the Subcommittee on the HASS Requirement; minimum of 9 units required for HASS credit.

Staff
21H.392 Undergraduate Independent Study (21H.933)
Prereq: None
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. HASS credit awarded only by individual petition to the Subcommittee on the HASS Requirement; minimum of 9 units required for HASS credit.

Staff

SPECIAL SUBJECTS

21H.S01 Special Subject: History (New)
Prereq: Permission of instructor
U (Fall, IAP, Spring)
3-0-9
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, Spring)
2-0-10
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.

Staff

21H.ThU History Thesis
Prereq: 21H.ThT
U (Fall, 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.

Staff

GRADUATE SUBJECTS

21H.902 Reading Seminar in American History: 1877 to Present (21H.952)
Prereq: 21H.991
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-Level Grad Credit

Develops a teaching knowledge of the field through extensive reading and discussion of major works. Readings cover a broad range of topics (political, economic, social, and cultural) and represent a variety of historical methods. Students make frequent oral presentations and prepare a 20-page review essay.

M. Jacobs

21H.980J People and Other Animals (21H.969)
(Same subject as 21A.835J)
(Subject meets with 21A.380J, 21H.380J)
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
2-0-10
See description under subject 21H.380J.

H. Ritvo

21H.981 Seminar in Nature, Environment, and Empire (21H.968)
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
Prereq: None
3-0-9

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.

H. Ritvo

21H.991 Theories and Methods in the Study of History
Prereq: Permission of instructor
G (Fall)
3-0-9

Focuses on the development of social and cultural history in the 20th century. Topics include agrarian history, class, race, and gender as historical categories, historical demography, new economic, and environmental history, microhistory, and history on film. Topics drawn from European, American, and Asian history. Open to qualified undergraduates.

H. Ritvo

21H.992 Graduate Independent Study
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit

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

For individual research in History, register for 21H.UR or 21H.URG. Descriptions of these subjects can be found in the beginning of this section under 21.UR and 21.URG. For History pre-thesis tutorial, register for 21H.ThT. For undergraduate thesis, register for 21H.ThU.
# Bachelor of Science in History/Course 21H

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
</tbody>
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**Total GIR Subjects Required for SB Degree**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>17</td>
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</tbody>
</table>

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:

- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).</td>
<td></td>
</tr>
<tr>
<td>Required Subjects</td>
<td>45–48</td>
</tr>
<tr>
<td>One 21H seminar subject (9–12 units)</td>
<td></td>
</tr>
<tr>
<td>21H.390 Seminar in Historical Methods, 12, CI-M, HASS-H *</td>
<td></td>
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<tr>
<td>21H.TH T History Pre-Thesis Tutorial, 12</td>
<td></td>
</tr>
<tr>
<td>21H.THU History Thesis, 12, CI-M *</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>84–114</td>
</tr>
<tr>
<td>A coherent program of seven subjects from the history curriculum; and three related subjects from a second HASS discipline.</td>
<td></td>
</tr>
<tr>
<td>Departmental Program Units That Also Satisfy the GIRs</td>
<td>(27–33)</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
<td>48–72</td>
</tr>
</tbody>
</table>

**Total Units Beyond the GIRs Required for SB Degree**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.</td>
<td>180</td>
</tr>
</tbody>
</table>

**Notes**

*Prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
(1) Introductory subjects (21L.001–21L.044), all carrying HASS Distribution and Communications Intensive (CI-H or CI-HW) credit.

(2) Samplings (21L.301–21L.345) are six-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. These subjects focus on critical exploration, textual comprehension, and group discussion, with less sustained attention to analytic writing skills. Students can combine two six-unit Samplings subjects to count as a single 12-unit HASS Elective, equivalent to a subject in the Intermediate tier. No more than four Sampling subjects may be combined in this manner.

(3) Intermediate subjects (21L.420–21L.522), some carrying HASS Distribution credit and some limited to students who have already taken one literature course. Intermediate subjects explore literary forms in greater depth and center on historical periods, literary themes, or genres. Students are encouraged to consult individual instructors about prerequisite requirements.

(4) Seminars (21L.640–21L.715), restricted to students who have taken at least two previous subjects in literature. Enrollment in seminars is strictly limited to a maximum of 12 students.

A supplement to this catalog, available on-line and from the Literature Section offices, offers more detailed descriptions of all literature subjects.

**INTRODUCTORY SUBJECTS**

**21L.000J Writing About Literature**
(Same subject as 21W.041)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-E); 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.

*Fall: W. Kelley, N. Jackson*
*Spring: I. Lipkowitz*

**21L.001 Foundations of Western Culture: Homer to Dante**
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 2); 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.

*H. Eiland*

**21L.002 Foundations of Western Culture: The Making of the Modern World**
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 2); CI-H

Complementary to 21L.001. 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 HASS-H (HASS-D 1); CI-H

Introduces prose narrative, both short stories and the novel. Examines the construction of narrative and the analysis of literary response. Enrollment limited.

*Fall: A. Braithwaite, I. Lipkowitz*
*Spring: A. Braithwaite, H. Eiland*

**21L.004 Reading Poetry**
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-D 1); CI-H


*Fall: S. Tapscott, Staff*
*Spring: M. Fuller, N. Jackson*

**21L.005 Introduction to Drama**
Prereq: None
U (Spring)
3-0-9 HASS-A, HASS-H (HASS-D 3); 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. Bahr*

**21L.006 American Literature**
Prereq: None
U (Fall, Spring)
3-0-9 HASS-D (HASS-D 1); CI-H

Studies the national literature of the United States since the early 19th century. Considers novels, essays, films, and poems, focusing on efforts to define and reform a sense of American identity amidst increasing awareness of cultural diversity. Readings usually include works by Hawthorne, Thoreau, Frederick Douglass, Dickinson, Frost, Faulkner, Maxine Kingston, and Amy Tan. Enrollment limited.

*Staff*

**21L.007 World Literatures**
Prereq: None
U (Fall)
3-0-9 HASS-D (HASS-D 1); 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. In-
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.

**Staff**

21L.008J Black Matters: Introduction to Black Studies
(Same subject as 2A.912J, 21A.114J, 21H.106J, 21W.741J, WGS.190J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-A, HASS-H (HASS-D 4); CI-H
See description under subject 24.912J.
A. Braithwaite, M. DeGraff

21L.009 Shakespeare
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-D 1); CI-H
Focuses on a close reading of six to eight of Shakespeare’s 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). Plays vary between sections and from term to term, and have recently included *Henry IV Part 1, Hamlet, A Midsummer Night’s Dream, King Lear, Twelfth Night, and The Tempest*. Enrollment limited.
Fall: P. Donaldson
Spring: P. Donaldson, S. Raman

21L.010J Writing with Shakespeare
(Same subject as 21W.042J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Focuses on writing and speaking using Shakespeare as a model and means for mastery of English language skills. Emphasizes the 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 HASS-A (HASS-D 3); CI-H
An introduction to narrative film, emphasizing the unique properties of the movie house and the motion picture camera, the historical evolution of the film medium, and the intrinsic artistic qualities of individual films. Syllabus changes from term to term, but usually includes such directors as Griffith, Chaplin, Renoir, Ford, Hitchcock, De Sica, and Fellini.
Fall: D. Thormbourn
Spring: E. Brinkema

21L.012 Forms of Western Narrative
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 1); CI-H
Examines forms of storytelling that have developed in Western cultures from Homer to the present. Emphasis on literary and cultural issues; the emergence of different narrative genres and media; story forms as anthropological artifacts. Syllabus varies but usually includes folk tales, and authors such as Homer, Sophocles, Cervantes, Lactos or Tolsley, Poe, and at least one film.
E. Brinkema

21L.013J The Supernatural in Music, Literature and Culture
(Same subject as 21A.113J, 21M.013J)
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-D 3); CI-H
See description under subject 21M.013J.
C. Shadle, J. Howe, M. Fuller

21L.014J Empire: Introduction to Ancient and Medieval Studies
(Same subject as 21H.007J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E); CI-H
See description under subject 21H.007J.
A. Bahr, W. Broadhead, E. Goldberg

21L.015J Exploring Globalization
Prereq: None
U (Fall)
3-0-6 HASS-H (HASS-D 4); CI-H
Examines the cultural paradoxes of contemporary globalization. Studies the cultural, linguistic, social and political impact of globalization across international borders and on specific language communities. Students analyze contending definitions of globalization and principal
agents of change, and why some of them engender backlash; learn to distinguish what is considered new, hybrid, and traditional; identify the agents, costs and benefits of global networks; and explore how world citizens preserve cultural specificity. Students also develop cultural literacy through study of second language and culture, research, development of virtual materials, and interactions with MIT's international students. Students cannot receive credit without simultaneous completion of a 9-unit language subject. Preference to freshmen.

M. Resnick

21L.029j Exploring Identity through Asian American Literature (New)
(Same subject as 21F.029j)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 4); CI-H
See description under subject 21F.029j.
E. Teng

21L.044j Classics of Chinese Literature in Translation (New)
(Same subject as 21F.044j, WGS.235j)
(Subject meets with 21F.195)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
See description under subject 21F.044j.
E. Teng

21L.220 Literary Studies: The Legacy of England
Prereq: One subject in Literature
U (Spring)
3-0-6 HASS-H (HASS-E)
Credit cannot also be received for 21L.420
Examines English literature across genre and historical period. Designed for students who wish to study English literature or writing in some depth, or wish to know more about English literary culture and history. Learn about the relationships between literary themes, forms, and conventions and the times in which they were produced. Students examine Renaissance lyrics, Enlightenment satire, and modernist short stories. Focused on England because of its historical importance and its usefulness as an example for illustrating patterns over the centuries. Students form a framework for understanding how more focused subjects fit into literary studies, and what terms, concerns, and methods provide connections among the diverse subjects grouped under "literature." Meets with 21L.420 when offered concurrently. Students taking the 12-unit version complete additional assignments.
S. Tapscott

21L.285 Modern Fiction
Prereq: One subject in Literature
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-6 HASS-H (HASS-E)
Credit cannot also be received for 21L.485
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. Meets with 21L.485 when offered concurrently. Students taking the 12-unit version complete additional assignments.
D. Thorburn

21L.286 Modern Drama
Prereq: One subject in Literature
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-6 HASS-H (HASS-E)
Credit cannot also be received for 21L.486
S. Tapscott

21L.301J Doing Right (New)
(Same subject as 24.190j)
Prereq: None
U (Fall, Spring)
2-0-4
Examines how literary fiction dramatizes a variety of ethical issues, such as self-protection and altruism, lawfulness and justice, and gender and race. Discussions focus on unpacking the ethical implications of literary texts and the literary means by which these implications are communicated. Students are encouraged to attend the Technology and Culture public forums whenever relevant to the text at hand.
R. Perry, R. Langton

21L.310 Bestsellers
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
2-0-4
Can be repeated once for credit if content differs
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. Enrollment limited.
Staff

21L.315 Prizewinners
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
2-0-4
Can be repeated once for credit if content differs
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.
Staff

21L.320 Big Books
Prereq: None
U (Fall, Spring)
2-0-4
Can be repeated once for credit if content differs
Emphasis 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. Content varies from term to term. Enrollment limited.
Fall: M. Fuller
Spring: Staff

21L.325 Small Wonders
Prereq: None
U (Fall, Spring)
2-0-4
Can be repeated once for credit if content differs
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. Enrollment limited.
Fall: R. Perry
Spring: N. Jackson
21L.330 Latin I
Prereq: None
U (Fall; first half of term)
3-0-3
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 Elective. Limited to 20.
Staff

21L.335 Latin II
Prereq: 21L.330 or permission of instructor
U (Fall, second half of term)
3-0-3
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 Elective. Limited to 20.

21L.345 On the Screen (New)
Prereq: Permission of instructor
U (IAP)
Can be repeated for credit once with permission of instructor
2-0-4
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.
E. Brinkema

INTERMEDIATE SUBJECTS

Genres and Themes

21L.420 Literary Studies: The Legacy of England
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H (HASS-E)
Credit cannot also be received for 21L.220
Examines English literature across genre and historical period. Designed for students who wish to study English literature or writing in some depth, or wish to know more about English literary culture and history. Learn about the relationships between literary themes, forms, and conventions and the times in which they were produced. Students examine Renaissance

21L.430 Popular Culture and Narrative
(Same subject as 21M.223J)
Prereq: None
U (Fall)
3-1-8 HASS-A (HASS-D 3); CI-H
See description under subject 21M.223J.
G. Ruckert, R. Perry

21L.431 Comedy
Prereq: None
U (Fall, Spring)
3-3-6 HASS-H (HASS-D 1); 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, Molière, Austen, Wilde and Chaplin.
Fall: H. Eiland
Spring: W. Kelley

21L.432 Understanding Television
(Subject meets with CMS.915)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-3-6 HASS-H (HASS-E)
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 primetime 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. Meets with CMS.915, but assignments differ.
Staff

21L.433 Film Styles and Genres
Prereq: 21L.011 or permission of instructor
U (Spring)
3-3-6 HASS-H (HASS-E)
Can be repeated for credit with permission of instructor
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.
Staff

21L.434 Science Fiction and Fantasy
Prereq: None
U (Fall, Spring)
3-3-6 HASS-H (HASS-E)
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.
Fall: A. Braithwaite
Spring: Staff

Previously taught topics include Elements of Style and Popular Culture in an Age of Media Convergence. 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.
Staff
21L.435 Literature and Film
(Subject meets with CMS.840)
Prereq: One subject in Literature or Comparative Media Studies
U (Fall, Spring)
3-3-6 HASS-H (HASS-E)
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. Previously taught topics include Shakespeare, Film and Media. Meets with CMS.840, but assignments differ.

Fall: P. Donaldson
Spring: A. Kibel

21L.448| Darwin and Design
(Same subject as 21W.739)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-D 2); 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.

Fall: J. Paradis
Spring: A. Kibel

21L.449 Literature and the Environment
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

A brief history of conflicting ideas about mankind’s relation to the natural environment as exemplified in works of poetry, fiction, and discursive argument from ancient times to the present. Examines views about the overall character of the natural world and whether mankind’s relation to it is one of stewardship and care or hostility and exploitation. Readings include Aristotle, *The Book of Genesis*, Shakespeare, Descartes, *Robinson Crusoe*, Swift, Rousseau, Wordsworth, Darwin, Thoreau, Faulkner, and Lovelock’s *Gaia*.

A. Kibel

21L.450 Leadership, Ethics, and Literature
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Examination of literary works to explore competing ethical concepts and the ethical implications of certain actions and commitments. Topics include origins of morality, ideals of justice, the nature of the virtues, notions of responsibility, ethics and politics, and the ethics of extreme situations. Philosophic texts by Plato, Aristotle, Machiavelli, Hobbes, and Kant. Narrative and dramatic texts by Sophocles, Euripides, Shakespeare, Swift, Ibsen, Shaw, Dostoyevsky, and Conrad, as well as some Biblical materials.

A. Kibel

21L.451 Introduction to Literary Theory
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

Examines the ways texts can be read and questions that readers ask of texts. Aims to provide students with a sense of the different critical approaches to literature. Topics include: structuralism and semiotics; post-structuralism and post-modernism; historicism and historicist paradigms; psychoanalysis; intertextuality; and cultural criticism.

S. Raman

**Periods of World Literature**

21L.455 Classical Literature
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

Can be repeated once for credit if specific topic is different

Explores the classical roots of Western civilizations through a close examination of the social and cultural contexts in which selected literary texts were first produced, the influence of political structures and ideologies, the function of rhetorical forms, the purpose and significance of ancient mythologies, and the relation of literature to shared developments in art, architecture, and religion. Texts taught in translation, but direct readings in the original languages are encouraged. Authors include Livy, Lucretius, Cicero, Julius Caesar, Virgil, Horace, and Ovid. Texts and topics vary from year to year. Enrollment limited.

A. Bahr

21L.458 The Bible
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

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. Investigation of the Bible as influence in later narrative, philosophic, and artistic traditions.

I. Lipkowitz

21L.460 Medieval Literature
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H (HASS-E)

Can be repeated for credit

Surveys a range of literary works across different European cultures from the Roman Empire to the beginnings of the Renaissance. Literary movements and cultural developments discussed in their social, political, and historical contexts. Topics covered include the growth of religious communities, the shift from orality to literacy, the culture of chivalry and courtly love, the emergence of scholasticism and universities, changes in devotional practices and popular piety, religious intolerance and the Crusades, and the rise of nationalism and class consciousness. Previously taught topics include Medieval Women Writers, The Crusades, and Dante, Boccaccio and Chaucer. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Enrollment limited.

A. Bahr

21L.463 Renaissance Literature
Prereq: One subject in Literature
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)

Readings are organized around topics (Renaissance self-fashioning, courtship and courtiership, gender and the emerging individual) or literary genres (lyric, epic, drama, prose). Works drawn primarily from the Italian and English Renaissance, and may include such figures as Petrarch, Shakespeare, More, Jonson, Machiavelli, Castiglione, Milton, Spenser, Bacon, Donne, and Sidney. Previously taught topics include Renaissance Poetry and Strivers and Slackers. Enrollment limited.

M. Fuller
21L.470 18th-Century Literature
Prereq: One subject in Literature
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
An examination of 18th-century English writers in their historical context. Authors James Thomson, Joseph Addison, Laurence Sterne, Mary Robinson, and Mary Wollstonecraft address issues of capitalism and class mobility; romantic love and the changing definition of femininity and masculinity; the mutual emergence of mass culture and of high-cultural aesthetics; and colonialism and international travel.
Staff

21L.471 Major English Novels
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H (HASS-E)
Can be repeated for credit with permission of instructor
Studies important examples of the literary form that, between the beginning of the 18th century and the end of the 19th century, became an indispensable instrument for representing modern life, in the hands of such writers as Defoe, Richardson, Fielding, Sterne, Burney, Austen, Scott, Dickens, the Brontës, Eliot, Hardy, and Conrad. The class alternates between 18th- and 19th-century topics.
I. Lipkowitz

21L.472 Major European Novels
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
Staff

21L.473J Jane Austen
(Same subject as WGS.240J)
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H (HASS-E)
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. Instruction and practice in oral and written communication provided. Enrollment limited.
R. Perry

21L.476 Romantic Poetry
Prereq: One subject in Literature
U (Fall)
3-0-9 HASS-H (HASS-E)
Close readings of the major British Romantic poets (Blake, Wordsworth, Coleridge, Byron, Scott, Shelley, and Keats) and important fiction writers (Mary Shelley and Walter Scott). Attention given to literary and historical contexts.
N. Jackson

21L.481 Victorian Literature and Culture
Prereq: One subject in Literature
U (Fall)
3-0-9 HASS-H (HASS-E)
Can be repeated for credit
British literature and culture during Queen Victoria’s long reign, 1837–1901. Authors studied may include Charles Dickens, the Brontës, Lewis Carroll, George Eliot, Robert Browning, Oscar Wilde, Arthur Conan Doyle, Rudyard Kipling, and Alfred Lord Tennyson. Discussion of many of the era’s major developments such as urbanization, steam power, class conflict, Darwin, religious crisis, imperial expansion, information explosion, and bureaucratization. Fiction, nonfiction, poetry; syllabi vary.
Staff

21L.485 Modern Fiction
Prereq: One subject in Literature
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)
Credit cannot also be received for 21L.285
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. Meets with 21L.285 when offered concurrently. Students taking the 12-unit version complete additional assignments. Enrollment limited.
D. Thorburn

21L.486 Modern Drama
Prereq: One subject in Literature
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
Credit cannot also be received for 21L.286

S. Tapscott

21L.487 Modern Poetry
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H (HASS-E)
S. Tapscott

21L.488 Contemporary Literature
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H (HASS-E)
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.
A. Braithwaite

21L.489J Interactive and Non-Linear Narrative: Theory and Practice
(Same subject as 21W.765J)
(Subject meets with CMS.845)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-A (HASS-E)
See description under subject 21W.765J.
N. Montfort

American Literature

See also 21L.006.
21L.501 The American Novel
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

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”). Enrollment limited.

W. Kelley

21L.504J Race and Identity in American Literature
(Same subject as WGS.140j)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

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 Cultural Encounters from 1492 to the Civil War, Immigrant Stories, African American Literature, and Asian American Literature.

W. Kelley

21L.512 American Authors
Prereq: One subject in Literature
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

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, Hemingway, and American Short Fiction. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program.

S. Alexandre

International Literatures

See also 21L.007 and 21L.020j.

21L.522J International Women’s Voices
(21F.022)
(Same subject as 21F.022j, WGS.141j)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 1); CI-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 Bâ, Isabel Allende, Anita Desai, Maxine Hong Kingston, Toni Morrison, Doris Lessing, Alifa Rifaat, Yang Jiang, Nawal Al-Saadawi, and Sawako Ariyoshi. Taught in English.

M. Resnick

SEMINARS

(21F.740j)
(Same subject as 21F.740j)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)

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 Almodóvar and Saura, educational reforms instituted by the socialist government, and the fiction of Carmen Riera and Terenci Moix. Special emphasis on the emergence of mass media as a vehicle for expression in Spain. Discusses 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 Interpretation
Prereq: Two subjects in Literature
U (Fall)
3-0-9 HASS-H (HASS-E)
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 Reading Poetry. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Limited to 12.

S. Raman

21L.702 Studies in Fiction
Prereq: Two subjects in Literature
U (Fall, Spring)
3-0-9 HASS-H (HASS-E)
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. Limited to 12.

Fall: J. Bazard
Spring: D. Thorburn

21L.703 Studies in Drama
Prereq: Two subjects in Literature
U (Spring)
3-0-9 HASS-H (HASS-E)
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, and Tom Stoppard, Caryl Churchill. Limited to 12.

D. Henderson
21L.704 Studies in Poetry  
Prereq: Two subjects in Literature  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Fall, Spring)  
3-0-9 HASS-H (HASS-E)  
Can be repeated for credit  

Extensive reading of works by a few major poets. Emphasis on the evolution of each poet’s work and the questions of poetic influence and literary tradition. Instruction and practice in oral and written communication. Previously taught topics include Does Poetry Matter?, Poetry and the Science of Mind, 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. Limited to 12.  
Fall: S. Tapscott  
Spring: D. Henderson  

21L.705 Major Authors  
Prereq: Two subjects in Literature  
U (Fall, Spring)  
3-0-9 HASS-H (HASS-E)  
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. Limited to 12.  
Fall: W. Kelley  
Spring: M. Fuller  

21L.706 Studies in Film  
(Subject meets with CMS.830)  
Prereq: 21L.011, one subject in Literature or Comparative Media Studies; or permission of instructor  
U (Fall, Spring)  
3-3-6 HASS-H (HASS-E)  
Can be repeated for credit  

Intensive study of films from a particular period or genre, or films by a single director. Instruction and practice in oral and written communication provided. Previous topics include Technologies of Seeing: Pre-Cinema to Early Cinema, Hollywood/Bollywood, Film Analysis, and Shakespeare on Film. Students taking graduate version complete different assignments. Limited to 12.  
Fall: E. Brinkema  
Spring: P. Donaldson  

21L.707 Problems in Cultural Interpretation  
Prereq: Two subjects in Literature or permission of instructor  
U (Fall)  
3-0-9 HASS-H (HASS-E)  
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. Limited to 12.  
S. Tapscott  

21L.709 Studies in Literary History  
Prereq: Two subjects in Literature or History  
U (Spring)  
3-0-9 HASS-H (HASS-E)  
Can be repeated for credit  

Close examination of the literature of a particular historical period. Syllabi vary. Instruction and practice in oral and written communication. Limited to 12.  
R. Perry  

21L.715 Media in Cultural Context  
(Subject meets with CMS.871)  
Prereq: Two subjects in Literature or Comparative Media Studies; or permission of instructor  
U (Spring)  
3-3-6 HASS-H (HASS-E)  
Can be repeated for credit  

Seminar designed to provide close case study examinations of 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, specific genres or movements, specific media, or specific historical moments. Instruction and practice in written and oral communication provided. 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.  
Staff  

21L.700 Independent Study (21L.999)  
Prereq: Permission of instructor  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit with permission of instructor  

21L.901 Independent Study (New)  
Prereq: Permission of instructor  
U (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit with permission of instructor  
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.  
Staff  

21L.592 Special Subject in Literature (21L.992)  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit if the subjects are different  

21L.593–21L.594 Special Subject in Literature (21L.993–21L.994)  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit if the subjects are different  

21L.595 Special Subject in Literature (21L.995)  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit if the subjects are different  
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.  
Staff  

21L.596 Special Subject in Film and Media (21L.996)  
Prereq: Two subjects in Film and Media; permission of the director of Comparative Media Studies  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit with additional permission of the instructor  

21L.597 Special Subject in Film and Media (21L.997)  
Prereq: Two subjects in Film and Media; permission of director of Comparative Media Studies  
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit with additional permission of the instructor

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.

Staff

21L.THT Literature Pre-Thesis Tutorial
Prereq: None
U (Fall, Spring)
1-0-5
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.

Staff

21L.UR Undergraduate Research
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

For individual research in Literature, register for 21L.UR or 21L.URG. For Literature pre-thesis tutorial, register for 21L.ThT. For undergraduate thesis, register for 21L.ThU. Descriptions of these subjects can be found in the beginning of this section under 21.UR, 21.URG, 21.ThT, and 21.ThU.
### Bachelor of Science in Literature/Course 21L

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>( \text{Units} )</th>
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<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by subjects in the Departmental Program]</td>
<td></td>
<td>8</td>
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<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
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<td>2</td>
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<tr>
<td>Laboratory Requirement</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

### Communication Requirement
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
- 2 subjects designated as Communication Intensive in the Major (CI-M).

### PLUS Departmental Program
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

#### Required Subjects
Three seminar level subjects

To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take two subjects from this list of approved CI-M subjects for Course 21L: 21L.473J, 21L.701, 21L.702, 21L.703, 21L.704, 21L.705, 21L.706, 21L.707, 21L.708, 21L.709.

Note: Four of the 10 subjects required to satisfy the major (three of the eight for joint majors) must be chosen, in consultation with a faculty advisor, either from four of five historical periods (ancient/medieval; Renaissance; Restoration and 18th century; 19th century; 20th century and contemporary) or from four of five thematic complexes (historical period; genre; author study; film, media, and popular culture; gender studies, ethnic studies, and theory).

#### Restricted Electives
A coherent program of seven additional subjects from the literature curriculum (see above).

#### Departmental Program Units That Also Satisfy the GIRs
(27–36)

#### Unrestricted Electives
87–117

#### Total Units Beyond the GIRs Required for SB Degree
180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
The Music subjects described below are grouped within six areas: Introductory, History/Literature, Theory/Composition, 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 HASS-A (HASS-D 3); CI-H

Gives students a broad overview of Western music from the Middle Ages to the 20th century, with emphasis on late baroque, classical, romantic, and modernist styles. Enhances 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 may be limited.

Fall: M. Marks, T. Neff
Spring: G. Ruckert, T. Neff, A. Boyles

21M.013J The Supernatural in Music, Literature and Culture
(Same subject as 21A.113J, 21L.013J)
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-D 3); 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 a better 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 will also include selections from the most recent scholarship on magic and the supernatural. Writing assignments will range from web-based projects to analytic essays. No previous experience in music is necessary. Projected guest lectures, musical performances, field trips.

C. Shadle, J. Howe, M. Fuller

21M.030 Introduction to World Music
Prereq: None
U (Fall, Spring)
3-0-9 HASS-A (HASS-D 3); 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.

Fall: G. Ruckert, P. Tang
Spring: P. Tang

21M.051 Fundamentals of Music
Prereq: None
U (Fall, Spring)
3-3-6 HASS-A (HASS-E)

Introduces students to the rudiments of Western 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. Limited to 20 by lottery. Not open to students who have completed 21M.301 or 21M.302.

Fall: P. Wood, E. Kwon
Spring: P. Wood

21M.065 Introduction to Musical Composition
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-D 3)

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. No formal training is required. Weekly listening, reading, and composition assignments draw on a broad range of musical styles and intellectual traditions, from various cultures and historical periods. Limited to 20.

E. Ziporyn

HISTORY/LITERATURE

21M.215 American Music
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS-A (HASS-E)

A survey of music in the United States from the colonial period to the present in the context of American cultural history, with an emphasis on Boston’s musical life whenever feasible. Listening and writing assignments concern classical, popular, folk, musical theater, and jazz repertories.

Staff

21M.220 Early Music
Prereq: None. Coreq: 21M.301
U (Fall)
3-0-9 HASS-A (HASS-E)

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.223J Folk Music of the British Isles and North America
(Same subject as 21L.423J)
Prereq: None
U (Fall)
3-1-8 HASS-A (HASS-D 3); 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.

G. Ruckert, R. Perry
21M.226 Jazz
Prereq: None
U (Fall, Spring)
3-0-9 HASS-A (HASS-D 3)
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 Monteverdi to Mozart: 1600–1800
Prereq: 21M.301 or permission of instructor
U (Fall)
3-0-9 HASS-A (HASS-E)
Surveys seven Baroque and Classical genres: opera, oratorio, cantata, sonata, concerto, quartet, and symphony. Includes the composers Bach, Handel, Haydn, Monteverdi, Mozart, Purcell, Schütz and Vivaldi. Bases written essays and oral presentations on live performances as well as listening and reading assignments. Basic score-reading ability recommended.
L. Lindgren

21M.250 Beethoven to Mahler: 1800–1910
Prereq: 21M.301 or permission of instructor
U (Spring)
3-0-9 HASS-A (HASS-E)
Surveys six Romantic genres: Lied/song, choral music, opera, piano sonata/character cycle, concerto, and symphony/symphonic poem. Includes the composers Beethoven, Berlioz, Brahms, Chopin, Debussy, Puccini, Schubert, Tchaikovsky, and Verdi. Bases written essays and oral presentations on live performances as well as listening and reading assignments. Requires basic score-reading ability.
L. Lindgren

21M.260 Stravinsky to the Present
Prereq: 21M.301 or permission of instructor
U (Spring)
3-0-9 HASS-A (HASS-E)
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.
M. Marks

21M.269 Studies in Western Music History (New)
Prereq: 21M.301 or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-A (HASS-E)
Can be repeated for credit with permission of instructor
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.
M. Cuthbert

21M.271 Symphony and Concerto: 1720–Present
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS-A (HASS-E)
Listening assignments include movements from 28 symphonies and 28 concertos. Class discussion and oral presentations focus on works in 16 miniature scores. Students write three essays, each reviewing a live performance. Basic score-reading ability required.
L. Lindgren

21M.273 Opera: 1607 to Present
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-E)
Focuses on the text, music and staging of excerpts from nearly fifty works by approximately twenty-five composers, most notably Mozart, Wagner, Verdi, and Puccini. Essays review live performances. Includes presentations based on works dating from the past 150 years.
L. Lindgren

21M.283 Musicals of Stage and Screen
Prereq: One subject in film, music, or theater; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall, Spring)
3-0-9 HASS-A (HASS-E)
Can be repeated for credit with permission of instructor
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. 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, or the Hollywood film score.
Staff

21M.289 Studies in Western Classical Genres (New)
Prereq: 21M.301 or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-A (HASS-E)
Surveys styles and dramatic functions of music for silent films of the 1910s–1920s, 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.291 Music of India
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-E)
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
many rich traditions and styles (minstrelsy, characterizes modern music, and how it reflects hundred years. Examines the ethnic mixture that to the history and sociology of the last two hundred years. Examines the ethnic mixture that routed by mass media. Various popular music genres from around the world are studied through listening and reading assignments, while considering issues of musical change, syncrasy, Westernization, globalization, the impact of recording industries, and the post-colonial era. Case studies include bhangra, Afro-pop, reggae, and global hip-hop.

21M.294 Popular Musics of the World
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-E)

Focuses on musical traditions of West Africa. A variety of musical practices and their cultural contexts are explored through listening, reading and writing assignments with an emphasis on class discussion. Subject includes in-class instruction in Senegalese drumming, song and dance, as well as live lecture-demonstrations by guest performers from throughout West Africa.

P. Tang

21M.293 Music of Africa
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-E)

Focuses on musical traditions of West Africa. A variety of musical practices and their cultural contexts are explored through listening, reading and writing assignments with an emphasis on class discussion. Subject includes in-class instruction in Senegalese drumming, song and dance, as well as live lecture-demonstrations by guest performers from throughout West Africa.

P. Tang

21M.292 Music of Indonesia
Prereq: None
U (Spring)
2-2-8 HASS-A (HASS-E)

Provides an introduction to the fascinating, intricate music of Indonesia. The Indonesian archipelago is home to a wide variety of cultures and musical traditions, many of them largely unknown in the West. From the Gamelan percussion orchestras of Bali and Java to the indigenous folk traditions of Sumatra and Borneo, and Western-influenced pop and street traditions.

E. Ziporyn

21M.299 Studies in World, Traditional, and Popular Music (New)
Prereq: 21M.030 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall, Spring)
3-0-9 HASS-A (HASS-E)

Can be repeated for credit with permission of instructor

Studies of selected topics in ethnomusicology (the study of music in culture). Topics vary. Examples include fieldwork methodologies, Asian classical traditions, Senegalese Mbalax, Hindustani Khyal, Brazilian Samba, or Duke Ellington.

Staff

THEORY/COMPOSITION

21M.301 Harmony and Counterpoint I
Prereq: 21M.051; or placement exam and permission of instructor
U (Fall, Spring)
3-3-6 HASS-A (HASS-D 3)

Covers basic writing skills in music of the common-practice period (Bach to Brahms). Regular written assignments lead to the composition of short pieces. Analyzes representative works from the literature, keyboard laboratory, and sight-singing choir. Background in concert music listening or performing recommended. Enrollment limited.

Fall: M. Harvey, P. Child, E. Ruehr
Spring: M. Harvey, G. Ruckert, E. Ruehr

21M.302 Harmony and Counterpoint II
Prereq: 21M.301 or permission of instructor
U (Fall, Spring)
3-2-7 HASS-A (HASS-E)

A continuation of 21M.301, including chromatic harmony and modulation, a more extensive composition project, keyboard laboratory, and musicianship laboratory. Enrollment limited.

Fall: P. Child, K. Makan
Spring: C. Shadle, W. Cutter

21M.303 Writing in Tonal Forms I
Prereq: 21M.302
U (Fall, Spring)
3-1-8 HASS-A (HASS-E)

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.

Fall: C. Shadle, P. Wood, G. Saraydarian
Spring: P. Child, P. Wood, G. Saraydarian

21M.304 Writing in Tonal Forms II
Prereq: 21M.303
U (Spring)
3-1-8 HASS-A (HASS-E)

Further written and analytic exercises in tonal music, focusing on larger or more challenging forms. For example, students might compose a 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.

C. Shadle, P. Wood, G. Saraydarian

21M.310 Techniques of 20th-Century Composition
Prereq: 21M.302, 21M.260, or permission of instructor
U (Fall)
3-0-9 HASS-A (HASS-E)

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. Enrollment limited.

K. Makan

21M.340 Jazz Harmony and Arranging
Prereq: 21M.051, 21M.226, or permission of instructor
U (Spring)
3-0-9 HASS-A (HASS-E)

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 20.

M. Harvey
21M.341 Jazz Composition  
Prereq: 21M.226, 21M.340, or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Fall)  
3-0-9 HASS-A (HASS-E)  
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, Evans, Nelson, Golson, Coleman, Coltrane, Threadgill, Hemphill, and others. Performance of student compositions. Limited to 20.  
M. Harvey

21M.342 Composing for Jazz Orchestra  
Prereq: Permission of instructor  
Acad Year 2011–2012: U (Fall)  
Acad Year 2012–2013: Not offered  
3-0-9 HASS-A (HASS-E)  
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 20.  
M. Harvey

21M.350 Musical Analysis  
Prereq: 21M.302 or permission of instructor  
U (Spring)  
3-0-9 HASS-A (HASS-E)  
Introduction to the analysis of tonal music. Students develop analytical techniques based upon concepts learned in 21M.301–21M.302. Examines rhythm and form, harmony, line and motivic relationships at local and large scale levels of musical structure. Several works from the Baroque, Classical and Romantic periods will be studied in depth.  
P. Child

21M.351 Music Composition  
(Subject meets with 21M.505)  
Prereq: 21M.304, 21M.310, or permission of instructor  
U (Fall)  
3-0-9 HASS-A (HASS-E)  
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.  
E. Ziporyn

21M.355 Musical Improvisation  
Prereq: Permission of instructor  
U (Fall, Spring)  
3-0-9 HASS-A (HASS-E)  
Can be repeated for credit  
Students study improvisation techniques in solo and ensemble contexts, culminating in one or more public performances. Examines relationships between improvisation, composition, and performance from a score. Topics, with occasional guest lectures, may include jazz, non-western music, and improvisation in western concert music. Can be repeated for credit with permission of instructor. Enrollment may be limited; open by audition to instrumental or vocal performers.  
D. Fox

21M.361 Electronic Music Composition I  
Prereq: None  
U (Fall, Spring)  
2-1-9 HASS-A (HASS-E)  
Students develop basic skills in composition and performance from a score. Topics, with occasional guest lectures, may include jazz, non-western music, and improvisation in western concert music. Can be repeated for credit with permission of instructor. Enrollment may be limited; open by audition to instrumental or vocal performers.  
C. Ariza

21M.362 Electronic Music Composition II  
Prereq: 21M.361 or permission of instructor  
U (Spring)  
2-2-8 HASS-A (HASS-E)  
Explores sophisticated synthesis techniques, from finely tuned additive to noise filtering and distortion, granular synthesis to vintage emu- lation. 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 8.  
P. Whincop

21M.380 Music and Technology  
Prereq: Permission of instructor  
U (Fall, Spring)  
3-0-9 HASS-A (HASS-E)  
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, or recording techniques. May involve hands-on components such as a laptop music ensemble, new instrument building, or comparing the theory and practice of audio recording.  
C. Ariza

PERFORMANCE

Each of the following subjects earns 6 units. A total of 12 units is needed for a subject to count toward Institute Requirements in Humanities, Arts, and Social Sciences, by petition to the Committee on Curriculum.

21M.401 MIT Concert Choir  
Prereq: None  
U (Fall, Spring)  
0-4-2  
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
oratories of our own time. Open to graduate and undergraduate students by audition.

A. Boyles

21M.405 MIT Chamber Chorus
Prereq: None
U (Fall, Spring)
3-0-3
Can be repeated for credit
Rehearsal and performance of choral repertoire

A. Boyles

21M.410 Vocal Repertoire and Performance
(Subject meets with 21M.515)
Prereq: None. Coreq: Participation in ensemble for vocalists
U (Spring)
3-0-3
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
Can be repeated for credit
Rehearsal preparation 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.301, 21M.302, or permission of instructor
U (Fall, Spring)
3-4-5 HASS-A (HASS-E)
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.

A. Boyles

21M.426 MIT Wind Ensemble
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit
Open by audition to 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.

F. Harris

21M.442 MIT Festival Jazz Ensemble
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit
Open by audition to 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. Experience in improvisation preferred but not required. Opportunities to work with professional jazz artists and perform commissioned works by recognized jazz composers.

F. Harris

21M.445 Chamber Music Society
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit
Study of chamber music literature through analyses, rehearsal, and performance. Weekly seminars and coaching. Open to string, piano, brass, woodwind players, and singers. By audition.

M. Thompson, D. Deveau, J. Rife, J. Harbison, F. Harris

21M.450 MIT Balinese Gamelan
Prereq: Permission of instructor
U (Fall, Spring)
0-3-3
Can be repeated for credit
A performing ensemble dedicated to the traditional music of Bali and East Java. Members of the ensemble rehearse and study techniques on MIT’s three distinctive sets of gamelan instruments and perform in conjunction with Gamelan Galak Tika. No previous experience necessary, but prior enrollment in 21M.030 or 21M.292 is strongly recommended. Limited to 25 students by audition.

E. Ziporyn

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 for 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
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 20 students by audition.

L. Toure
21M.480 Advanced Music Performance (Subject meets with 21M.512)  
Prereq: None  
U (Fall, Spring)  
1-2-3  
Can be repeated for credit  

Open by audition to 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. Meets with graduate subject 21M.512, but assignments differ.  
D. Deveau, M. Thompson

21M.490 Emerson Scholar Solo Recital (Subject meets with 21M.525)  
Prereq: Permission of instructor  
U (Spring)  
1-0-5  
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 Emerson Scholars Stellar site for application deadlines and conditions. Restricted to Emerson Scholars.  
M. Thompson, D. Deveau, J. Rife

21M.500 Senior Seminar in Music  
Prereq: 21M.302 and two 21M.2xx subjects  
U (Fall)  
3-0-9 HASS-A (HASS-E)  

Develop analytic and research skills in music. Focus upon a small number of important works, which are studied in depth. Strong emphasis upon student presentations and discussion, and a substantial writing project.  
M. Marks

21M.505 Music Composition (Subject meets with 21M.351)  
Prereq: 21M.304, 21M.310, or permission of instructor  
G (Fall)  
3-0-9  
Can be repeated for credit  

See description under subject 21M.351.  
E. Ziporyn

21M.512 Advanced Music Performance (Subject meets with 21M.480)  
Prereq: None  
G (Fall, Spring)  
1-2-3  
Can be repeated for credit  

Meets with undergraduate subject 21M.480, but assignments differ.  
D. Deveau, M. Thompson

21M.515 Vocal Repertoire and Performance (Subject meets with 21M.410)  
Prereq: None  
G (Spring)  
3-0-3  
Can be repeated for credit  

See description under subject 21M.410.  
A. Boyles

21M.525 Emerson Scholars Solo Recital (Subject meets with 21M.490)  
Prereq: None  
G (Spring)  
1-2-3  
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.533, 21M.554 Special Subject in Music (21M.5539, 21M.5542)  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
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

21M.580] Musical Aesthetics and Media Technology (Same subject as MAS.825])  
Prereq: Permission of instructor  
G (Fall)  
3-3-3 H-LEVEL Grad Credit  

See description under subject MAS.825].  
T. Machover

21M.581] Projects in Media and Music (Same subject as MAS.826])  
Prereq: MAS.825]  
G (Spring)  
3-3-6 H-LEVEL Grad Credit  
Can be repeated for credit  
See description under subject MAS.826].  
T. Machover

THEATER ARTS

The subjects listed below are arranged in three sections: Introductory Subjects; Intermediate Subjects; and Advanced/Special Subjects. For Subjects dealing with the literature of the theater, see 21L.009, 21L.422, 21L.486, 21L.703 in Literature.

INTRODUCTORY SUBJECTS

21M.600 Introduction to Acting  
Prereq: None  
U (Fall, Spring)  
4-0-5 HASS-A (HASS-E)  

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. Brody, K. Mancuso, A. Kohler

21M.603 Introduction to Design for the Theater  
Prereq: None  
U (Fall)  
3-0-6 HASS-A (HASS-E)  

Focuses on the process of designing for the theater. Projects center on awakening the imagination in response to an object, and finding the visual way to represent that response. Explores ways designers approach a script or take a piece of music to create something visual, or to arrange and move a series of objects to tell a story. Students work individually and collaboratively to create drawings, paintings, sculptures, models, collages, and live tableaux.  
S. L. Brown
21M.604J Playwriting I
(Same subject as 21W.754J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-A (HASS-E)
Introduces the craft of writing for the theater, with special attention to the "play" in playwriting. Through weekly assignments and in-class exercises, students explore scene structure, action, events, voice, and dialogue. In workshop format, students present individual work for feedback and are encouraged to bring a sense of fun, joy and playfulness to their writing. Readings include published plays, which provide exposure to a variety of styles, voices, and structures. Emphasizes process, risk taking, and finding one's own voice and vision.
L. Harrington

21M.605 Voice and Speech for the Actor
Prereq: None
U (Fall, Spring)
4-0-5 HASS-A (HASS-E)
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 Linklater's approach 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.
K. Eastley

21M.606 Introduction to Stagecraft
Prereq: None
U (Fall, Spring)
4-3-2 HASS-A (HASS-E)
Introduces the essential technical and engineering knowledge necessary to realize the design of a theatrical production and provides experience with the variety and scope of stagecraft. Students develop a working vocabulary; learn basic shop and handwork skills, including drafting, cutting patterns; and the safe use of all shop machines. Provides a theoretical overview of, and hands-on experience with, the various activities that occur in each shop, including sets, costumes, and lighting. Students complete projects that use all basic skills learned in these technical and design domains. Students design and build an individual final project of their choosing that employs the stagecraft skills acquired over the term. Limited to 12.
M. Katz, S. Brown, K. Perlow, L. Held

21M.611 Foundations of Theater Practice
Prereq: None
U (Fall)
3-3-6 HASS-A (HASS-D 3)
Introduces the ideas, skills, and aesthetic issues which comprise the creation of the theatrical event. Guest artists and faculty members introduce the work of different disciplines such as directing, stagecraft, design, acting, dramaturgy, and criticism. Readings and in-class exercises help students understand and experience the basic creative impulse in each area.
J. Sonenberg

21M.616 Learning from the Past: Drama, Science, Performance
(Subject meets with 21L.016)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring) 3-0-9 HASS-A, HASS-H (HASS-D 3); CI-H
Explores the creation (and creativity) of the modern scientific and cultural world through study of western Europe in the 17th century, the age of Descartes and Newton, Shakespeare, Milton and Ford. Compares period thinking to present-day debates about the scientific method, art, religion, and society. This team-taught, interdisciplinary subject draws on a wide range of literary, dramatic, historical, and scientific texts and images, and involves theatrical experimentation as well as reading, writing, researching and conversing.
D. Henderson, J. Sonenberg

21M.618 Making Theater About Science
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring) 3-5-4 HASS-A (HASS-E); CI-H
Can be repeated for credit
Explores a scientific research issue integral to MIT through the medium of theater. Includes lectures by faculty from Theater Arts and the sciences and notable Boston theater artists. Students develop a theater piece in collaboration with a professional playwright and an MIT scientist whose work focuses on the issue at hand. Students also develop short theater pieces dealing with the subject and present a workshop production for the campus community through Playwrights in Performance. Examples of research issues include the science of memory, aspects of evolutionary theory, and bioengineering. Limited to 18.
A. Brody

21M.621J Theater and Cultural Diversity in the US
(Same subject as WGS.192J)
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-D 3)
Explores contemporary American theatrical expression around issues of gender, ethnic, and cultural identities. Analyzes performances, scripts, video documentation, and invention of original documents of theatrical expression, and construction of gender within particular formations of American culture. Class lectures and discussions analyze samples of Native American, Chicano, African-American, and Asian-American theater, considering the historical and political context for the creation of these works. Performance exercises help identify theatrical forms used by these theaters and consider how these techniques contribute to the overall goals of specific theatrical expressions.
Staff

21M.624 Acting with the Camera (New)
Prereq: 21M.600 or permission of instructor
U (Fall) 4-0-5 HASS-A
Explores the complex discipline of acting for the camera through exploration of the discipline in the context of the history of cinema, television, and multimedia stage performance. In-class exercises, with students both filming and being filmed, provide a platform for experimentation with the theory and practice of performing for and with the camera, culminating in the making of a student-written, edited, and most importantly, acted short film. Limited to 20.
A. Kohler

21M.645 Motion Theater
Prereq: 21M.600 or permission of instructor
U (Fall) 3-0-6 HASS-A (HASS-D)
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.
J. Scheib
MUSIC AND THEATER ARTS

21M.703 Media and Methods: Performing
(Same subject as CMS.403J)
Prereq: CMS.100, 21L.011, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-6 HASS-H (HASS-E)
See description under subject CMS.403J.
J. Scheib

21M.704 Musical Theater Workshop
Prereq: 21M.600 or permission of instructor
U (Spring)
3-0-6 HASS-A (HASS-E)
Introduces students to the art and technique of musical theater performance. Movement, singing, and acting are explored during the term, with a focus on the use of the body as an expressive tool. Students develop an understanding of how musicals are composed and the nature of the actor’s contribution to this dynamic form. Previous experience in musical theater preferred.
Staff

21M.705 The Actor and the Text
Prereq: 21M.600 or permission of instructor
U (Fall, Spring)
4-0-5 HASS-A (HASS-E)
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.
Fall: A. Kohler
Spring: J. Sonenberg

21M.710 Script Analysis
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-E); CI-H
Focuses on reading a script theatrically with a view to mounting a coherent production. Through careful, intensive reading of a variety of plays from different periods and different aesthetics, a pattern emerges for discerning what options exist for interpreting a script. Students discuss the consequences of those options for production. Enrollment limited.
A. Brody

21M.711 Production Seminar
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-6 HASS-A (HASS-E)
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.713 Selected Studies in Theater
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-A (HASS-E)
Can be repeated for credit
Discussion-oriented class that focuses on the theater of a particular culture or a specific theatrical form. Students read several plays over the course of the term that may be supplemented by history, theory, contemporary source documents, etc. At the discretion of the instructor, additional requirements may include attending theatrical productions in Boston and written assignments, such as a reader journal, response papers, or an analytical paper. Possible topics include plays about science, Latino theater, feminist theater, and gay/lesbian theater.
Staff

21M.714 Selected Topics in Theater Arts
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Provides opportunity for study of topics in theater arts not covered by the regular subject listings, particularly experimental subjects offered by permanent and visiting faculty.
Consult Theater Arts Office

21M.715 Topics in Technical Theater Design Exploration
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Provides opportunity for study of theater design or technical topics not covered by the regular subject listings. Experimental subjects, advanced design exploration, advanced craft techniques such as structural design for the stage, or specialty costume designs like chainmail or hat construction.
Theater Arts Faculty

21M.732 Costume Design for the Theater
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-3-6 HASS-A (HASS-E)
Provides an intermediate workshop designed for students who have a basic understanding of the principles of theatrical design and who want a more intensive study of costume design and the psychology of clothing. Students develop designs that emerge through a process of character analysis, based on the script and directorial concept. Period research, design, and rendering skills are fostered through practical exercises. Instruction in basic costume construction, including drafting and draping, provide tools for students to produce final projects.
L. Cocuzzo-Held

21M.733 Scenic Design
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-3-6 HASS-A (HASS-E)
Through a series of 4 to 5 design projects, students develop scenic designs for various types of live performance. Focuses on developing one’s own process for approaching design as well as on learning basic communication skills utilized by scenic designers, including research, drawing, model building, painting, computer drafting, and use of Photoshop.
S. Brown

21M.734 Lighting Design for the Theater
Prereq: Permission of instructor
U (Fall)
3-3-3 HASS-A (HASS-E)
Explores artistry of lighting design. Students gain overall technical working knowledge of tools and apply it to final design. Stresses artistic, conceptual, and collaborative side of the craft utilizing a “hands on” format. Students take advantage of greater Boston venues with backstage tours of various theaters to see how architecture affects lighting design choices. Small projects assigned during term. Final project involves execution of fully realized production. Limited to 10.
K. Perlow

INTERMEDIATE SUBJECTS

21M.701 Production Seminar
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-6 HASS-H (HASS-E)
See description under subject CMS.403J.
J. Scheib

21M.710 Script Analysis
Prereq: None
U (Fall, Spring)
4-0-5 HASS-A (HASS-E)
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.
Fall: A. Kohler
Spring: J. Sonenberg

21M.711 Production Seminar
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-6 HASS-A (HASS-E)
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.713 Selected Studies in Theater
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-A (HASS-E)
Can be repeated for credit
Discussion-oriented class that focuses on the theater of a particular culture or a specific theatrical form. Students read several plays over the course of the term that may be supplemented by history, theory, contemporary source documents, etc. At the discretion of the instructor, additional requirements may include attending theatrical productions in Boston and written assignments, such as a reader journal, response papers, or an analytical paper. Possible topics include plays about science, Latino theater, feminist theater, and gay/lesbian theater.
Staff

21M.714 Selected Topics in Theater Arts
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Provides opportunity for study of topics in theater arts not covered by the regular subject listings, particularly experimental subjects offered by permanent and visiting faculty.
Consult Theater Arts Office

21M.715 Topics in Technical Theater Design Exploration
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Provides opportunity for study of theater design or technical topics not covered by the regular subject listings. Experimental subjects, advanced design exploration, advanced craft techniques such as structural design for the stage, or specialty costume designs like chainmail or hat construction.
Theater Arts Faculty

21M.732 Costume Design for the Theater
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-3-6 HASS-A (HASS-E)
Provides an intermediate workshop designed for students who have a basic understanding of the principles of theatrical design and who want a more intensive study of costume design and the psychology of clothing. Students develop designs that emerge through a process of character analysis, based on the script and directorial concept. Period research, design, and rendering skills are fostered through practical exercises. Instruction in basic costume construction, including drafting and draping, provide tools for students to produce final projects.
L. Cocuzzo-Held

21M.733 Scenic Design
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-3-6 HASS-A (HASS-E)
Through a series of 4 to 5 design projects, students develop scenic designs for various types of live performance. Focuses on developing one’s own process for approaching design as well as on learning basic communication skills utilized by scenic designers, including research, drawing, model building, painting, computer drafting, and use of Photoshop.
S. Brown

21M.734 Lighting Design for the Theater
Prereq: Permission of instructor
U (Fall)
3-3-3 HASS-A (HASS-E)
Explores artistry of lighting design. Students gain overall technical working knowledge of tools and apply it to final design. Stresses artistic, conceptual, and collaborative side of the craft utilizing a “hands on” format. Students take advantage of greater Boston venues with backstage tours of various theaters to see how architecture affects lighting design choices. Small projects assigned during term. Final project involves execution of fully realized production. Limited to 10.
K. Perlow
21M.735 Technical Design: Scenery, Mechanisms, and Special Effects
Prereq: 21M.606 or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-3-6 HASS-A (HASS-E)

Looks at special structural and artistic challenges of theatrical scenery, effects, and construction needs. Explores the technical design process and emphasizes safety, budgeting, and problem solving. Work includes actual production assignments and paper design projects. Final project required to explore each student’s specific interests.

M. Katz

21M.736 The Craft of Costume (New)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-3-3 HASS-A

Explores techniques and materials used to craft costume pieces that are not sewn, such as armor, masks, millinery, wigs, jewelry, and kinetic costume pieces. Students work with traditional materials in innovative ways, as well as with the latest techniques and materials, including thermoplastics, hardware and found objects. Involves research, designing, engineering and creating both character-specific and abstract pieces.

L. C. Held

21M.785J Playwrights’ Workshop
(Same subject as 21W.769J)
(Subject meets with 21M.789)
Prereq: 21M.604, 21W.754 or permission of instructor
U (Spring)
3-2-7 HASS-A (HASS-E)
Can be repeated for credit

Continued work in the development of play scripts for the theater. Writers work on sustained pieces in weekly workshop meetings, individual consultation with the instructor, and in collaboration with student actors, directors, and designers. Fully developed scripts eligible for inclusion in the Playwrights’ Workshop production.

A. Brody

21M.789 Playwrights’ Workshop
(Subject meets with 21M.785J, 21W.769J)
Prereq: 21M.604, 21W.754 or permission of instructor
G (Spring)
3-2-7
Can be repeated for credit

Meets with 21M.785J and 21W.754J but assignments differ.

A. Brody

21M.790 Directing
(Subject meets with 21M.791)
Prereq: 21M.600; 21M.710 or permission of instructor
U (Spring)
4-0-5 HASS-A (HASS-E)

21M.791 Directing
(Subject meets with 21M.790)
Prereq: 21M.600; 21M.710 or permission of instructor
G (Spring)
4-0-5

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

SPECIAL ADVANCED TOPICS AND PRACTICA

21M.805 Theater Practicum
Prereq: At least one studio subject or permission of instructor
U (Fall, Spring; second half of term)
0-3-3
Can be repeated for credit

Provides directed practice in acting or directing on a sustained theater piece, either one-act or full length, from pre-rehearsal preparation to workshop production. Consult Theater Arts Office.

Staff

21M.815 Technical Theater Practicum
Prereq: One Theater Arts subject or permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit

Provides directed practice in theater design or technical production while working on a Theater Arts production.

Consult Rinaldi Staff

21M.820 Technical Theater Special Topics
Prereq: At least one Theater Arts subject or permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit

Provides opportunity to study theater design and technical production subjects including technical theater practica or experimental subjects offered by the permanent or visiting faculty.

Staff

21M.830 Acting: Techniques and Style
(Subject meets with 21M.835)
Prereq: 21M.600, 21M.705
U (Fall, Spring)
4-0-8 HASS-A (HASS-E)
Can be repeated for credit

21M.835 Acting: Techniques and Style
(Subject meets with 21M.830)
Prereq: 21M.600, 21M.705
G (Fall, Spring)
4-0-8
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 of texts from several different historical periods of the Western theatrical tradition. Periods may differ from term to term. Graduate students are expected to complete additional assignments.

Staff

21M.840 Performance Media
(Subject meets with 21M.841)
Prereq: None
U (Spring)
4-2-6 HASS-A (HASS-E)

21M.841 Performance Media
(Subject meets with 21M.840)
Prereq: None
G (Spring)
4-2-6

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, where necessary, is provided. Graduate students are expected to complete additional assignments.

J. Scheib

21M.846 Topics in Performance Studies
(Subject meets with 21M.847)
Prereq: None
U (Spring)
3-2-7 HASS-A (HASS-E)
Can be repeated for credit

21M.847 Topics in Performance Studies
(Subject meets with 21M.846)
Prereq: None
G (Spring)
3-2-7
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. New topics are discussed each year. Students taking the graduate version complete different assignments.

Staff

21M.851 Special Topics in Drama
Prereq: Permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit

21M.852 Special Topics in Drama
Prereq: Permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged [P/D/F]
Can be repeated for credit

Allows students to pursue topics of interest as independent study.

Consult Theater Arts Office

21M.863 Advanced Topics in Theater Arts
Prereq: Any two subjects in Theater Arts or permission of instructor
U (Fall, IAP, Spring; second half of term)
Units arranged
Can be repeated for credit

Gives opportunity for advanced study in theater arts not covered by the regular subject listings. Includes experimental subjects offered by permanent and visiting faculty. Students seeking an individual program of study with a particular faculty member must also obtain the approval of the director of Theater Arts.

Consult Theater Arts Office

21M.864 Theater Studies
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Provides opportunity for the study of theatrical topics not covered in the regular curriculum, particularly experimental subjects offered by faculty or visiting faculty.

Consult Theater Arts Office

21M.865 Research in Theater
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged
Can be repeated for credit with permission

Offers directed research of advanced theatrical subjects occurring in either the performance or theoretical spheres.

Consult Theater Arts Office

21M.873 IAP Theater Arts Topics
Prereq: Permission of instructor
U (IAP)
Units arranged
Can be repeated for credit

Provides opportunity for the study of theater arts topics not covered by regular subject listings, including experimental subjects offered by permanent and visiting faculty. Students seeking an individual program of study with a faculty member must also obtain the approval of the director of Theater Arts. Consult Theater Arts Office for departmental form.

Staff

21M.THT Music Pre-Thesis Tutorial
Prereq: 21M.ThT
U (Fall, Spring)
1-0-5
Can be repeated for credit

Definition of and early-stage work on thesis project leading to 21M.ThU Undergraduate Thesis in Music. 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 Music Headquarters

21M.THU Undergraduate Thesis in Music
Prereq: 21M.ThT
U (Fall, Spring)
Units arranged
Can be repeated for credit

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

Consult Music Headquarters

21M.UR Research in Music
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

21M.URG Research in Music
U (Fall, Spring)
Units arranged
Can be repeated for credit

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

Staff

Note that thesis is not a requirement of the music program.

Th eater Arts students are required to produce a thesis. Since their programs are major departures in the School of Humanities, Arts, and Social Sciences they should register for 21M.ThT and 21M.ThU. They should also register for 21.MUR or 21.URG when doing UROP projects.
# Bachelor of Science in Music/Course 21M

**General Institute Requirements (GIRs)**

- **Science Requirement**
  - Humanities, Arts, and Social Sciences Requirement [three subjects can be from the Departmental Program]
  - 8 subjects
- **Restricted Electives in Science and Technology (REST) Requirement**
  - 2 subjects
- **Laboratory Requirement**
  - 1 subject

**Total GIR Subjects Required for SB Degree**

- 17 subjects

**Communication Requirement**

The program includes a Communication Requirement of 4 subjects:

- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21M.220 Early Music, 12, HASS-A, CI-M; 21M.302*</td>
<td>84</td>
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<tr>
<td>or 21M.260 Stravinsky to the Present, 12, HASS-A; 21M.301*</td>
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<tr>
<td>21M.235 Monteverdi to Mozart: 1600-1800, 12, HASS-A, CI-M; 21M.301*</td>
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<tr>
<td>or 21M.250 Beethoven to Mahler: 1800-1910, 12, HASS-A; 21M.301*</td>
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<tr>
<td>21M.301 Harmony and Counterpoint I, 12, HASS-AT; 21M.051*</td>
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<tr>
<td>or 21M.302 Harmony and Counterpoint II, 12, HASS-A; 21M.301</td>
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<tr>
<td>21M.308 Writing in Tonal Forms I, 12, HASS-A; 21M.302</td>
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<tr>
<td>or 21M.350 Musical Analysis, 12, HASS-A; 21M.302*</td>
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</tbody>
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**Restricted Electives**

- Two terms of Performance subjects, 21M.401–21M.499 (6 units each)
- 21M.500 Senior Seminar in Music, 12, HASS-A, CI-M; 21M.302, two 21M.2xx subjects

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>Units</th>
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<tbody>
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<td>(36)</td>
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</table>

**Unrestricted Electives**

- 96 units

**Total Units Beyond the GIRs Required for SB Degree**

- 180 units

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

**Notes**

* Alternate prerequisites and corequisites are listed in the subject description.
* Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.
* For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
The Program in Writing and Humanistic Studies has three undergraduate subject options:

(1) Creative Writing
(2) Science Writing
(3) Digital Media

Introductory subjects are designed for beginning college writers; advanced subjects are designed to develop greater competence in one or more special forms of writing.

INTRODUCTORY

First-year Writing Subjects

Students write frequently, give and receive feedback on work in progress, improve their work by revising, read the work of accomplished writers, and participate actively in class discussions and workshops. Short oral presentations are also required. Emphasizes writing with an awareness of audience and purpose. Writing and Rhetoric focuses on forms of exposition, including narration, critique, argument, and persuasion, to develop students’ ability to write clear and effective prose. Writing and Experience focuses on the ways writers transform experience into finished and polished writing in the forms of essay, memoir, and autobiography. Science Writing and New Media focuses on writing about science and new media and develops students’ ability to write clear and effective prose for a range of media. Writing about Literature focuses on reading and writing skills used to analyze literary texts. Writing with Shakespeare focuses on writing and speaking, using Shakespeare as a model. Readings and assignments vary by subject and focus on themes relevant to each genre. Enrollment in each subject is limited to 18.

21W.011 Writing and Rhetoric: Rhetoric and Contemporary Issues (New)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for 21W.012, 21W.013, 21W.730

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 photography, 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 (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for 21W.011, 21W.013, 21W.730

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.
K. Boiko

21W.013 Writing and Rhetoric: Introduction to Contemporary Rhetoric (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for 21W.011, 21W.012, 21W.730

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.
D. Unger

21W.021 Writing and Experience: MIT Inside, Live (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for 21W.022, 21W.023, 21W.024, 21W.025, 21W.731

Acting as participant-observers, students investigate MIT’s history and culture through visits to the Institute’s archives and museums, tours of campus architecture, and the hidden byways of MIT’s hackers. Students chronicle their experiences and insights through a variety of writing projects, culminating in the completion of a portfolio. Limited to 18.
L. Marx

21W.022 Writing and Experience: Reading and Writing Autobiography (New)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for 21W.021, 21W.023, 21W.024, 21W.025, 21W.731

Draws on a range of autobiographical writing, including the memoir Furthering My Education. 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.
W. Corbett
21W.023 Writing and Experience: Envisioning Narrative (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for 21W.021, 21W.022, 21W.024, 21W.025, 21W.731

Explores the relationship between the written word and the visual image, taking both popular media images and museum images as cues for writing assignments. Addresses how to translate what one sees into language, and how to use writing to create meaningful images that communicate one’s understanding of self and of the world. Students watch films and read essays about visual perception, photography, painting, and popular media. They also read and create texts that combine words and images, such as blogs, graphic memoirs, and ‘zines.’ Limited to 18.
S. Lewitt

21W.024 Writing and Experience: Culture Shock (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for 21W.021, 21W.022, 21W.023, 21W.025, 21W.731

Focusing on American popular culture, broadly defined, provides an introduction to writing prose for a public audience specifically, prose that is both critical and personal, that features students’ ideas, perspectives, and voices to engage readers. Through reading and writing assignments, students consider how purpose and intended audience shape how one writes and develop skills to employ vivid personal voice and presence in their work. Students collaborate to publish an edition of *Culture Shock!,* an online magazine of writings on American popular culture, at the end of the term. Limited to 18.
R. Faery

21W.025 Writing and Experience: Border Crossings (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for 21W.021, 21W.022, 21W.023, 21W.024, 21W.731

Promotes greater understanding of the experiences of people who speak more than one language, whose ancestry or origins are in a country other than the US, and who have crossed borders of nation, language, culture, or class to amalgamate into the large and diverse culture that is America. Students read personal narratives of bilingual and bicultural writers, some of whom have struggled to assimilate, and others who have celebrated their own contributions to a culture of diversity. Includes four essays, one of which is an investigative essay where students focus on a subject of their choice, research it thoroughly, and write with authority about it. Limited to 18.
R. Faery

21W.031 Science Writing and New Media: Explorations in Communicating about Science and Technology (New)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for ES.033, 21W.032, 21W.034, 21W.035, 21W.732

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.032 Science Writing and New Media: Introduction to Digital Media (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for ES.033, 21W.031, 21W.034, 21W.035, 21W.732

Focuses on digital media production and associated written and oral reports. Working individually and in small, collaborative teams, students create a variety of digital media projects throughout the term, culminating in a larger final project of their choosing. Assignments include audio and video essays, website design, games and interactive fiction, mobile technology, and readings. Students write bi-weekly short essays analyzing their digital projects, as well as a proposal, progress report and completion report for the final project. Limited to 18.
E. Barrett

21W.033 Science Writing and New Media: Engineering Communication in Context (New)
(Same subject as ES.033)
Prereq: None
U (Fall)
3-1-8 HASS-H (HASS-E); CI-HW

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

21W.034 Science Writing and New Media: Perspectives on Medicine and Public Health (New)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for ES.033, 21W.031, 21W.032, 21W.035, 21W.732

Addresses issues, from a writer’s perspective, in medicine and public health, including as AIDS, asthma, malaria control, and obesity. Studies writings intended for multiple purposes (professional and otherwise), by such writers as Atul Gawande, Danielle Ofri, Jerome Groopman, Rafael Campo, and William Carlos Williams. Includes a variety of assignments, such as a critical review, a literature review, a report suitable for general publication, an autobiographical narrative, a resume, a job application letter, and oral presentations. Limited to 18.
Fall: C. Taft
Spring: K. Boiko

21W.035 Science Writing and New Media: Elements of Science Writing for the Public (New)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); CI-HW
Credit cannot also be received for ES.033, 21W.031, 21W.032, 21W.034, 21W.732

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

21W.011 to 21W.035

subjects 21W.011 to 21W.035
21W.041J Writing About Literature (21W.734)  
(Same subject as 21L.000J)  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-H (HASS-E); 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. 
*Fall:* W. Kelley, N. Jackson  
*Spring:* I. Lipkowitz  

21W.042J Writing with Shakespeare (New)  
(Same subject as 21L.010J)  
Prereq: None  
U (Fall)  
3-0-9 HASS-H (HASS-E); CI-HW  
See description under subject 21L.010J.  
D. Henderson  

**CREATIVE WRITING**

**Introductory**


**Advanced**

21W.735 Writing and Reading the Essay  
Prereq: 21W.730, or excellent writing sample and permission of instructor  
U (Spring)  
3-0-9 HASS-H (HASS-D 1); 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.  
R. Faery  

21W.740 Writing Autobiography and Biography  
Prereq: None  
U (Fall)  
3-0-9 HASS-A (HASS-E)  
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.741J Black Matters: Introduction to Black Studies  
(Same subject as 24.912J, 21A.114J, 21H.106J, 21L.008J, WGS.190J)  
Prereq: None  
U (Spring)  
3-0-9 HASS-A, HASS-H (HASS-D 4); CI-H  
See description under subject 24.912J.  
A. Brothwulf, M. DeGraff  

21W.742J Writing about Race  
(Same subject as WGS.231J)  
Prereq: None  
U (Spring)  
3-0-9 HASS-H (HASS-D 2); 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.745 Advanced Essay Workshop  
Prereq: Permission of instructor  
U (Spring)  
3-0-9 HASS-H (HASS-E); 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.  
R. Faery  

21W.747 Rhetoric  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-H (HASS-D 2); 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.  
S. Strang, L. Perelman, S. Lane  

21W.754J Playwriting I  
(Same subject as 21M.604J)  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-A (HASS-D 3); CI-H  
See description under subject 21M.604J.  
L. Harrington  

21W.755 Writing and Reading Short Stories  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-H (HASS-E)  
Introduction to the short story. Students write stories and short descriptive sketches. Readings from European and American stories from the 18th, 19th, and 20th centuries. Class discussion of students’ writing and of the assigned stories in their historical and social contexts.  
H. Lee
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.

21W.757 Fiction Workshop
Prereq: 21W.755
U (Fall, Spring)
3-0-9 HASS-A (HASS-E)
Can be repeated for credit

For students interested in developing their understanding of the craft of fiction. Weekly workshop discussions of students' work focus on analysis of structure, style, and characterization. Emphasis on editing and revision. Reading and discussion of 19th- and 20th-century authors, such as Babel, Carver, Chekhov, Faulkner, Kafka, Orwell, Márquez, and Woolf.

Fall: H. Lee
Spring: S. Lewitt

21W.758 Genre Fiction Workshop
Prereq: A subject in writing short fiction or comparable writing experience
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-A (HASS-E)

Students read stories and novels from various genres. Includes Warriors, a collection of short stories in genres such as fantasy, science fiction, historical fiction, and horror. Includes novels such as True Grit (western), Hit and Run (crime), Coraline (fantasy/horror), and Starship Troopers and The Dispossessed (both science fiction). Considers genre protocols and how to write within the restrictions and freedoms associated with each genre. Students write a short reaction to each novel, and one short story within a genre (or "between" genres) for round-table workshop. Limited to 15.

J. Haldeman

21W.759 Writing Science Fiction
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-E)

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.

J. Haldeman

21W.760 Poetry Workshop
Prereq: None
U (Fall, Spring)
3-0-9 HASS-A (HASS-E)
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.

Fall: E. Barrett
Spring: A. Borsuk

21W.769 Playwrights' Workshop
(Same subject as 21M.785)
(Subject meets with 21M.789)
Prereq: 21M.604, 21W.754 or permission of instructor
U (Spring)
3-2-7 HASS-A (HASS-E)
Can be repeated for credit

See description under subject 21M.785.

A. Brady

21W.770 Advanced Fiction Workshop
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 HASS-A (HASS-E)
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.

Fall: J. Diaz
Spring: A. Lightman

21W.771 Advanced Poetry Workshop
Prereq: Prior manuscript submission required
U (Spring)
3-0-9 HASS-A (HASS-E)
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 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-A (HASS-E)

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.

J. Haldeman

SCIENCE WRITING

Introductory

See subjects 21W.031–21W.035.

Advanced

21W.736 News Writing
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)

An introduction to the basics of print journalism, including an overview of journalistic ethics and life in the newsroom. Students learn basic reporting techniques, interviewing, and news writing, with an emphasis on accuracy, clarity, and brevity. Most writing done in class whereby students learn to write under time pressure, as well as in a distracting environment. Techniques of investigative reporting—including interviewing and research into public and private
sources—are assigned on a weekly basis for outside classroom work.
B. D. Colen

21W.739J Darwin and Design (Same subject as 21L.448J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-D 2); Cl-H
See description under subject 21L.448J.
Fall: J. Paradis
Spring: A. Kibel

21W.746 Humanistic Perspectives on Medicine: From Ancient Greece to Modern America
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E); Cl-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.
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 (Spring)
3-0-9 HASS-A (HASS-E)
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 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-D 1); Cl-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.
Staff

21W.777 The Science Essay
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
Drawing in part from their own interests and ideas, students write about science within various cultural contexts. Students employ a broad repertoire of literary tools, such as narrative, scene-setting, and attention to larger issues of structure. Students study the work of science writers such as Alan Lightman, Oliver Sacks and Malcolm Gladwell to help them create essays of substance and grace that have science and technology as their subjects. Not a technical writing class.
S. Mnookin

21W.778 Science Journalism
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); Cl-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 (Spring)
0-12-0 HASS-H (HASS-E)
Can be repeated for credit
Part-time internships in Boston-area media and industries are arranged for students wishing to develop professional writing and publishing skills. Students planning to take this subject must contact the instructor by November of the previous term.
Staff

DIGITAL MEDIA

Introductory
See subject 21W.032.

Advanced

21W.750 Experimental Writing
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-A (HASS-E)
Students use innovative compositional techniques to write extraordinary texts, 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.751J Writing for Social Media (Same subject as CMS.613J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-A (HASS-E)
Explores how social media is changing our understanding of writing, multimedia, and authorship. Through individual assignments and collaborative work, students contribute to an overarching writing project developed in a networked software environment. Original and re-mixed journalism, memoir, opinion, fiction, poetry, graphics, photos and video are all possible contributions. Assigned readings include exemplary selections from existing public social
media projects, as well as scholarly work and analysis by noted media critics. Limited to 18.  
F. Klink

21W.752 Making Documentary: Audio, Video, and More  
(Subject meets with 21W.824)  
Prereq: 21W.786, 21A.339, or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Spring)  
3-6-3 HASS-A (HASS-E)  
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| Phantasmal Media: Theory and Practice  
(Same subject as CMS.314J)  
(Subject meets with CMS.814)  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Fall)  
3-0-9 HASS-A (HASS-E)  
See description under subject CMS.314J.  
D. Harrell

21W.763J Transmedia Storytelling: Modern Science Fiction  
(Same subject as CMS.309J)  
(Subject meets with CMS.809)  
Prereq: None  
U (Fall)  
3-0-9 HASS-A (HASS-E)  
Explores transmedia storytelling by investigating how science fiction stories are told across different media, such as the short story, the screenplay, moving image, and games. Students read and write critical essays and collaborate to produce their own work of science fiction in a roundtable workshop environment. Students taking graduate version complete additional assignments.  
F. Klink

21W.764J The Word Made Digital  
(Same subject as CMS.609J)  
(Subject meets with CMS.846)  
Prereq: None  
U (Spring)  
3-0-9 HASS-A (HASS-E)  
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. The graduate section includes additional assignments. Limited to 18.  
N. Montfort

21W.765J Interactive and Non-Linear Narrative: Theory and Practice  
(Same subject as 21L.489J)  
(Subject meets with CMS.845)  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Spring)  
3-0-9 HASS-A (HASS-E)  
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.767J Writing for Videogames  
(Same subject as CMS.612J)  
(Subject meets with CMS.866)  
Prereq: None  
U (Spring)  
3-0-9 HASS-A (HASS-E)  
See description under subject CMS.612J.  
C. Fernandez Vara

21W.768J Social and Cultural Facets of Digital Games  
(Same subject as CMS.616J)  
(Subject meets with CMS.868)  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Spring)  
3-0-9 HASS-H (HASS-E)  
See description under subject CMS.616J.  
M. Consolvo

21W.772 Digital Poetry  
Prereq: None  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Spring)  
3-0-9 HASS-A (HASS-E)  
Digital forms of poetry, including hypertext poems, Flash-animated poems, poems within short digital videos and interactive forms of poetry and games. Readings in early hypertext theory and creative writing. Experiment with creating poetry for wireless access on hand held devices. Test the assumptions of these early theorists through practice of creating digital poetry. Students discuss online examples of each of these kinds of digital poetry and then compose their own work, to present in class for critique and revision. The final project allows students to build upon their experience throughout the term with these forms.  
Staff

21W.784 Becoming Digital: Writing about Media Change  
Prereq: None  
U (Fall)  
3-0-9 HASS-H (HASS-D 4); CI-H  
Compares pre-digital to digital media to explore the unique problems that arise in this transition in relation to documenting conflicts from the perspectives of soldiers, journalists, and civilians. Class selects periods, conflicts and readings. Readings include subject-specific texts and media, augmented by technical and theoretical articles relevant to the course themes. Frequent writing and revision, an oral presentation, and intensive class participation are required. Limited to 18.  
N. Montfort

21W.785 Communicating with Web-Based Media  
Prereq: None  
U (Spring)  
3-0-9 HASS-A (HASS-E); CI-H  
Analysis, design, implementation, and testing of various forms of digital communication through group collaboration. Students are encouraged
to think about the Web and other new digital interactive media not just in terms of technology but also broader issues such as language (verbal and visual), design, information architecture, communication and community. Students work in small groups on a term-long project of their choice. Various written and oral presentations document project development.

E. Barrett

21W.786J The Social Documentary: Analysis and Production
(Same subject as CMS.336J)
(Subject meets with CMS.876)
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-E)

An introduction to the history of the social documentary from the 1960s through the 1980s. Explores how social upheaval and the shift to smaller, more portable film cameras, and ultimately hand-held video, converged to bring about an upsurge of socially engaged documentary film production. Students screen and analyze a series of key films from the period and work in groups to produce their own short documentary using digital video and computer-based editing. 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 (Spring)
3-0-9 HASS-H (HASS-E)

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.788J South Asian America: Transnational Media, Culture, and History
(Same subject as CMS.334J)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)

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.789 Communicating with Mobile Technology
Prereq: 1.00, 6.005, or permission of instructor
U (Spring)
3-0-9 HASS-H (HASS-E); CI-H

Students work in small collaborative design teams to propose, build, and document a semester-long project focused on mobile applications for cell phones. Additional assignments include creating several small mobile applications such as context-aware mobile media capture and games. Students document their work through a series of written and oral proposals, progress reports, and final reports. Covers the basics of J2ME and explores mobile imaging and media creation, GPS location, user-centered design, usability testing, and prototyping. Java experience recommended.

E. Barrett

21W.791J Identity and the Internet
(Subject same as CMS.614J)
(Subject meets with CMS.867)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

See description under subject CMS.614J.

M. Consalvo

Additional Subjects

21W.798, 21W.799 Independent Study in Writing
Prereq: None
U (Fall, 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.

T. Levenson

21W.THU Writing and Humanistic Studies Thesis Tutorial
Prereq: None
U (Fall, Spring)
1-0-5

Definition of and early stage work on a thesis project leading to 21W.TH. 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.W.Th.

Staff

21W.THU Writing and Humanistic Studies Thesis Pre-Thesis Tutorial
Prereq: 21W.TH
U (Fall, Spring)
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.W.Th.

Staff
21W.UR Research in Writing and Humanistic Studies
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

21W.URG Research in Writing and Humanistic Studies
U (Fall, Spring)
Units arranged
Can be repeated for credit

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

T. Levenson

Graduate Subjects

21W.794 Graduate Technical Writing Workshop
Prereq: None
G (Fall)
Units arranged
Draft a thesis proposal, thesis chapter, journal article, progress report, or specification, and review basics of engineering writing. Sessions cover the processes of organizing and drafting professional papers, improving writing style, and revising documents. Students determine their own projects; each project increment receives instructor's editorial suggestions.

Staff

21W.820J Writing: Science, Technology, and Society
(Same subject as STS.477J)
Prereq: 21H.991J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject STS.477J.

K. Manning

21W.824 Making Documentary: Audio, Video, and More
(Subject meets with 21W.752)
Prereq: 21W.786, 21A.339, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-6-3
See description under subject 21W.752.

T. Levenson

21W.825 Advanced Science Writing Seminar I
Prereq: Permission of instructor
G (Fall)
6-0-18 H-LEVEL Grad Credit
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.

T. Levenson

21W.826 Advanced Science Writing Seminar II
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.892 Science Writing Internship
Prereq: Permission of instructor
G (Summer)
0-12-0 [P/D/F] H-LEVEL Grad Credit
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 Science Writing
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Opportunity for advanced independent study of science writing under regular supervision by a faculty member. Projects require prior approval, as well as a written proposal and a final report.

Consult Graduate Program Headquarters

21W.899 Graduate Independent Study in Science Writing
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Opportunity for advanced independent study of science writing under regular supervision by a faculty member. Projects require prior approval, as well as a written proposal and a final report.

Consult Graduate Program Headquarters

21W.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring)
6-0-18 H-LEVEL Grad Credit
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.

M. Bartusiak
Bachelor of Science in Writing/Course 21W

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [three subjects may be satisfied by subjects in the Departmental Program]</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication Requirement</th>
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</thead>
<tbody>
<tr>
<td>The program includes a Communication Requirement of 4 subjects:</td>
<td></td>
</tr>
<tr>
<td>2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and</td>
<td></td>
</tr>
<tr>
<td>2 subjects designated as Communication Intensive in the Major (CI-M).</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PLUS Departmental Program Program</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Option 1: Creative Writing (fiction, nonfiction, poetry)**

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21W.TH1 Writing and Humanistic Studies Pre-Thesis Tutorial, 6</td>
<td></td>
</tr>
<tr>
<td>21W.THU Writing and Humanistic Studies Thesis, 12, CI-M; 21W.TH7</td>
<td></td>
</tr>
<tr>
<td>One of the following (CI-M): 21W.757, 21W.758, 21W.759, 21W.762, 21W.770, 21W.771, or 21W.777</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td></td>
</tr>
<tr>
<td>Six subjects centered on creative writing, of which one is normally introductory; three subjects in literature, one of which may be in CMS.</td>
<td></td>
</tr>
</tbody>
</table>

**Option 2: Science Writing**

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21W.777 The Science Essay, 12, HASS-H, CI-M</td>
<td></td>
</tr>
<tr>
<td>21W.778 Science Journalism, 12, HASS-H, CI-H</td>
<td></td>
</tr>
<tr>
<td>21W.792 Science Writing Internship, 12, HASS-H</td>
<td></td>
</tr>
<tr>
<td>21W.TH1 Writing and Humanistic Studies Pre-Thesis Tutorial, 6</td>
<td></td>
</tr>
<tr>
<td>21W.THU Writing and Humanistic Studies Thesis, 12, CI-M; 21W.TH7</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td></td>
</tr>
<tr>
<td>Four subjects in writing, of which one is normally introductory; three are writing subjects approved for this major, one of which is in digital media (48 units).</td>
<td></td>
</tr>
<tr>
<td>One approved Science, Technology, and Society subject (12 units).</td>
<td></td>
</tr>
</tbody>
</table>

**Option 3: Digital Media**

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21W.764J The Word Made Digital, 12, HASS-A</td>
<td></td>
</tr>
<tr>
<td>21W.765J Interactive and Non-Linear Narrative: Theory and Practice, 12, HASS-A</td>
<td></td>
</tr>
<tr>
<td>21W.785 Communicating with Web-Based Media, 12, HASS-A, CI-H</td>
<td></td>
</tr>
<tr>
<td>21W.TH1 Writing and Humanistic Studies Pre-Thesis Tutorial, 6</td>
<td></td>
</tr>
<tr>
<td>21W.THU Writing and Humanistic Studies Thesis, 12, CI-M; 21W.TH7</td>
<td></td>
</tr>
<tr>
<td>One of the following (CI-M): 21W.757, 21W.758, 21W.759, 21W.762, 21W.770, 21W.771, or 21W.777</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td></td>
</tr>
<tr>
<td>Three subjects in writing, which may be in digital media, creative writing, or science writing, and three related subjects from another department.</td>
<td></td>
</tr>
</tbody>
</table>

**Departmental Program Units That Also Satisfy the GIRs**

<table>
<thead>
<tr>
<th>(27–36)</th>
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</thead>
</table>

**Unrestricted Electives**

| Option 1 | 42–69 |
| Option 2 | 66   |
| Option 3 | 42–60 |

**Total Units Beyond the GIRs Required for SB Degree**

| 180 |

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
UNDERGRADUATE SUBJECTS

22.00 Introduction to Modeling and Simulation
Engineering School-Wide Elective Subject
(Offered under: 1.021, 3.021, 10.333)
Prereq: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 REST
See description under subject 3.021.
M. Buehler, J. Grossman

22.01 Introduction to Nuclear Engineering and Ionizing Radiation
Prereq: None
U (Fall)
5-0-7 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.
D. Whyte

22.011 Seminar in Nuclear Science and Engineering
Prereq: None
U (Fall)
2-0-4
Survey the range of diverse subjects in nuclear science and engineering covered by the department. Topics include quantum computing, energy and power, radiation effects-stem cells and DNA, BNCT, nuclear space applications, fusion, airport security, accelerators, magnetic resonance imaging, non-proliferation, risk assessment, safety, biology and medicine. A demonstration of the MIT Reactor as a research tool is given as well as a tour of the MIT Tokomak fusion machine and accelerators used in research.
Staff

22.012 Seminar in Fusion and Plasma Physics
Prereq: None
U (Spring)
2-0-4
Lectures and discussion introducing the range of topics relevant to plasma physics and fusion engineering. Introductory discussion of the economic and ecological motivation for the development of fusion power. Contemporary magnetic confinement schemes, theoretical questions, and engineering considerations are presented by expert guest lecturers. Tour of Plasma Science and Fusion Center experimental facilities.
A. White

22.013 Applications of Radiation Science and Technology in Biomedical Research
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
2-0-4
Seminar lectures, led by practicing clinicians and scientists in a case presentation format, on current research topics and specific projects in the biomedical field in which radiation science and radiological engineering play an important role. Emphasis on nuclear imaging techniques such as magnetic resonance and positron emission tomography, and on radiation therapy. Term paper required. Lectures shared with freshman advisor seminar 22.A09 Career Options for Biomedical Research.
B. Rosen

22.02 Introduction to Applied Nuclear Physics
Prereq: Physics II (GIR), Calculus II (GIR); 8.03 or permission of instructor
U (Spring)
5-0-7 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.
P. Cappellaro

22.033 Nuclear Systems Design Project
(Subject meets with 22.33)
Prereq: None
U (Fall)
3-0-9
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.
M. Short

22.05 Neutron Science and Reactor Physics
Prereq: 22.02, 18.03
U (Fall)
5-0-7
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

22.055 Radiation Biophysics
(Subject meets with 22.55J, HST.560J)
Prereq: Permission of instructor
U (Spring)
3-0-9
See description under subject 22.55J.
Staff


22.058 **Radiation Systems Engineering and Tomographic Imaging**
Prereq: 18.03, Physics II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)

3-3-6

An introduction to radiation systems engineering with examples taken from tomographic imaging. Includes a series of lectures with a parallel set of recitations that provide demonstrations of basic principles. Both ionizing and non-ionizing radiation are covered, including x-ray, PET, MRI, and ultrasound. Emphasis is on the physics and engineering of image formation.

J. Buongiorno

22.06 **Engineering of Nuclear Systems**
Prereq: 2.005, 22.05
U (Fall)
3-0-9

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.

J. Buongiorno

22.070 **Materials for Nuclear Applications**
(Subject meets with 22.70)
Prereq: Permission of instructor
U (Spring)
3-0-9

See description under subject 22.70. Preference to juniors and seniors.

B. Yildiz

22.071J **Electronics, Signals, and Measurement**
(Same subject as 6.071J)
Prereq: 18.03
U (Spring)
3-3-6 REST

See description under subject 6.071J.

I. Hutchinson, A. White

22.081J **Introduction to Sustainable Energy**
(Same subject as 2.650J, 10.291J)
(Subject meets with 1.818J, 2.65J, 10.391J, 11.371J, 22.811J, ESD.166J)
Prereq: Permission of instructor
U (Fall)
3-1-8

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: 22.02
U (Spring)
2-6-4 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.

R. C. Lanza, G. Kohse, J. Bernard

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.

D. Whyte

22.EPE **UPOP Summer Practice Experience**
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit

See description under subject 2.EPE.

S. Luperfoy

22.EPR **UPOP Reflective Learning Experience**
Engineering School-Wide Elective Subject
(Offered under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall)
0-0-3 [P/D/F]

See description under subject 2.EPR.

S. Luperfoy

22.EPW **UPOP IAP Workshop**
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW)
Prereq: None
U (IAP)
3-0-0 [P/D/F]

See description under subject 2.EPW.

S. Luperfoy

22.THT **Undergraduate Thesis Tutorial**
Prereq: 22.09
U (Fall)
1-0-2 [P/D/F]

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.

Staff

22.THU **Undergraduate Thesis**
Prereq: 22.THT
U (Fall, 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.

D. Whyte
22.058 Undergraduate Research Opportunities
Program
Prereq: None
Fall, IAP, Spring, Summer
Units arranged [P/D/F]
Can be repeated for credit

22.059 Undergraduate Research Opportunities
Program
Prereq: None
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.

R. Ballinger

GRADUATE SUBJECTS

Nuclear Physics

22.101 Applied Nuclear Physics
Prereq: 22.02
G (Fall)
3-0-9 H-LEVEL Grad Credit


B. Yildiz

22.105 Electromagnetic Interactions
Prereq: Physics II (GIR), 8.03, Calculus II (GIR), 18.03
G (Fall)
3-0-9 H-LEVEL Grad Credit

Principles and applications of electromagnetism, starting from Maxwell’s equations, with emphasis on phenomena important to nuclear engineering and radiation sciences. Solution methods for electrostatic and magnetostatic fields. Charged particle motion in those fields.

22.106 Neutron Interactions and Applications
Prereq: 22.101
G (Spring)
3-0-9 H-LEVEL Grad Credit

Comprehensive treatment of neutron interactions in condensed matter at energies from thermal to MeV, focusing on particle distributions most relevant to fission, fusion and radiation research applications. Neutron distributions in reactor, accelerator and material structures resulting from single and multiple reactions, and in wave phenomena (optics) and inelastic scattering experiments. Comparison of neutron and fluid transport. Particle simulations. Term paper and presentation required.

B. Forget

Nuclear Reactor Physics

22.211 Nuclear Reactor Physics I
Prereq: 18.075
G (Spring)
3-0-9 H-LEVEL Grad Credit

Reviews the physics basis for modern nuclear reactor design. Topics include the continuous energy transport equation and its adjoint; reduction to diffusion theory and the group diffusion equations; calculation of neutron spectra and determination of few group diffusion constants. The final segment is devoted to heterogeneous reactor analysis.

Staff

22.212 Nuclear Reactor Analysis II
Prereq: 22.106, 22.211, permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-2-7 H-LEVEL Grad Credit

Addresses advanced topics in nuclear reactor physics with an additional focus towards computational methods and algorithms. Covers current computational methods employed in lattice physics calculations such as resonance models, critical spectrum adjustments, advanced homogenization techniques and fine mesh transport theory models. Deterministic transport approximation techniques such as the method of characteristics, discrete ordinates methods, response matrix methods and finite elements methods presented as well as adaptivity methods. Acceleration techniques for these various solution schemes and extension to 3-D core calculations discussed. Non-linear algorithms for eigenvalue problems and multiphysics coupling also covered. Requires a strong computational background and knowledge of C/C++ or Fortran.

B. Forget

22.251 Systems Analysis of the Nuclear Fuel Cycle
Prereq: 22.05
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-2-7 H-LEVEL Grad Credit

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.

M. S. Kazimi

Nuclear Reactor Engineering

22.312 Engineering of Nuclear Reactors
Prereq: 2.001, 2.005; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

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.

M. S. Kazimi

22.313J Thermal Hydraulics in Power Technology
Prereq: 2.59, 10.536
G (Fall)
3-2-7 H-LEVEL Grad Credit

Emphasis on thermo-fluid dynamic phenomena and analysis methods for conventional and nuclear power stations. Kinematics and

22.314J Structural Mechanics in Nuclear Power Technology
(Same subject as 1.56J, 2.084J)
Prereq: 2.001 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Structural components in nuclear power plant systems, their functional purposes, operating conditions, and mechanical/structural design requirements. Combines mechanics techniques with models of material behavior to determine adequacy of component design. Considerations include mechanical loading, brittle fracture, inelastic behavior, elevated temperatures, neutron irradiation, vibrations and seismic effects. M. S. Kazimi, O. Buyukozturk

22.33 Nuclear Engineering Design
(Subject meets with 22.033)
Prereq: 22.312
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.033. M. Short

22.38 Probability and Its Applications To Reliability, Quality Control, and Risk Assessment
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

22.39 Integration of Reactor Design, Operations, and Safety
Prereq: 22.211, 22.312
G (Fall)
3-2-7 H-LEVEL Grad Credit
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. N. E. Todreas, R. G. Ballinger, M. W. Golay

22.40J Fundamentals of Advanced Energy Conversion
(Same subject as 2.62J, 3.64J, 10.392J)
Prereq: 2.006, 3.044, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 2.62J. A. F. Ghoniem, M. Kazimi, Y. Chiang

Radiation Interactions and Applications

22.51 Quantum Theory of Radiation Interactions
Prereq: 22.101, 22.105
G (Fall)
3-0-9 H-LEVEL Grad Credit
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. P. Cappellaro

22.53 Statistical Processes and Atomistic Simulations
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

22.55J Radiation Biophysics
(Same subject as HST.560J)
(Subject meets with 22.055)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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

22.56J Noninvasive Imaging in Biology and Medicine
(Same subject as 9.173J, 20.483J, HST.561J)
Prereq: 18.03, 8.03, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Background in the theory and application of noninvasive imaging methods in biology and medicine, with emphasis on neuroimaging. Focuses on the modalities most frequently used in scientific research (x-ray CT, PET/SPECT, MRI, and optical imaging), and includes discussion of molecular imaging approaches used in conjunction with these scanning methods. Lectures are supplemented by in-class discussions of problems in research and demonstrations of imaging systems. A. Jasanoff

22.561J Magnetic Resonance Analytic, Biochemical, and Imaging Techniques
(Same subject as HST.584J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-12 H-LEVEL Grad Credit
See description under subject HST.584J. L. Wald, B. Rosen
22.562 Spatial Aspects of Nuclear Magnetic Resonance Spectroscopy
Prereq: 18.03, 8.05
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Discusses the theory and application of nuclear magnetic resonance spectroscopy to questions of the spatial distribution of spins. Covers NMR imaging, localized spectroscopy, and local geometries as determined by diffusionary processes. The theory is discussed in terms of the density operator and reciprocal space (for both imaging and motional studies). Describes applications to rapid imaging, dynamic imaging, microscopy, and localized spectroscopy. Instrumentation and experimental constraints are also described.

Staff

Plasmas and Controlled Fusion

22.611J Introduction to Plasma Physics I
(Same subject as 6.651J, 8.613J)
Prereq: 6.013, 8.07, or 22.105; 18.04 or Coreq: 18.075
G (Fall)
3-0-9 H-LEVEL Grad Credit


J. Egedal-Pedersen

22.612J Introduction to Plasma Physics II
(Same subject as 6.652J, 8.614J)
Prereq: 6.651J, 8.613J, or 22.611J
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 8.614J.

Staff

22.615 MHD Theory of Fusion Systems
Prereq: 22.611J, 6.651J, or 8.613J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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.

J. P. Freidberg

22.616 Plasma Transport Theory
Prereq: 22.615
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit

The Fokker-Planck operator for Coulomb collisions, including the Landau and Rosenbluth potential forms, is derived, expanded to obtain useful limits, and used to define characteristic times. Classical collisional transport in an arbitrary magnetic field is developed first, and then the high (Pfirsch-Schluter), low (banana), and intermediate (plateau) collisionality regimes of tokamak transport are examined with emphasis on the banana regime where bootstrap current is most pronounced. Gyrokinetics and zonal flow is discussed.

F. Parra-Diaz

22.62 Fusion Energy
Prereq: 22.611
G (Spring)
3-0-9 H-LEVEL Grad Credit

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 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit


D. Whyte

22.67 Principles of Plasma Diagnostics
Prereq: 6.651J, 8.613J, or 22.611J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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

22.70 Materials for Nuclear Applications
(Subject meets with 22.070)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introductory subject for students who are not specializing in nuclear materials. Applications and selection of materials for use in nuclear applications. Radiation damage, radiation effects, and their effects on performance of materials in fission and fusion environments. Students taking graduate version complete additional assignments.
B. Yildiz

22.71J Modern Physical Metallurgy
(Same subject as 3.40J)
(Subject meets with 3.14)
Prereq: 3.022, 3.032
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.40J.

c. Schuh

22.72J Corrosion: The Environmental Degradation of Materials
(Same subject as 3.54J)
Prereq: 3.012
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 3.54J.
R. G. Ballinger

22.76 Nuclear Chemical Engineering
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-1-8 H-LEVEL Grad Credit
Staff

22.77 Nuclear Waste Management
Prereq: 22.76 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
R. K. Lester, C. Forsberg

22.78 Principles of Nuclear Chemical Engineering and Waste Management
Prereq: Permission of instructor
G (Spring)
3-0-9
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, 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.
C. Forsberg

Systems, Policy, and Economics

22.811J Sustainable Energy
(Same subject as 1.818J, 2.65J, 10.391J, 11.371J, ESD.166J)
(Subject meets with 2.650J, 10.291J, 22.081J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
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

22.812J Managing Nuclear Technology
(Same subject as ESD.163J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines current economic, management, and policy issues concerning nuclear power and its fuel cycle. Introduces methods for analyzing private and public policy alternatives, including techniques in economic and financial analysis. Application to specific problem areas, including nuclear waste management, weapons proliferation, and the economic competitiveness of nuclear power. Other topics include deregulation and restructuring in the electric power industry.
R. K. Lester

22.813 Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.63, 5.00, 10.579, ESD.174)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduces advanced undergraduates or graduate students in the Schools of Engineering and Science to the integration of technical, economic, political, and environmental consideration required for the successful implementation of new technology. Case studies are drawn from the energy and environment sectors with some emphasis on analytic techniques that serve as a “tool box” for students. Technologies considered include fossil, nuclear, solar, wind, fuel cell and energy conservation. International aspects, such as weapons proliferation and global climate effects, also discussed. Enrollment limited.
J. Deutch, R. Lester

22.814 Nuclear Non-Proliferation (New)
Prereq: None
G (Fall)
4-0-8
Examines the historical development of nuclear weapons, the policies and technical strategies currently in place to secure and control the movement of nuclear materials, and the short- and long-term effects of weapons utilized under different scenarios. Considers issues such as
how to restrict the global proliferation of nuclear weapons, whether nuclear energy can be made proliferation-proof and what has changed in the wake of the Cold War, as well as lessons to be learned from past experience. Emphasizes advanced approaches to both production and detection of nuclear materials.

J. C. Yanch, R. C. Lanza

22.82 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 6.938, 10.816, 16.862, ESD.72)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.72.

G. Apostolakis

General

22.90 Nuclear Science and Engineering Laboratory
(Subject meets with 22.09)
Prereq: 22.101
G (Spring)
2-6-4 H-LEVEL Grad Credit
See description under subject 22.09.

R. C. Lanza, G. Kohse, J. Bernard

22.911 Seminar in Nuclear Science and Engineering
Prereq: None
G (Fall)
2-0-1 [P/D/F]
Can be repeated for credit

22.912 Seminar in Nuclear Science and Engineering
Prereq: None
G (Spring)
2-0-1 [P/D/F]
Can be repeated for credit

Restricted to graduate students engaged in doctoral thesis research.
C. Forsberg, D. Whyte

22.915 Seminar in Magnetic Resonance
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
2-0-1 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Discusses current topics in magnetic resonance including research issues by graduate students and staff members.
D. G. Cory

22.920J Interactive Introduction to Nuclear Magnetic Resonance
(Same subject as 8.22J)
Prereq: Calculus II (GIR)
G (IAP)
1-2-0 H-LEVEL Grad Credit
Interactive introduction to NMR presenting background in classical theory and instrumentation. Each lecture followed by lab experiments both to demonstrate ideas presented during the lecture and to familiarize students with state-of-the-art NMR instrumentation. Experiments cover topics ranging from spin dynamics to spectroscopy, and include both imaging and quantum information processing.

D. G. Cory

22.921 Nuclear Power Plant Dynamics and Control
Prereq: None
G (IAP)
1-0-2
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 startup. 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 and Engineering
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

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 the availability of suitable assignments.

R. K. Lester

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.

M. S. Kazimi

22.5904 Special Subject in Nuclear Science and Engineering (22.904)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

22.5905 Special Subject in Nuclear Science and Engineering (22.905)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
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. 22.5905 is graded P/D/F.

M. S. Kazimi

22.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.

M. S. Kazimi
Bachelor of Science in Nuclear Science and Engineering/Course 22

General Institute Requirements (GIRs)

| Subjects | Science Requirement | 6 |
| Humanities, Arts, and Social Sciences Requirement | 8 |
| Restricted Electives in Science and Technology (REST) Requirement | 2 |
| [can be satisfied from among 8.03; 18.03; 18.034; 22.01; 22.02; and 22.071, in the Departmental Program] |
| Laboratory Requirement | 1 |
| [can be satisfied by 22.09 in the Departmental Program] |
| Total GIR Subjects Required for SB Degree | 17 |

Communication Requirement

The program includes a Communication Requirement of 4 subjects:

- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the major (CI-M).

PLUS Departmental Program

Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics)

| Units | Basic Requirements |
| 84 |
| 2.005 Thermal-Fluids Engineering I, 12, REST; Physics II (GIR), Calculus II (GIR), 18.03 |
| 6.00 Introduction to Computer Science and Programming, 12, REST or 12.010 Computational Methods of Scientific Programming, 12; Calculus II (GIR), Physics I (GIR) |
| 8.03 Physics III, 12, REST; Physics II (GIR), Calculus II (GIR) |
| 18.03 Differential Equations, 12, REST; Calculus II (GIR) or 18.03a Differential Equations, 12, REST; Calculus II (GIR) |
| 18.085 Computational Science and Engineering I, 12; Calculus II (GIR), 18.03* |
| 22.01 Introduction to Nuclear Engineering and Ionizing Radiation, 12, REST |
| 22.070a Electronics, Signals, and Measurement, 12, REST, 18.03 |

| Units | Required Nuclear Science and Engineering Core Subjects |
| 72 |
| 22.02 Introduction to Applied Nuclear Physics, 12, REST; Physics II (GIR), Calculus II (GIR), 8.03* |
| 22.033 Nuclear Systems Design Project, 12 |
| 22.05 Neutron Science and Reactor Physics, 12; 18.03, 22.02 |
| 22.09 Principles of Nuclear Radiation Measurement and Protection, 12, LAB, CI-M; 22.02 |

Choose two of the following:

- 22.05b Radiation Systems Engineering and Tomographic Imaging, 12; Physics II (GIR), 18.03 |
- 22.05s Radiation Biophysics, 12; permission of instructor |
- 22.06 Engineering of Nuclear Systems, 12; 2.005, 22.05 |
- 22.070 Materials for Nuclear Applications, 12; permission of instructor |

| Units | Required Undergraduate Nuclear Science and Engineering Thesis |
| 12 |
| 22.ThT Undergraduate Thesis Tutorial (minimum of 3 units); 22.09 |
| 22.ThU Undergraduate Thesis (minimum of 9 units), CI-M; 22.ThT |

| Units | Departmental Program Units That Also Satisfy the GIRs |
| 36 |

| Units | Unrestricted Electives |
| 60 |

| Units | Total Units Beyond the GIRs Required for SB Degree |
| 192 |

No subject can be counted both as part of the 17-subject GIRs and as part of the 192 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes

*Alternate prerequisites and corequisites are listed in the subject description.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
PHILOSOPHY

Undergraduate Subjects

24.00 Problems of Philosophy
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 2); 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.
C. Hare

24.01 Classics of Western Philosophy
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 2); 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.
R. Langton

24.02 Moral Problems and the Good Life
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 2); 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?
Staff

24.04 Justice
(Same subject as 17.01)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 2); CI-H

An examination of alternative theories of justice—utilitarianism, rights theories, social contract theory, and communitarianism—and the implications of those theories for problems of liberty, equality, and community. Readings drawn principally from the work of contemporary political philosophers, including Rawls, Nozick, Dworkin, Walzer, MacIntyre, and Buchanan.
L. Stanczyk

24.06 Bioethics
(Same subject as STS.006)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-D 2); 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.
C. Hare

24.08J Philosophical Issues in Brain Science
(Same subject as 9.48J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-D 2); 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.
A. Byrne, P. Sinha

24.09 Minds and Machines
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 2); 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?
A. Byrne

24.11 Philosophy of Quantum Mechanics
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

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.
Staff

24.112 Space, Time, and Relativity
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Philosophical questions raised by relativistic and pre-relativistic physics, especially questions about space and time. Discussions focus on Newton’s arguments for the existence of absolute space and time; pre-relativistic arguments that the geometry of space is a matter of convention; and counter arguments from relativity showing that the passage of time is not a real phenomenon. Other topics include the
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LINGUISTICS AND PHILOSOPHY

Close examination of a text, an author, or an instructor and advisor. Can be repeated for credit with permission of the instructor.

3-0-9 HASS-H (HASS-E)

Acad Year 2012–2013: U (Fall)
Acad Year 2011–2012: Not offered

24.114j A Philosophical History of Energy
(Same subject as 10.04J, CC.114j)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E); CI-H

See description under subject 10.04j.
B. L. Trout, L. D. Perlman

24.118 Paradox and Infinity
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

Different kinds of infinity; the paradoxes of set theory; the reduction of arithmetic to logic; formal systems; paradoxes involving the concept of truth; Gödel's incompleteness theorems; the nonformalizable nature of mathematical truth; and Turing machines.
A. Rayo

24.120 Moral Psychology
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)

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.
I. Singer

24.209 Philosophy in Film and Other Media
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Works of film examined in relation to thematic issues of philosophical importance that also occur in other arts, particularly literature and opera. Emphasis on film's ability to represent and express feeling as well as cognition.
I. Singer

24.211 Theory of Knowledge
Prereq: One philosophy subject
U (Spring)
3-0-9 HASS-H (HASS-E)

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.
R. White

24.213 Philosophy of Film
(Subject meets with CMS.820)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

Philosophical analysis of film art, with an emphasis on the ways in which it creates meaning through techniques that define a formal structure. Particular focus on aesthetic problems about appearance and reality, literary and visual effects, communication and alienation through film technology.
R. White

24.214 Introduction to Philosophy of the Arts
(Subject meets with CMS.811)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Interdisciplinary introduction to principles of aesthetics in arts such as literature, film, music, and the media arts. Topics include the nature of imagination and creativity, and the role of art and aesthetics in science, ethics, and religion. Relevant screenings as well as readings. Students taking graduate version complete additional assignments.
I. Singer

24.215 Topics in the Philosophy of Science
Prereq: One philosophy subject
U (Spring)
3-0-9 HASS-H (HASS-E)

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 (Fall)
3-0-9 HASS-H (HASS-E)

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.
R. White

24.222 Decisions, Games and Rational Choice
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

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?
R. Stalnaker

24.231 Ethics
Prereq: One philosophy subject
U (Fall)
3-0-9 HASS-H (HASS-E)

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.
J. Markovits
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
U (Fall)
3-0-9 HASS-H (HASS-E)
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.
R. Stalnaker

24.245 Theory of Models
Prereq: 24.241 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
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
U (Fall)
3-0-9 HASS-H (HASS-E)
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.
S. Yablo

24.253 Philosophy of Mathematics
Prereq: One philosophy subject or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
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 HASS-H (HASS-E)
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

24.263 The Nature of Creativity
(Subject meets with CMS.810)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
Introduction to the nature of creativity as it pervades human experience and behavior. Questions about imagination and innovation studied in relation to the history of philosophy as well as more recent work in philosophy, affective psychology, cognitive studies, and art theory. Readings and guidance with student’s focus of interest. Instruction and practice in oral and written communication provided.
I. Singer

24.280 Foundations of Probability
Prereq: One philosophy subject or one subject on probability
U (Spring)
3-0-9 HASS-H (HASS-E)
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

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.

Staff

24.500 Special Subject: Philosophy (New)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall, Spring)
3-0-9
Can be repeated for credit

24.520 Special Subject: Philosophy (New)
Prereq: One philosophy subject or permission of instructor
U (Fall, Spring)
3-0-9
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

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

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.
Linguistics: E. Flemming
Philosophy: I. Singer

Graduate Subjects

24.400 Proseminar in Philosophy I
Prereq: Permission of instructor
G (Fall)
6-0-18 H-LEVEL Grad Credit

24.401 Proseminar in Philosophy II
Prereq: Permission of instructor
G (Spring)
6-0-18 H-LEVEL Grad Credit

24.410 Topics in the History of Philosophy
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
Intensive study of a philosopher or philosophical movement. Content varies from year to year.
R. Langton

24.500 Topics in Philosophy of Mind
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
R. Holton

24.191 Being, Thinking, Doing (or Not): Ethics in Your Life (New)
Prereq: None
U (Spring)
2-0-4 [P/D/F]
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.
S. Haslanger, R. Weinmann

24.501 Problems in Metaphysics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
A. Rayo

24.502 Topics in Metaphysics and Ethics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
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.
S. Haslanger

24.503 Topics in Philosophy of Religion (New)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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, R. Langton

24.601 Topics in Moral Philosophy
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated with permission of instructor and advisor
Systematic examination of selected problems in moral philosophy. Content varies from year to year.
Fall: J. Markovits
Spring: C. Hare

Undergraduate Seminars

24.190J Doing Right (New)
(Same subject as 21L.301J)
Prereq: None
U (Fall)
2-0-4
See description under subject 21L.301J.
R. Perry, R. Langton

24.191 Being, Thinking, Doing (or Not): Ethics in Your Life (New)
Prereq: None
U (Spring)
2-0-4 [P/D/F]
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.
S. Haslanger, R. Weinmann

24.501 Problems in Metaphysics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
A. Rayo

24.502 Topics in Metaphysics and Ethics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
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.
S. Haslanger

24.503 Topics in Philosophy of Religion (New)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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, R. Langton

24.601 Topics in Moral Philosophy
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated with permission of instructor and advisor
Systematic examination of selected problems in moral philosophy. Content varies from year to year.
Fall: J. Markovits
Spring: C. Hare

Undergraduate Seminars

24.190J Doing Right (New)
(Same subject as 21L.301J)
Prereq: None
U (Fall)
2-0-4
See description under subject 21L.301J.
R. Perry, R. Langton

24.191 Being, Thinking, Doing (or Not): Ethics in Your Life (New)
Prereq: None
U (Spring)
2-0-4 [P/D/F]
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.
S. Haslanger, R. Weinmann

24.501 Problems in Metaphysics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
A. Rayo

24.502 Topics in Metaphysics and Ethics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
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.
S. Haslanger

24.503 Topics in Philosophy of Religion (New)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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, R. Langton

24.601 Topics in Moral Philosophy
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated with permission of instructor and advisor
Systematic examination of selected problems in moral philosophy. Content varies from year to year.
Fall: J. Markovits
Spring: C. Hare

Undergraduate Seminars

24.190J Doing Right (New)
(Same subject as 21L.301J)
Prereq: None
U (Fall)
2-0-4
See description under subject 21L.301J.
R. Perry, R. Langton

24.191 Being, Thinking, Doing (or Not): Ethics in Your Life (New)
Prereq: None
U (Spring)
2-0-4 [P/D/F]
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.
S. Haslanger, R. Weinmann

24.501 Problems in Metaphysics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
A. Rayo

24.502 Topics in Metaphysics and Ethics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor and advisor
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.
S. Haslanger

24.503 Topics in Philosophy of Religion (New)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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, R. Langton

24.601 Topics in Moral Philosophy
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated with permission of instructor and advisor
Systematic examination of selected problems in moral philosophy. Content varies from year to year.
Fall: J. Markovits
Spring: C. Hare
24.611J Political Philosophy  
(Same subject as 17.000J)  
Prereq: Permission of instructor  
Acad Year 2011–2012: G (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
See description under subject 17.000J.  
S. Haslanger, R. Langton

24.711 Topics in Philosophical Logic  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit with permission of instructor and advisor  
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.  
V. McGee

24.729 Topics in Philosophy of Language  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit with permission of instructor  
Major issues in the philosophy of language. Topics change each year.  
S. Yablo

24.805 Topics in Theory of Knowledge  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit with permission of instructor  
Major issues in theory of knowledge. Topics change each year.  
R. White

24.810 Topics in Philosophy of Science  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit with permission of instructor and advisor  
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.  
B. Skow

24.891 Independent Study: Philosophy  
Prereq: Permission of advisor  
G (Fall, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

24.892 Independent Study: Philosophy  
Prereq: Permission of advisor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit

Open to qualified graduate students in philosophy who wish to pursue special studies or projects.  
Consult Department Headquarters

24.899 Topics in Linguistics and Philosophy  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit

Selected topics at the intersection of linguistics and philosophy. Intended for graduate students in either linguistics or philosophy. Topics vary from year to year.  
K. von Fintel

24.THG Graduate Thesis  
Prereq: None  
G (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit

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

24.S40 Special Seminar: Philosophy (New)  
Prereq: None  
G (Fall, Spring)  
3-0-9  
Can be repeated for credit

24.S41 Special Seminar: Philosophy (New)  
Prereq: Permission of Instructor  
G (Fall, Spring)  
3-0-9 H-LEVEL Grad Credit  
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 HASS-S (HASS-D 2); CI-H  
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: M. DeGraff  
Spring: O. Preminger

24.901 Language and Its Structure I: Phonology  
(Subject meets with 24.931)  
Prereq: 24.900  
U (Fall)  
3-0-9 HASS-S (HASS-E)  
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.  
D. Steriade

24.902 Language and Its Structure II: Syntax  
(Subject meets with 24.932)  
Prereq: 24.900  
U (Fall)  
3-0-9 HASS-S (HASS-E)  
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.  
S. Iatridou
24.903 Language and Its Structure III: Semantics and Pragmatics
(Subject meets with 24.933)
Prereq: 24.900
U (Spring)
3-0-9 HASS-S (HASS-E)
M. Toosarvandani

24.904J Language Acquisition
(Same subject as 9.57J)
Prereq: 24.900 or permission of instructor
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)
See description under subject 9.57J.
K. Wexler

24.905J Psycholinguistics
(Same subject as 9.59J)
Prereq: 24.900 or permission of instructor or Coreq: 9.00
U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 9.59J.
E. Gibson

24.906J The Linguistic Study of Bilingualism
(Same subject as 21F.024J)
Prereq: 24.900
U (Fall)
3-0-9 HASS-S (HASS-E); 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

24.907J Abnormal Language
(Same subject as 9.56J)
Prereq: 24.900 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 9.56J.
K. Wexler

24.908 Creole Languages and Caribbean Identities
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E); 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, permission of instructor
U (Fall)
3-1-8 Institute LAB
Explores the structure of an unfamiliar language through direct work with a native speaker. Students complete a grammatical sketch of the language. Provides instruction and practice in written and oral communication. Enrollment limited.
N. Richards, M. Toosarvandani

24.910 Advanced Topics in Linguistic Analysis
Prereq: 24.901, 24.902, 24.903; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
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.

24.912J Black Matters: Introduction to Black Studies
(Same subject as 21A.114J, 21H.106J, 21L.008J, 21W.741J, WGS.19O)
Prereq: None
U (Spring)
3-0-9 HASS-A, HASS-H (HASS-D 4); 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.
A. Braithwaite, M. DeGraff

24.913J Language and Technology (New)
(Same subject as 21A.335J, STS.070)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E); CI-H
See description under subject 21A.335J.
G. Jones

24.914 Language Variation and Change
Prereq: 24.900
U (Spring)
3-0-9 HASS-S (HASS-E)
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.
S. Flynn

24.915 Linguistic Phonetics
(Subject meets with 24.963)
Prereq: 24.900
U (Fall)
3-0-9 HASS-S (HASS-E)
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
Graduate Subjects

24.921 Independent Study: Linguistics
Prereq: Permission of advisor
G (Fall, Spring, Summer) 3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

24.922 Independent Study: Linguistics
Prereq: Permission of advisor
G (Fall, Spring, Summer) 3-0-9 H-LEVEL Grad Credit
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 or permission of instructor
G (Fall) 3-0-9 H-LEVEL Grad Credit
Meets with 24.901, but assignments differ. See description under 24.901.
D. Steriade

24.932 Language and Its Structure II: Syntax
(Subject meets with 24.902)
Prereq: 24.900 or permission of the instructor
G (Fall) 3-0-9 H-LEVEL Grad Credit
Meets with 24.902, but assignments differ. See description under 24.902.
S. Iatridou

24.933 Language and Its Structure III: Semantics and Pragmatics
(Subject meets with 24.903)
Prereq: 24.900 or permission of instructor
G (Spring) 3-0-9 H-LEVEL Grad Credit
Meets with 24.903, but assignments differ. See description under 24.903.
M. Toosarvandani

24.942 Topics in the Grammar of a Less Familiar Language
Prereq: 24.951
G (Spring) 3-0-6 H-LEVEL Grad Credit
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 H-LEVEL Grad Credit
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. Toosarvandani

24.945J Language Processing
(Same subject as 9.591J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring) Acad Year 2012–2013: Not offered 3-0-6
See description under subject 9.591J.
E. Gibson

24.946 Linguistic Theory and Japanese Language
(Subject meets with 21F.514)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered Acad Year 2012–2013: G (Fall) 3-0-6
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. Meets with undergraduate subject 21F.514, but assignments differ. Assumes familiarity with linguistic theory.
S. Miyagawa

24.947 Language Disorders in Children
Prereq: None
G (Fall) 3-0-9
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 Language Acquisition
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6
Reading and discussion of current linguistic theory, first language acquisition research, and data concerning adult second language acquisition. Focus on development of a theory of second language acquisition within a theory of universal grammar. Emphasis on syntactic, lexical, and phonological development. Examination of ways in which this body of data confronts theories of language.
S. Flynn

24.949J Language Acquisition I
(Same subject as 9.601J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 9.601J.
K. Wexler

24.951 Introduction to Syntax
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
S. Iatridou, D. Pesetsky

24.952 Advanced Syntax
Prereq: 24.951
G (Spring)
3-0-9 H-LEVEL Grad Credit
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. Miyagawa, N. Richards

24.954 Pragmatics in Linguistic Theory
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
B. George

24.955 More Advanced Syntax
Prereq: 24.951, 24.952
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
An advanced-level survey of topics in syntax.
S. Iatridou

24.956 Topics in Syntax
Prereq: 24.951
G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
S. Iatridou, D. Pesetsky

24.960 Syntactic Models
Prereq: 24.951, 24.952
G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
O. Preminger

24.961 Introduction to Phonology
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Introduction to the current research questions in phonological theory. Topics include metrical and prosodic structure, features and their phonetic basis in speech, acquisition and parsing, phonological domains, morphology, and language change and reconstruction. Activities include problem solving, squibs, and data collection.
M. Kenstowicz

24.962 Advanced Phonology
Prereq: 24.961
G (Spring)
4-0-8 H-LEVEL Grad Credit
Continuation of 24.961.
D. Steriade

24.963 Linguistic Phonetics
(Subject meets with 24.915)
Prereq: None
G (Fall)
3-0-9
See description under subject 24.915.
E. Flemming

24.964 Topics in Phonology
Prereq: 24.961
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
In-depth study of a topic in current phonological theory.
E. Flemming

24.965 Morphology
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
A. Albright, D. Pesetsky

24.966J Laboratory on the Physiology, Acoustics, and Perception of Speech
(Same subject as 6.542J, HST.712J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
2-2-8 H-LEVEL Grad Credit
See description under subject 6.542J.
L. D. Braida, S. Shattuck-Hufnagel
24.967 Topics in Experimental Phonology  
Prereq: 24.961, 24.963, or permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
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.  
A. Albright, E. Flemming

24.968J Speech Communication  
(Same subject as 6.541J, HST.710J)  
Prereq: Permission of instructor  
G (Spring)  
3-1-8 H-LEVEL Grad Credit  
See description under subject 6.541J.  
L. D. Braida, R. E. Hillman, S. Shattuck-Hufnagel

24.970 Introduction to Semantics  
Prereq: Permission of instructor  
G (Fall)  
3-0-9  
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, B. George

24.973 Advanced Semantics  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Current work on semantics and questions of logic and meaning for syntactic systems in generative grammar.  
I. Heim

24.979 Topics in Semantics  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Seminar on current research in semantics and generative grammar. Topics may vary from year to year.  
R. Nouwen

24.981 Topics in Computational Phonology  
Prereq: 24.961 or permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
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 (New)  
Prereq: Permission of instructor  
G (Fall, Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
An intensive group tutorial/seminar for discussion of research being conducted by participants. No listeners.  
Fall: N. Richards, D. Steriade  
Spring: M. DeGraff, M. Kenstowicz

24.992 Survey of General Linguistics  
Prereq: Permission of instructor  
G (Fall)  
3-0-9  
Can be repeated for credit  
Reading and discussion of certain important papers in syntax, semantics, and phonology designed to familiarize the student with central ideas in current linguistic research. Organization of discussion is primarily in the hands of seminar participants.  
B. George, M. Hackl, S. Iatridou, M. Kenstowicz, D. Pesetsky

24.993 Tutorial in Linguistics and Related Fields  
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit  
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

24.994 Special Seminar: Linguistics (New)  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Covers topics in linguistics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.  
D. Fox

24.995 Special Seminar: Linguistics (New)  
Prereq: Permission of Instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit

24.S94 Special Seminar: Linguistics (New)  
Prereq: Permission of Instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall, Spring)  
3-0-9 H-LEVEL Grad Credit  
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.  
24.S95: M. Hackl, I. Heim  
24.S96: Staff

24.THG Graduate Thesis  
Prereq: None  
G (Fall, IAP, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit  
Program of research and writing of thesis, to be arranged by the student with supervising committee.  
Staff
### Bachelor of Science in Philosophy/Course 24-1

#### General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement (three subjects can be satisfied by subjects in the Departmental Program)</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

#### Communication Requirement

The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Subjects</td>
<td></td>
</tr>
<tr>
<td>One CI-H philosophy subject</td>
<td>72</td>
</tr>
<tr>
<td>One History of Philosophy subject:</td>
<td></td>
</tr>
<tr>
<td>24.01 Classics of Western Philosophy, 12, HASS-HT, CI-H</td>
<td></td>
</tr>
<tr>
<td>24.201 Topics in the History of Philosophy, 12, HASS-H, CI-M*</td>
<td></td>
</tr>
<tr>
<td>One Knowledge and Reality subject:</td>
<td></td>
</tr>
<tr>
<td>24.08 Philosophical Issues in Brain Science, 12, HASS-HT, CI-H</td>
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</tr>
<tr>
<td>24.09 Minds and Machines, 12, HASS-HT, CI-H</td>
<td></td>
</tr>
<tr>
<td>24.111 Philosophy of Quantum Mechanics, 12, HASS-H</td>
<td></td>
</tr>
<tr>
<td>24.114 A Philosophical History of Energy, 12, HASS-HT, CI-H</td>
<td></td>
</tr>
<tr>
<td>24.211 Theory of Knowledge, 12, HASS-H*</td>
<td></td>
</tr>
<tr>
<td>24.215 Topics in the Philosophy of Science, 12, HASS-H*</td>
<td></td>
</tr>
<tr>
<td>24.221 Metaphysics, 12, HASS-H, CI-M*</td>
<td></td>
</tr>
<tr>
<td>24.251 Introduction to Philosophy of Language, 12, HASS-H, CI-M*</td>
<td></td>
</tr>
<tr>
<td>24.253 Philosophy of Mathematics, 12, HASS-H*</td>
<td></td>
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<tr>
<td>24.280 Foundations of Probability, 12, HASS-H*</td>
<td></td>
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<tr>
<td>One Value subject:</td>
<td></td>
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<tr>
<td>24.02 Moral Problems and the Good Life, 12, HASS-HT, CI-H</td>
<td></td>
</tr>
<tr>
<td>24.04 Justice, 12, HASS-HT, CI-H</td>
<td></td>
</tr>
<tr>
<td>24.06 Ethics, 12, HASS-HT, CI-H</td>
<td></td>
</tr>
<tr>
<td>24.120 Moral Psychology, 12, HASS-H, CI-M</td>
<td></td>
</tr>
<tr>
<td>24.209 Philosophy in Film and Other Media, 12, HASS-H</td>
<td></td>
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<tr>
<td>24.213 Philosophy of Film, 12, HASS-H</td>
<td></td>
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<tr>
<td>24.214 Introduction to Philosophy of the Arts, 12, HASS-H</td>
<td></td>
</tr>
<tr>
<td>24.222 Decisions, Games and Rational Choice, 12, HASS-H</td>
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</tr>
<tr>
<td>24.231 Ethics, 12, HASS-H, CI-M*</td>
<td></td>
</tr>
<tr>
<td>24.233 Philosophy of Law, 12, HASS-H*, CI-M</td>
<td></td>
</tr>
<tr>
<td>24.237 Feminist Political Thought, 12, HASS-H, CI-M*</td>
<td></td>
</tr>
<tr>
<td>24.263 The Nature of Creativity, 12, HASS-H, CI-M*</td>
<td></td>
</tr>
<tr>
<td>One Logic subject:</td>
<td></td>
</tr>
<tr>
<td>24.118 Paradox and Infinity, 12, HASS-H</td>
<td></td>
</tr>
<tr>
<td>24.241 Logic I, 12, HASS-H</td>
<td></td>
</tr>
<tr>
<td>24.242 Logic II, 12, HASS-H*</td>
<td></td>
</tr>
<tr>
<td>24.243 Classical Set Theory, 12, HASS-H*</td>
<td></td>
</tr>
<tr>
<td>24.244 Modal Logic, 12, HASS-H*, 24.241</td>
<td></td>
</tr>
<tr>
<td>24.245 Theory of Models, 12, HASS-H*</td>
<td></td>
</tr>
<tr>
<td>and 24.260 Topics in Philosophy, 12, HASS-H, CI-M*</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>45–60</td>
</tr>
</tbody>
</table>

A coherent program of five additional subjects, of which two must be in philosophy.

To satisfy the requirement that students take two CI-M subjects, students must take 24.260 and one of the following: 24.120, 24.201, 24.221, 24.231, 24.235, 24.237, 24.251, or 24.263.

#### Departmental Program Units That Also Satisfy the GIRs

(36)
## Unrestricted Electives

<table>
<thead>
<tr>
<th>Total Units Beyond the GIRs Required for SB Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
</tr>
</tbody>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

### Notes

*Prerequisites and corequisites are listed in the subject description.

† Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.

* No more than four of the total number of philosophy subjects for the major may be CI-H philosophy subjects. At least three of the total number of philosophy courses must be at the 200 level or above.

* May not also satisfy the departmental distribution requirement in philosophy.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
### Bachelor of Science in Linguistics and Philosophy/Course 24-2

**General Institute Requirements (GIRs)**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
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</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [three subjects can be satisfied by subjects in the Departmental Program (for the field of concentration)]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

**Communication Requirement**
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- and 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.900 Introduction to Linguistics, 12, HASS-S†, CI-H</td>
<td>12</td>
</tr>
</tbody>
</table>

*Students choose either a linguistics or philosophy track*

**Linguistics Track**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.901 Language and Its Structure I: Phonology, 12, HASS-S*</td>
<td>12</td>
</tr>
<tr>
<td>24.902 Language and Its Structure II: Syntax, 12, HASS-S, CI-M*</td>
<td>12</td>
</tr>
<tr>
<td>24.903 Language and Its Structure III: Semantics and Pragmatics, 12, HASS-S*</td>
<td>12</td>
</tr>
<tr>
<td>24.918 Workshop in Linguistic Research, 12, HASS-S, CI-M*</td>
<td>12</td>
</tr>
</tbody>
</table>

*One of the following three Linguistic Analysis subjects:*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.909 Field Methods in Linguistics, 12, LAB, CI-M*</td>
<td>12</td>
</tr>
<tr>
<td>24.910 Advanced Topics in Linguistic Analysis, 12, HASS-S, CI-M*</td>
<td>12</td>
</tr>
<tr>
<td>24.914 Language Variation and Change, 12, HASS-S, CI-M*</td>
<td>12</td>
</tr>
</tbody>
</table>

*One of the following three Philosophy subjects:*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.09 Minds and Machines, 12, HASS-HT, CI-H</td>
<td>12</td>
</tr>
<tr>
<td>24.241 Logic I, 12, HASS-H</td>
<td>12</td>
</tr>
<tr>
<td>24.251 Introduction to Philosophy of Language, 12, HASS-H, CI-M*</td>
<td>12</td>
</tr>
</tbody>
</table>

*One of the following five Experimental Results subjects:*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.904 Language Acquisition, 12, HASS-S*</td>
<td>12</td>
</tr>
<tr>
<td>24.905 Psycholinguistics, 12, HASS-S*</td>
<td>12</td>
</tr>
<tr>
<td>24.906 The Linguistic Study of Bilingualism, 12, HASS-S, CI-H*</td>
<td>12</td>
</tr>
<tr>
<td>24.907 Abnormal Language, 12*, HASS-S</td>
<td>12</td>
</tr>
<tr>
<td>24.915 Linguistic Phonetics, 12, HASS-S*</td>
<td>12</td>
</tr>
</tbody>
</table>

**Philosophy Track**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.201 Topics in the History of Philosophy, 12, HASS-H, CI-M*</td>
<td>12</td>
</tr>
<tr>
<td>24.241 Logic I, 12, HASS-H</td>
<td>12</td>
</tr>
<tr>
<td>24.251 Introduction to the Philosophy of Language, 12, HASS-H, CI-M*</td>
<td>12</td>
</tr>
<tr>
<td>24.260 Topics in Philosophy, 12, HASS-H, CI-M*</td>
<td>12</td>
</tr>
</tbody>
</table>

*One of the following two subjects:*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.080 Philosophical Issues in Brain Science, 12, HASS-HT, CI-H</td>
<td>12</td>
</tr>
<tr>
<td>24.09 Minds and Machines, 12, HASS-HT, CI-H</td>
<td>12</td>
</tr>
</tbody>
</table>

*One of the following Knowledge and Reality subjects:*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.111 Philosophy of Quantum Mechanics, 12, HASS-H</td>
<td>12</td>
</tr>
<tr>
<td>24.112 Space, Time, and Relativity, 12, HASS-H</td>
<td>12</td>
</tr>
<tr>
<td>24.114 A Philosophical History of Energy, 12, HASS-H</td>
<td>12</td>
</tr>
<tr>
<td>24.211 Theory of Knowledge, 12, HASS-H*</td>
<td>12</td>
</tr>
<tr>
<td>24.215 Topics in the Philosophy of Science, 12, HASS-H*</td>
<td>12</td>
</tr>
<tr>
<td>24.221 Metaphysics, 12, HASS-H*</td>
<td>12</td>
</tr>
<tr>
<td>24.253 Philosophy of Mathematics, 12, HASS-H*</td>
<td>12</td>
</tr>
<tr>
<td>24.280 Foundations of Probability, 12, HASS-H*</td>
<td>12</td>
</tr>
</tbody>
</table>

*One of the following three subjects:*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.65 Cognitive Processes, 12, HASS-S</td>
<td>12</td>
</tr>
<tr>
<td>24.904 Language Acquisition, 12, HASS-S*</td>
<td>12</td>
</tr>
<tr>
<td>24.905 Psycholinguistics, 12, HASS-S*</td>
<td>12</td>
</tr>
</tbody>
</table>

**Restricted Electives**

A coherent program of three additional subjects from linguistics, philosophy, or a related area.

**Departmental Program Units That Also Satisfy the GIRs**

(36)
Unrestricted Electives
84–93

Total Units Beyond the GIRs Required for SB Degree
180

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

Notes

*Prerequisites and corequisites are listed in the subject description.
† Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.

For an explanation of credit units, or hours, please refer to the online help in the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.
CONCOURSE PROGRAM

CONCOURSE SCIENCE SUBJECTS

Chemistry

CC.3091 Introduction to Solid-State Chemistry (New)
(Subject meets with 3.091, ES.3091)
Prereq: None. Coreq: CC.A10 or CC.A010
U (Fall, Spring)
5-0-7 CHEMISTRY
Equivalent to 3.091; see 3.091 for description.
Students attend regular 3.091 lectures and are assigned to recitations taught by Concourse faculty. Limited to students in Concourse.

Mathematics

CC.181A Calculus (New)
(Subject meets with 18.01A)
Prereq: Knowledge of differentiation and elementary integration; Coreq: CC.A10 or CC.010
U (Fall)
5-0-7 CALC I
Equivalent to 18.01A; see 18.01A for description.
Students attend regular 18.01A lectures and are assigned to recitations taught by Concourse faculty. Limited to students in Concourse.

CC.1802 Calculus (New)
Prereq: Calculus I (GIR); Coreq: CC.A10, CC.010, or CC.011
U (Fall, Spring)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.021, 18.022, ES.802, ES.8022
Equivalent to 18.02A; see 18.02A for description.
Students attend regular 18.02A lectures and are assigned to recitations taught by Concourse faculty. Limited to students in Concourse.

CC.1803 Differential Equations (New)
Prereq: None. Coreq: Calculus II (GIR); CC.A10, CC.010 or CC.011
U (Fall, Spring)
5-0-7 REST
Credit cannot also be received for 18.03, 18.034, 18.036, ES.1803
Equivalent to 18.03; see 18.03 for description.
Limited to students in Concourse.

Physics

CC.801 Physics I (New)
(Subject meets with CC.8012)
Prereq: None. Coreq: CC.A10 or CC.010
U (Fall)
5-0-7 PHYSICS I
Credit cannot also be received for 8.01, 8.011, 8.012, 8.01L, CC.8012, ES.801, ES.8012
Equivalent to 8.01; see 8.01 for description.
Limited to students in Concourse.

CC.802 Physics II (New)
Prereq: None. Coreq: CC.A10, CC.010, or CC.011
U (Fall, Spring)
5-0-7 PHYSICS II
Credit cannot also be received for 8.02, 8.021, 8.022, ES.802, ES.8022
Equivalent to 8.02; see 8.02 for description.
Limited to students in Concourse.

CC.802 Physics II (New)
Prereq: None. Coreq: CC.A10, CC.010, or CC.011
U (Fall, Spring)
5-0-7 PHYSICS II
Credit cannot also be received for 8.02, 8.021, 8.022, ES.802, ES.8022
Equivalent to 8.02; see 8.02 for description.
Limited to students in Concourse.
S. Mtingwa

CONCOURSE HASS SUBJECTS

CC.110 Becoming Human: Ancient Perspectives on the Best Life (SP.319)
Prereq: None. Coreq: CC.A10 or CC.010
U (Fall)
3-0-9 HASS-H (HASS-E)
Considers how ancient writers thought about the best human life. Students examine the contrasting views of selected major works by authors such as Plato, Aristotle, Thucydides, Herodotus, Epicurus, Lucretius, and St. Augustine. Texts are also used as tools for thinking about the goals and purposes of modern life. Limited to students in Concourse.
L. Perlman, L. Rabieh

CC.111 Modern Conceptions of Freedom (SP.320)
Prereq: None. Coreq: CC.011
U (Spring)
3-0-9 HASS-H (HASS-E); 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. Limited to students in Concourse.
L. Perlman
CC.112 Philosophy of Love (New)  
Prereq: None. Coreq: CC.011  
U (Spring)  
3-0-9 HASS-H (HASS-E)  
Explores the nature of love through works of philosophy, literature, film, poetry, and individual experience. Investigates the distinction among eros, philia, and agape. 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. Limited to students in Concourse.  
L. Perlman

CC.113 Ancient Greek Philosophy and Mathematics (New)  
Prereq: None. Coreq: CC.A10 or CC.010  
U (Fall)  
3-0-9 HASS-H (HASS-D 2); 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. Limited to students in Concourse.  
L. Perlman

CC.114j A Philosophical History of Energy (New)  
(Same subject as 10.04j, 24.114j)  
Prereq: None  
Acad Year 2011–2012: U (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9 HASS-H (HASS-E); CI-H  
See description under subject 10.04j.  
B. L. Trout, L. D. Perlman

CONCOURSE SEMINARS

CC.010 Seminar I (New)  
Prereq: Permission of instructor  
U (Fall)  
2-0-4 [P/D/F]  
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. Meets with CC.A10 (freshman advising seminar).  
Staff

CC.011 Seminar II (New)  
Prereq: Permission of instructor  
U (Spring)  
2-0-4 [P/D/F]  
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 students in Concourse.  
Staff

CONCOURSE TEACHING AND RESEARCH

CC.200 Concourse Program Undergraduate Teaching (SP.315)  
Prereq: Permission of instructor  
U (Fall)  
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 (New)  
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.UR Undergraduate Research (New)  
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.  
B. L. Trout

CONCOURSE SPECIAL SUBJECTS

CC.S10 Special Subject: Concourse (SP.343)  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit

CC.S11 Special Subject: Concourse (SP.344)  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit

CC.S20 Special Subject: Concourse (New)  
Prereq: None  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit

CC.S21 Special Subject: Concourse (New)  
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
CMS.100 Introduction to Media Studies
Prereq: None
U (Fall, Spring)
3-3-6 HASS-H (HASS-D 4); 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.
Fall: T. Harper, F. Klink
Spring: Staff

CMS.300 Introduction to Videogame Theory
(Subject meets with CMS.841)
Prereq: None
U (Fall, Spring)
3-3-6 HASS-H (HASS-E)
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.
C. Fernandez Vara

CMS.309J Transmedia Storytelling: Modern Science Fiction
(Same subject as 21W.763)
(Subject meets with CMS.809)
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-E)
Explores transmedia storytelling by investigating how science fiction stories are told across different media, such as the short story, the screenplay, moving image, and games. Students read and write critical essays and collaborate to produce their own work of science fiction in a roundtable workshop environment. Students taking graduate version complete additional assignments.
F. Klink

CMS.314J Phantasmal Media: Theory and Practice
(Same subject as 21W.753)
(Subject meets with CMS.814)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-A (HASS-E)
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. Harrell

CMS.334J South Asian America: Transnational Media, Culture, and History
(Same subject as 21W.788)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)
See description under subject 21W.788.
V. Bald

CMS.336J The Social Documentary: Analysis and Production
(Same subject as 21W.786)
(Subject meets with CMS.836)
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-E)
An introduction to the history of the social documentary from the 1960s through the 1980s. Explores how social upheaval and the shift to smaller, more portable film cameras, and ultimately hand-held video, converged to bring about an upsurge of socially engaged documentary film production. Students screen and analyze a series of key films from the period and work in groups to produce their own short documentary using digital video and computer-based editing. Limited to 18.
V. Bald

CMS.360 Introduction to Civic Media (New)
(Subject meets with CMS.860)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
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.376 History of Media and Technology
(Subject meets with CMS.876)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E); 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.

B. Coleman, J. Paradis

**CMS.400 Media Systems and Texts**
Prereq: One subject in Comparative Media Studies or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-3-6 HASS-H (HASS-E)

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 (transmedia texts); and the ways in which media texts and systems cross cultural and national boundaries (global crossings).

Staff

**CMS.403J Media and Methods: Performing**
(Same subject as 21M.703J)
Prereq: CMS.100, 21L.011, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-3-6 HASS-H (HASS-E)

Seminar examines an array of performance disciplines from the perspective of the performer. Explores what it means to read the human body as a dynamic medium of expression; how fundamental techniques of the performer shift across cultural borders and in step with changing social contexts and historical traditions; and how the expressive tactics of one media platform adapt to the demands of another. Students engage in close analysis of performance practices, acquiring a theoretical and historical framework for thinking about performance across disciplines. Complemented by outside readings, video viewings, short essays, and studio performances, this course is intended to provide students with an introduction to core concepts in performance studies as they relate more generally to the study of media. Instruction and practice in written and oral communication provided. Limited to 20.

J. Scheib

**CMS.405 Media and Methods: Seeing and Expression**
Prereq: 21L.011 or CMS.100
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-3-6 HASS-H (HASS-E)

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. Students submit three papers and three visual projects. Final projects are displayed and critiqued in an exhibition at the end of term. Instruction and practice in written and oral communication provided. Limited to 20.

A. Borsuk

**CMS.407 Media and Methods: Sound**
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)
Credit cannot also be received for 21A.360

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.

Staff

**CMS.590J Computer Games and Simulations for Investigation and Education**
(Same subject as 11.127J)
(Subject meets with 11.252J, CMS.863J)
Prereq: None
U (Spring)
3-6-3 HASS-H (HASS-E)

See description under subject 11.127J.

E. Klopfer

**CMS.603 Independent Study**
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

**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.607 The Role of the Gamer: Theory, Criticism, and Practice**
(Subject meets with CMS.843)
Prereq: One introductory CMS subject or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)

Overview of scholarship in the emerging field of game studies examines gamers and their relationships with digital content as well as with other gamers in virtual and online spaces. Draws on current commercial practices in relation to underlying humanistic and social scientific theory and criticism to better understand player-game interactions, processes of identity formation, and participation in online communities. Historically situated analytic perspectives include effects, uses and gratifications, reader-response, and reception theories. Examines case studies of new computer interface design methodologies, usability testing, market research, and production issues related to contemporary game design and platforms. Students taking the graduate version complete additional assignments. Limited to 30.

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 HASS-A (HASS-E)

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

CMS.609J The Word Made Digital
(Same subject as 21W.764J)
(Subject meets with CMS.846)
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-E)
See description under subject 21W.764J.

N. Montfort

CMS.610J Media Industries and Systems
(Subject meets with CMS.922)
Prereq: Two CMS subjects or permission of instructor
U (Spring)
3-0-9 HASS-S (HASS-E)
Can be repeated for credit

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.611J Creating Video Games
(Same subject as 6.073J)
Prereq: One subject in CMS or 6.01
U (Spring)
3-3-6 HASS-A (HASS-E)

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. Experience in at least one of the following disciplines is recommended but not required: game design, audio design, visual arts, project management, computer programming. Limited to 24.

P. Tan, S. Verrilli, O. Macindoe, P. Kaelbling

CMS.612J Writing for Videogames
(Same subject as 21W.767J)
(Subject meets with CMS.866)
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-E)

Explores the convergence of fiction, dramatic writing and game design in writing for videogames. Addresses the problematic relationship between storytelling and games, from both an analytical and practical standpoint. Discusses theory and analysis of pre-existing games. Assignments provide students the opportunity to tackle specific writing problems in a creative way. Basic programming knowledge and previous coursework in game design, videogame theory, interactive narrative or play writing is useful but not required. Graduate students complete additional assignments. Limited to 15.

C. Fernandez Vara

CMS.613J Writing for Social Media
(Same subject as 21W.751J)
(Subject meets with CMS.867)
Can be repeated for credit

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.

F. Klink

CMS.614J Identity and the Internet
(Same subject as 21W.791J)
(Subject meets with CMS.868)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

Focuses on various aspects of identity, including gender, race, class, sexuality, ability and age, as they are expressed in and through internet-related technologies. Theories and readings focus on the cultural, social, economic and political aspects of Internet use and design. The Internet is defined broadly to include networked capabilities in computers, mobile devices, entertainment technologies, and emerging media forms. Covers foundational as well as more recent readings. Students taking the graduate version complete additional assignments.

M. Consalvo

CMS.615J Social and Cultural Facets of Digital Games
(Same subject as 21W.768J)
(Subject meets with CMS.869)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

Examines social, cultural, economic and political aspects of digital games across all platforms. Topics reflect a particular social or cultural theme and include the culture of gameplay, gaming communities, the politics and economics of production processes, persistence in virtual worlds, the ethics of games, and identity as it relates to gameplay. Discussions cover classic gameplay theories as well as more contemporary readings. Students taking graduate version complete additional assignments.

M. Consalvo

CMS.621 Fans and Fan Cultures
(Subject meets with CMS.821)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

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.

F. Klink

CMS.628 Advanced Identity Representation (New)
(Subject meets with CMS.828)
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-E)
Can be repeated for credit

Cultivates understanding and develops computational identity systems for games, social media, virtual worlds, and computer-based artwork. Includes topics such as developing improved characters, avatars, agents, social networking profiles, and online accounts. An interdisciplinary set of readings (cognitive science, computer science, art, and sociology) looks at both underlying technology and social/cultural aspects of identity. Explores issues such as how social categories are formed in digital media, including gender, class, and ethnicity, along with everyday
social categories, such as fan or friend. Engages students in on-going research projects. Students taking graduate version complete additional assignments.

D. F. Harrell

CMS.631 Systems Visualization (New)
(Subject meets with CMS.831)
Prereq: None
U (Fall)
3-0-9 HASS-A (HASS-E)
Explores methods of visualizing complex systems using a range of simple visual metaphors. Provides an appreciation of the importance of whole systems thinking, in contrast to silo-based, single component thinking. Presents powerful visualization methodologies to conceive and draw complex systems, be they financial, media, economic, biological, political, etc. Focuses on creating visualizations that go beyond conveying information to invoke an emotional response, integrating cultural and historical variables. Techniques include animations developed from hand-drawn illustrations, data-flow diagrams, and computer-designed visual stories. No previous drawing experience required. Work centers on readings, visualization exercises, and a final project. Visualizations can be done in any preferred medium. Students taking graduate version complete additional assignments.

S. Aiyadurai

CMS.THT Comparative Media Studies Pre-Thesis Tutorial
Prereq: Permission of advisor
U (Fall, Spring)
1-0-5
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, Spring)
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.S60 – CMS.S62 Special Subject:
Comparative Media Studies
Prereq: Permission of instructor
U (Spring)
Units arranged
Can be repeated for credit
Seminar or lecture on a topic that is not covered in the regular curriculum.

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
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 H-LEVEL Grad Credit
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 e- nographic 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 H-LEVEL Grad Credit
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.

Staff

CMS.796 Major Media Texts
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
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.

D. Thorburn

CMS.801 Media in Transition
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.

W. Uricchio

CMS.809 Transmedia Storytelling: Modern Science Fiction
(Subject meets with 21W.763J, CMS.309J)
Prereq: None
G (Fall)
3-0-9
See description under CMS.309J.

F. Klink

CMS.810 The Nature of Creativity
(Subject meets with 24.263)
Prereq: None
G (Spring)
3-0-9
Introduction to problems about creativity as it pervades human experience and behavior.
Questions about imagination and innovation studied in relation to the history of philosophy as well as more recent work in philosophy, affective psychology, cognitive studies, and art theory. Readings and guidance with student's focus of interest.

I. Singer

CMS.811 Introduction to Philosophy of the Arts
(Subject meets with 24.214)
Prereq: None
G (Fall) 3-0-9

Interdisciplinary introduction to principles of aesthetics in arts such as literature, film, music, and the media arts. Topics include the nature of imagination and creativity, and the role of art and aesthetics in science, ethics, and religion. Relevant screenings as well as readings. Students taking the graduate version will complete additional assignments.

I. Singer

CMS.814 Phantasmal Media: Theory and Practice
(Subject meets with 21W.753J, CMS.314J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall) 3-0-9

See description under subject CMS.314J.

D. Harrell

CMS.820 Philosophy of Film
(Subject meets with 24.213)
Prereq: None
G (Spring) 3-0-9

Philosophical analysis of film art, with an emphasis on the ways in which it creates meaning through techniques that define a formal structure. Particular focus on aesthetic problems about appearance and reality, literary and visual effects, communication and alienation through film technology.

I. Singer

CMS.821 Fans and Fan Cultures
(Subject meets with CMS.621)
Prereq: None
G (Spring) 3-0-9

See description under subject CMS.621.

F. Klink

CMS.828 Advanced Identity Representation
(New)
(Subject meets with CMS.628)
Prereq: None
Graduate (Fall) 3-0-9
Can be repeated for credit

See description under subject CMS.628.

D. F. Harrell

CMS.830 Studies in Film
(Subject meets with 21L.706)
Prereq: Permission of instructor
G (Fall, Spring) 3-0-9
Can be repeated for credit

Intensive study of films from a particular period or genre, or films by a single director. Previous topics include Technologies of Seeing: Pre-Cinema to Early Cinema, Hollywood/Bollywood, Film Analysis, and Shakespeare on Film. Students taking graduate version complete different assignments. Limited to 12.

Fall: E. Brinkema
Spring: P. Donaldson

CMS.831 Systems Visualization (New)
(Subject meets with CMS.631)
Prereq: None
G (Fall) 3-0-9

See description under subject CMS.631.

S. Ayyadurai

CMS.836 The Social Documentary: Analysis and Production
(Subject meets with 21W.786J, CMS.336J)
Prereq: None
G (Spring) 3-0-9

See description under subject CMS.336J.

V. Bald

CMS.837 Film, Music, and Social Change: Intersections of Media and Society
(Subject meets with 21W.787)
Prereq: None
G (Spring) 3-0-9

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.840 Literature and Film
(Subject meets with 21L.435)
Prereq: Permission of instructor
G (Fall, Spring) 3-0-9
Can be repeated for credit

Meets with 21L.435, but assignments differ. See description under subject 21L.435.

Fall: P. Donaldson
Spring: A. Kibel

CMS.841 Introduction to Videogame Theory
(Subject meets with CMS.300)
Prereq: None
G (Fall, Spring) 3-0-9

See description under subject CMS.300.

Fall: C. Fernandez Vara
Spring: Staff

CMS.843 The Role of the Gamer: Theory, Criticism, and Practice
(Subject meets with CMS.607)
Prereq: One introductory CMS subject or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring) 3-0-9

An overview of emerging game studies scholarship, examining gamers and their relationships with digital content as well as with other gamers in virtual and online spaces. Draws upon industrial “best practices” as well as underlying humanistic and social scientific theory and criticism for understanding player-game interactions and processes of identity formation and participation in online communities. Historically situated analytic perspectives will include effects, uses and gratifications, reader-response, and reception theories. Examines case studies in a variety of topics including new methodologies in computer interface design, usability testing, and market research, development and production issues related to contemporary game design and platforms. Students taking the graduate version (CMS.843) complete additional assignments. Limited to 30.

Staff
CMS.845 Interactive and Non-Linear Narrative: Theory and Practice
(Subject meets with 21L.489J, 21W.765J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9
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, Z. Husarova

CMS.846 The Word Made Digital
(Subject meets with 21W.764J, CMS.609J)
Prereq: None
G (Spring)
3-0-9
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 the graduate version of this subject (CMS.846) complete additional assignments. Limited to 18.
N. Montfort

CMS.863J Computer Games and Simulations for Investigation and Education
(Same subject as 11.252J)
(Subject meets with 11.127J, CMS.590J)
Prereq: None
G (Spring)
3-6-3
See description under subject 11.127J.
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
See description under subject CMS.608.
P. Tan

CMS.866 Writing for Videogames
(Subject meets with 21W.767J, CMS.612J)
Prereq: None
G (Spring)
3-0-9
See description under subject CMS.612J.
C. Fernandez Vara

CMS.867 Identity and the Internet
(Subject meets with 21W.791J, CMS.614J)
Prereq: None
G (Spring)
3-0-9
See description under subject CMS.614J.
M. Consalvo

CMS.868 Social and Cultural Facets of Digital Games
(Subject meets with 21W.768J, CMS.616J)
Prereq: None
G (Spring)
3-0-9
See description under subject CMS.616J.
M. Consalvo

CMS.871 Media in Cultural Context
(Subject meets with 21L.715)
Prereq: Permission of instructor
G (Spring)
3-3-6
Can be repeated for credit
Seminar designed to provide close case study examinations of specific media or media configurations and the larger social, cultural, economic, political, or technological contexts within which they operate. Subject organized around recurring themes in media history, specific genres or movements, specific media, or specific historical moments. Instruction and practice in written and oral communication provided. 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. Limited to 12.
Staff

CMS.876 History of Media and Technology
(Subject meets with CMS.376)
Prereq: None
G (Spring)
3-0-9
See description under subject CMS.376.
B. Coleman, J. Paradis

CMS.880 From Print to Digital: Technologies of the Word: 1450-Present
(Subject meets with 21H.343)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9
Explores the impact of new technology on the recording and distribution of words at three different times: the invention of the printing press ca. 1450; the adaptation of electricity to communication technology in the 19th century (telegraph, telephone, phonograph); and the emergence of digital media today. Assignments include essays and online projects. Meets with 21H.343, but assignments differ.
Staff

CMS.888 Advertising and Popular Culture: East Asian Perspectives
(Subject meets with 21F.036, 21F.190)
Prereq: Permission of instructor
G (Fall)
3-0-9
Meets with 21F.036 but assignments differ. See description under subject 21F.036.
J. Wang

CMS.915 Understanding Television
(Subject meets with 21L.432)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-3-6
Can be repeated for credit
Meets with 21L.432 but assignments differ. See description under subject 21L.432.
Staff
CMS.920 Popular Culture and Narrative  
(Subject meets with 21L.430)  
Prereq: Permission of instructor  
G (Spring)  
3-3-6  
Can be repeated for credit with permission of instructor  
Examine relationships between popular culture and high art, 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 and Popular Culture in an Age of Media Convergence. Students taking graduate version complete additional assignments.  
Staff

CMS.922 Media Industries and Systems  
(Subject meets with CMS.610)  
Prereq: Permission of instructor  
G (Spring)  
3-0-9  
See description under subject CMS.610.  
C. Weaver

CMS.925 Film Music  
(Subject meets with 21M.284)  
Prereq: Permission of instructor  
G (Spring)  
3-3-6  
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. Subsidary 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 (Spring)  
3-0-9  
Meets with 21W.749, but assignments differ.  
B. D. Colen

CMS.950 Workshop I  
Prereq: Permission of instructor  
G (Fall)  
4-2-6 H-LEVEL Grad Credit  
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.  
N. Montfort

CMS.951 Workshop II  
Prereq: CMS.950  
G (Spring)  
4-2-6 H-LEVEL Grad Credit  
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 [P/D/F]  
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.  
Fall: Staff  
Spring: 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 H-LEVEL Grad Credit  
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  
CMS.995 Independent Study  
Prereq: Permission of instructor  
G (Fall, IAP, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
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.996–CMS.999 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.THG Master’s Thesis  
Prereq: Permission of advisor  
G (Fall, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
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
# Bachelor of Science in Comparative Media Studies/Course CMS

**General Institute Requirements (GIRs)**
- Science Requirement: 6 subjects
- Humanities, Arts, and Social Sciences Requirement (four subjects may be satisfied by subjects in the Departmental Program): 8 subjects
- Restricted Electives in Science and Technology (REST) Requirement: 2 subjects
- Laboratory Requirement: 1 subject

Total GIR Subjects Required for SB Degree: 17 subjects

**Communication Requirement**
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

**PLUS Departmental Program**
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

**Required Subjects**
- Tier I
  - CMS.100 Introduction to Media Studies, 12, HASS-H†, CI-H
  - CMS.400 Media Systems and Texts, 12, HASS-H, CI-M; one subject in CMS or permission of instructor
  - CMS.403 Media and Methods: Performing, 12, HASS-H, CI-M; CMS.100, or permission of instructor
  - CMS.405 Media and Methods: Seeing and Expression, 12, HASS-H, CI-M; CMS.100
  - CMS.407 Media and Methods: Sound, 12, HASS-H, CI-M

- Tier II (Mid-tier)
  Choose one of the following:
  - CMS.700 Studies in Film, 12, HASS-H, CI-M; CMS.100, or permission of instructor
  - CMS.715 Media in Cultural Context, 12, HASS-H, CI-M; two subjects in CMS and/or Literature, or permission of instructor

- Tier III (Capstone)
  Choose one of the following:
  - CMS.700 Studies in Film, 12, HASS-H, CI-M; CMS.100, or permission of instructor
  - CMS.715 Media in Cultural Context, 12, HASS-H, CI-M; two subjects in CMS and/or Literature, or permission of instructor

**Restricted Electives**
Students choose six restricted electives. Qualified students may, with departmental approval, substitute a pre-thesis tutorial (CMS.ThT) and thesis (CMS.ThU) for one elective.

**Departmental Program Units That Also Satisfy the GIRs**
(48 units)

**Unrestricted Electives**
60–108 units

**Total Units Beyond the GIRs Required for SB Degree**
180 units

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.

**Notes**
1. Students who entered prior to fall 2010 may use this subject to satisfy the HASS-D requirement.

For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
CSB.100J Topics in Computational and Systems Biology
(Same subject as 7.89J)
Prereq: Permission of instructor
G (Fall)
2-0-10 H-LEVEL Grad Credit
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 [P/D/F] H-LEVEL Grad Credit
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] H-LEVEL Grad Credit
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] H-LEVEL Grad Credit
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, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Program of research leading to the writing of SM or PhD thesis; to be arranged by the student and the MIT faculty advisor.
Information: Faculty Advisor
EC SEMINARS

EC.050 Recreate Experiments from History: Inform the Future from the Past (New)  
(Subject meets with EC.090)  
Prereq: None  
U (Fall, IAP, Spring)  
1-3-2 [P/D/F]

EC.090 Recreate Experiments from History: Inform the Future from the Past (New)  
(Subject meets with EC.050)  
Prereq: None  
G (Fall, IAP, Spring)  
1-3-2

Students develop perspective for thinking about the future by studying and recreating historically significant experiments. Students develop perspective for thinking about the future by studying and recreating historically significant experiments. Builds awareness of the unexpected—even in familiar settings—through observing the sky and conducting lab activities with light, electricity, and motion. Working alone and in teams, students hone their skills in observation, exploration, and evaluation. They also read accounts by Galileo and other historical observers. Lab sessions complemented by museum and site visits. Students keep an observing notebook and write a reflective paper on their experience. Students taking graduate version complete additional assignments.

J. Bales, E. Cavicchi

EC.100 Electronics Fabrication and Design I (New)  
Prereq: None  
U (Fall, Spring; first half of term)  
0-3-0 [P/D/F]

Explores the science and art of building electronic devices. Using soldering techniques, each student builds the circuit board for a power supply from a kit, and installs the circuit into a case. In the process, students decide what connectors are required, where to place them, and how to incorporate a meter to measure the output voltage. No previous electronics experience necessary.

A. Caloggero

EC.101 Electronics Fabrication and Design II (New)  
Prereq: None  
U (Fall, Spring; second half of term)  
0-3-0 [P/D/F]

Covers printed circuit board (PCB) technologies that enabled the electronics revolution. Explores techniques for making circuit boards using computer-based design tools. Each student designs and fabricates a PCB, and has the opportunity to build it into useful circuits. No previous electronics experience necessary.

A. Caloggero

EC.110J Introduction to Digital Electronics (SP.702)  
(Same subject as 6.072J)  
Prereq: None  
U (Spring)  
0-3-3 [P/D/F]

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.

S. Banzaert

EC.120J Electronics Project Laboratory (New)  
(Same subject as 6.070J)  
Prereq: None  
U (Fall, Spring)  
2-2-2

See description under subject 6.070J.

J. Bales

EC.130 Introduction to Microcontrollers (SP.704)  
Prereq: None  
U (Spring; first half of term)  
2-2-2

Introduces design and implementation of practical microcontroller systems. Emphasizes practical application to outside projects. Covers the essentials of microcontrollers, e.g., inputs and outputs, analog/digital conversion, programming, closed-loop control, and serial communication. Includes weekly assigned projects and concludes with a project of the student’s design. No previous electrical or programming experience required. Limited to 10.

S. Banzaert

EC.210 Visualization for Mathematics, Science, and Technology Education (SP.736)  
Prereq: None  
U (Spring)  
3-2-7

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

EC.305 Digital and Darkroom Imaging (SP.757)  
Prereq: None  
U (Fall)  
2-0-4 [P/D/F]  
Credit cannot also be received for EC.310, SP.747

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 com-
bines 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 (SP.747)
Prereq: None
U (Spring)
2-1-6
Credit cannot also be received for EC.305,
SP.747

Subject centered around both film and digital
photography. Students use chemical darkrooms,
scanners, digital printers and cameras, and vid-
deo capture equipment. Software used includes
Adobe Photoshop, Illustrator and Premiere.
Subject deals with photography with emphasis
on the interplay between classical chemical and
digital techniques. Each student is expected to
develop a creative imaging term project of their
own choice. Intermediate goals are set.
T. Mislick, J. K. Vandiver

ENGINEERING AND DESIGN

EC.420J X PRIZE Workshop: Grand Challenges in
Health Care (New)
(Same subject as ESD.173j, HST.937j)
Prereq: Permission of instructor
G (Spring)
3-0-6
See description under subject ESD.173j.
E. Wagner, D. Newman, F. Murray, K. Zolot,
J. Shames, C. Cooney

EC.421J X PRIZE Workshop: Grand Challenges in
Energy (New)
(Same subject as ESD.172j)
Prereq: Permission of instructor
G (Fall)
3-0-6
See description under subject ESD.172j.
E. Wagner, D. Newman, F. Murray, K. Zolot,
J. Shames, C. Cooney

EC.430 Advanced Toy Product Design (SP.779)
Prereq: 2.00B or permission of instructor
U (Fall, Spring)
3-5-1
A continuation of 2.00B that provides students
with an opportunity for design projects in areas
of entertainment and play, as well as opportuni-
ties in creative product design and community
service. Students further develop ideas for new
washing clothes that serve clients in the community, and
work independently with local sponsors and
with experienced mentors on a themed toy de-
sign project. Provides opportunity for students
to demonstrate creativity and obtain experience in
advanced aspects of the product development
process and experience advanced aspects of the
product development process, including design
aesthetics, detailed design, prototyping, user
testing, and design for manufacture. Includes
written, visual, and oral communication.
D. Wallace

CULTURE AND INTERNATIONAL EXPERIENCE

EC.600 Developing Delhi (New)
Prereq: None
U (Fall)
2-0-4 [P/D/F]
Explores the planning, monuments, and
architectural history of Delhi using maps, city
planning documents, readings, films, and slides
as resources. Fosters a general understanding of
the cities and urban form through site visits
to Boston and Cambridge, as well as by each
student leading a discussion and presenting
on a city that they know well. Upon successful
completion of the seminar, students are eligible
to participate in an optional travel experience to
India during IAP for an additional fee; financial
assistance available based on need. Meets with
EC.A600 (freshman advising seminar).
D. Nijhawan

D-LAB

EC.701J D-Lab: Development (SP.721)
(Same subject as 11.025J)
(Subject meets with 11.472J, EC.781J)
Prereq: None
U (Fall)
3-2-7 HASS-S (HASS-E)
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.
A. B. Smith, B. Sanyal

EC.710 D-Lab: Health Technologies for the
Developing World (SP.725)
Prereq: Permission of instructor
U (Spring)
3-0-6
Provides a multi-disciplinary approach to global
health technology design through lectures and
a major team project based on fieldwork, which
involves partnering with community health
professionals in Nicaragua. Explores the current
state of global health challenges and teaches
students how to design medical technologies
that address those problems using interactive
laboratory modules. Culminates in the creation of
a product design solution to address the chal-
lenges observed in the field. Travel to Nicaragua
during spring break includes additional fee; con-
sult instructor for details. Students may be able
to arrange summer research opportunities based
on coursework experience. Enrollment limited.
J. Gomez-Marquez

EC.711 D-Lab: Energy (SP.775)
Prereq: None
U (Spring)
3-3-6
Provides a project-based approach that engages
students in understanding and addressing the
applications of alternative energy technology in
developing countries. Focuses on compact, ro-
 bust, low-cost systems for generating electrical
power. Includes projects such as micro-hydro,
solar, or wind turbine generators along with
theoretical analysis, design, prototype construc-
tion, evaluation and implementation. Students
will have the opportunity for an optional spring
break site visit to identify and implement proj-
ects, and to work collaboratively with graduate
students at the Masdar Institute of Science and
Technology in Abu Dhabi. Enrollment limited by
lottery; must attend first class session.
Staff

EC.712 D-Lab: Information and Communication
Technologies for Development (ICT) (SP.728)
(Subject meets with EC.782)
Prereq: None
U (Fall)
2-2-5
Explores the use of information and communica-
tion technologies (ICT) to address specific needs
in developing countries. Establishes knowledge
and engineering skills needed to successfully deploy an ICT project, with a focus on appropriateness, transferability, and long-term sustainability. Topics include mobile phone applications, antenna design, low-cost sensors, wireless communications (RFID, Bluetooth, and Wi-Fi), Voice over IP (VoIP), low-power optimization, and network architectures for data-collection and mapping. Students work in multidisciplinary teams, collaborating with local community partners, field practitioners, and local experts in relevant fields. Students taking graduate version complete additional assignments.

R. Fletcher, V. Grau Serrat

**EC.715 D-Lab: Disseminating Water/Environment, Sanitation, and Hygiene Innovations for the Common Good (SP.723)** (Subject meets with 11.474)
Prereq: None
U (Spring)
3-0-6

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 or water/environment innovation in a specific locale. Guest lectures on specific real-world WASH and water/environment 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

**EC.720 D-Lab: Design (SP.722)** (Same subject as 2.722)
Prereq: 2.670 or permission of the instructor
U (Spring)
3-0-9

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 SP.721. Enrollment limited by lottery; must attend first class.

A. B. Smith, V. Grau-Serrat

**EC.721 Wheelchair Design in Developing Countries (SP.784)**
Prereq: None
U (Spring)
2-2-5

Improve wheelchair technology in developing countries by applying sound engineering practices to create appropriate devices. Lectures focus on wheelchair usage, social stigmas, and manufacturing constraints. Includes lectures by third-world community partners, US wheelchair organizations, and MIT faculty. Multidisciplinary student teams conduct term-long wheelchair projects relating to hardware design, manufacturing optimization, biomechanics modeling, and business plan development. Funded opportunities are available for travel to implement class projects at wheelchair workshops in the field.

A. B. Smith, M. Bollini

**EC.722 Prosthetics for the Developing World (SP.733)**
Prereq: None
U (Spring)
2-2-5

Introduces the fundamentals of human walking. Provides an overview of different types of gait disabilities and the available technologies that address them. Presents patient perspective as well as current areas of research. Topics focus on lower-limb disabilities, such as polio and above- and below-knee amputation. Covers both developed and developing world techniques for overcoming these disabilities. Includes a term project in which teams of 3 to 5 students manufacture a prototype. Teams meet outside of class and work with a TA (project mentor) to research, design, prototype, and test a solution. Projects focus on low-cost orthotic and prosthetic knee designs for the developing world, as specified by partner organizations in India and Guatemala.

A. B. Smith

**EC.723 D-Lab: Cycle Ventures (SP.727)**
Prereq: None
U (Fall)
1-2-3 [P/D/F]

Explores bicycle technology as a way to provide human power for an array of purposes in underserved communities. Presents an historical perspective on bicycle technology via lectures, guest speakers, and laboratory exercises. Students work as a group on a joint design and fabrication project; they then form project teams to take on design challenges from community organizations that work with bicycle-based technologies around the world. Optional January travel to partner communities. Limited to 16.

G. Jones

**EC.727 Prototype to Product (SP.724)**
Prereq: Permission of instructor
U (Fall)
1-2-3
Can be repeated for credit

Students and teams who have started a project in D-Lab, the IDEAS Competition, Design for Demining, Product Engineering Processes or elsewhere can continue developing projects to be implemented in the field. Topics covered include prototyping techniques, materials selection, design-for-manufacturing, field-testing, and project management. All classwork directly relates to student projects. Students should have an existing project that they wish to advance to the next level. Teams are encouraged to enroll together. Limited to 15; no listeners.

A. Heafitz

**EC.743 An Introduction to Green Woodworking (SP.743)**
Prereq: None
U (Spring)
1-3-2 [P/D/F]

Students with little or no previous woodworking experience will design and build a post and rung stool. Starting with a green (not dried) oak log and using only hand tools, students will learn material properties and tool capabilities in the historical context of a 17th-century New England woodworker. The aim is to give undergraduates the experience of creating a functional stool from basic raw materials and gain insight on life and work in 17th-century New England.

K. Stone

**EC.781 D-Lab: Development (New)** (Same subject as 11.472J)
(Subject meets with 11.025J, EC.701J)
Prereq: None
G (Fall)
3-2-7

See description under subject 11.472J.

A. B. Smith, B. Sanyal
EC.782 D-Lab: Information and Communication Technologies for Development (ICT) (SP.738)
(Subject meets with EC.712)
Prereq: None
G (Fall)
2-2-5
Explores the use of information and communication technologies (ICT) to address specific needs in developing countries. Establishes knowledge and engineering skills needed to successfully deploy an ICT project, with a focus on appropriateness, transferability, and long-term sustainability. Topics include mobile phone applications, antenna design, low-cost sensors, wireless communications (RFID, Bluetooth, and Wi-Fi), Voice over IP (VoIP), low-power optimization, and network architectures for data-collection and mapping. Students work in multidisciplinary teams, collaborating with local community partners, field practitioners, and local experts in relevant fields. Students taking graduate version complete additional assignments.
R. Fletcher, V. Grau Serrat

EC.980 Edgerton Center Independent Study—Graduate (New)
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.
J. Kim Vandiver

EC.990 Edgerton Center Graduate Teaching (SP.732)
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 (SP.7UR)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
EC.URG Undergraduate Research (SP.7URG)
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.500–EC.505 Special Subject at the Edgerton Center (SP.710–SP.715)
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
EC.506–EC.510 Special Subject at the Edgerton Center (New)
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
EC.511 Special Subject at the Edgerton Center (SP.720)
Prereq: None
G (Fall, IAP, Spring)
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.
J. K. Vandiver

TEACHING, UROP, INDEPENDENT STUDY

EC.900 Independent Study (New)
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.910 Edgerton Center Undergraduate Teaching (SP.731)
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.
J. K. Vandiver

EC.920 Independent Study (New)
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.
J. Kim Vandiver

EC.930 Independent Study (New)
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.
J. Kim Vandiver

EC.940 Independent Study (New)
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.
J. Kim Vandiver

EC.950 Independent Study (New)
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.
J. Kim Vandiver

EC.960 Independent Study (New)
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.
J. Kim Vandiver

EC.970 Independent Study (New)
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.
J. Kim Vandiver

EC.980 Independent Study—Graduate (New)
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.
J. Kim Vandiver

EC.990 Edgerton Center Graduate Teaching (SP.732)
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 (SP.7UR)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
EC.URG Undergraduate Research (SP.7URG)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Undergraduate research opportunities in the Edgerton Center.
J. K. Vandiver
**ESG SCIENCE SUBJECTS**

### Biology

**ES.7013 Introductory Biology (New)**
- Prereq: None
- U (Spring)
- 5-0-7 BIOLOGY

Credit cannot also be received for 7.012, 7.013, 7.014
Equivalent to 7.013; see 7.013 for description. Instruction provided through small, interactive classes. Limited to students in ESG.

_P. Christie_

### Chemistry

**ES.3091 Introduction to Solid-State Chemistry (New)**
- (Subject meets with 3.091, CC.3091)
- Prereq: None
- U (Fall)
- 5-0-7 CHEMISTRY

Equivalent to 3.091; see 3.091 for description. Students attend regular 3.091 lectures and are assigned to recitations taught by ESG staff. Limited to students in ESG.

_P. Christie_

**ES.5111 Principles of Chemical Science (New)**
- (Subject meets with 5.111)
- Prereq: None
- U (Fall)
- 5-0-7 CHEMISTRY

Equivalent to 5.111; see 5.111 for description. Instruction provided through small, interactive classes taught by ESG staff. Limited to students in ESG.

_P. Christie_

**ES.5112 Principles of Chemical Science (New)**
- (Subject meets with 5.112)
- Prereq: None
- U (Fall)
- 5-0-7 CHEMISTRY

Equivalent to 5.112; see 5.112 for description. Instruction provided through small, interactive classes taught by ESG staff. Limited to students in ESG.

_P. Christie_

### Mathematics

**ES.1801 Calculus (New)**
- Prereq: None
- U (Fall)
- 5-0-7 CALC I

Credit cannot also be received for 18.01, 18.014, 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 (New)**
- Prereq: Calculus I (GIR)
- U (Fall, Spring)
- 5-0-7 CALC II

Credit cannot also be received for 18.02, 18.022, 18.023, 18.024, 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 (New)**
- Prereq: None. Coreq: Calculus II (GIR)
- U (Fall, Spring)
- 5-0-7 REST

Credit cannot also be received for 18.03, 18.034, 18.036, CC.1803
Equivalent to 18.03; see 18.03 for description. Instruction provided through small, interactive classes. Limited to students in ESG.

_J. Orloff, G. Stoy_

**ES.181A Calculus (New)**
- Prereq: Knowledge of differentiation and elementary integration
- U (Fall)
- 5-0-7 CALC I

Credit cannot also be received for 18.01, 18.014, 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 (New)**
- U (Fall, IAP)
- Prereq: Calculus I (GIR)
- 5-0-7 CALC II

Credit cannot also be received for 18.02, 18.022, 18.023, 18.024, 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 (New)**
- Prereq: None
- U (Fall)
- 5-0-7 PHYSICS I

Credit cannot also be received for 8.01, 8.011, 8.012, 8.01L, CC.801, CC.8012, ES.8012
Equivalent to 8.01; see 8.01 for description. Instruction provided through small, interactive classes. Limited to students in ESG.

_A. Barrantes_

**ES.8012 Physics I (New)**
- Prereq: None
- U (Fall)
- 5-0-7 PHYSICS I

Credit cannot also be received for 8.01, 8.011, 8.012, 8.01L, CC.801, CC.8012, ES.8012
Equivalent to 8.012; see 8.012 for description. Also covers connections to astrophysics; students complete individual and group projects. Limited to students in ESG.

_P. Rebusco_
ESG SEMINARS

ES.010 Chemistry of Sports: Understanding How Exercise Affects Your Body (New)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
2-1-3 [P/D/F]
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 a running study and 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

ES.011 Kitchen Chemistry (New)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
2-1-3 [P/D/F]
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 SPECIAL SUBJECTS

ES.S10–ES.S11 Special Subject in Science (SP.233–SP.240)
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 not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.
Staff

ES.S20–ES.S21 Special Subject in Mathematics (SP.241–SP.242)
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 not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.
Staff

ES.S30–ES.S31 Special Subject in Engineering and Computer Science (SP.243–SP.244)
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 not be used for GIR credit, but
may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S40–ES.S41 Special Subject in the Humanities (SP.245–SP.246)
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 not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S50–ES.S51 Special Subject in the Arts (SP.247–SP.248)
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 not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S60–ES.S61 Special Subject in Social Science (SP.249–SP.250)
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 not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff

ES.S70–ES.S71 Special Subject in Interdisciplinary Studies (SP.251–SP.252)
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 not be used for GIR credit, but may be repeated for credit with permission of instructor. Preference to students in ESG.

Staff
UNDERGRADUATE

ESD.00 Introduction to Engineering Systems
Prereq: None
U (Spring)
2-3-4
Students work on projects to address large, complex and seemingly intractable real-world problems, such as energy supply, environmental issues, health care delivery, and critical infrastructure (e.g., telecommunications, water supply, and transportation). Introduces interdisciplinary approaches—rooted in engineering, management, and the social sciences—to considering these critical contemporary issues. Small, faculty-led teams select an engineering systems term project to illustrate one or more of these approaches. Limited to 12; preference to freshmen.

J. Sussman

ESD.01J Transportation Systems Modeling
(Subject meets as 1.041J)
Prereq: 1.00, 1.010
U (Spring)
3-1-8
See description under subject 1.041J.
C. Osorio, J. Williams

ESD.018J Project Management
(Subject meets with 1.401J)
Prereq: Permission of instructor
G (Spring)
3-0-6
H-LEVEL Grad Credit
See description under subject 1.040.
F. Moavenzadeh

ESD.035J Engineering Design and Rapid Prototyping
(Subject meets as 16.810J)
Prereq: 16.01, 16.02 or 2.001, 2.002 or permission of instructor
U (IAP)
2-4-0
See description under subject 16.810J.
O. de Weck

ESD.05 Engineering Leadership Lab
(Subject meets with ESD.050)
Prereq: None
U (Fall, Spring)
0-2-1
Can be repeated for credit

ESD.050 Engineering Leadership Lab
(Subject meets with ESD.05)
Prereq: ESD.05
U (Fall, Spring)
0-2-4
Can be repeated for credit

ESD.051J Engineering Innovation and Design
(Subject meets as 6.902J)
Prereq: None
U (Fall, Spring)
4-0-5
Project-based seminar in effective design-thinking. Develops skills to conceive, evaluate, plan, organize, lead, and implement engineering design projects. Covers techniques to sharpen creative thinking and critical analysis of designs, using an iterative process, as well as techniques for managing project scope and balancing real-world constraints against limitations of technology and human cognition. Students conceive and design robust voice recognition applications using a simple web-based system. Lays foundation for departmental capstone work. Limited to 60; preference to juniors and seniors.
B. Kotelly, J. Schindall

ESD.052 Project Engineering
Prereq: Permission of instructor
U (Spring)
3-2-1
Credit cannot also be received for 1.040

ESD.053J Environmental Cancer Risks, Prevention, and Therapy
(Subject meets as 1.081J, 20.104J)
Prereq: Biology (GIR), Chemistry (GIR)
U (Spring)
3-0-9
See description under subject 20.104J.
W. Thilly, R. McCunney

ESD.054 Engineering Leadership (New)
Prereq: Permission of instructor
U (Fall, IAP, Spring; partial term)
2-2-2
Exposes students to the models and methods of engineering leadership within the contexts of conceiving, designing, implementing and operating products, processes and systems. Introduces models and theories, such as the 4 Capabilities Framework and the Capabilities of Effective Engineering Leaders. Discusses the appropriate times and reasons to use particular models to deliver engineering success. Includes guest speakers, team projects, and video analysis of team performance. Preference to students...
in the Bernard M. Gordon-MIT Engineering Leadership Program.

E. Crawley, K. Zolot

ESD.07j Statistical Thinking and Data Analysis
(Same subject as 15.075j)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
4-0-8 HASS-S (HASS-E); CI-H
See description under subject 15.075j.
C. Rudin

ESD.082j Science, Technology, and Public Policy
(Same subject as 17.309j, STS.082j)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
4-0-8 HASS-S (HASS-E); CI-H
See description under subject 17.309j.
K. Oye

GRADUATE

ESD.10j Introduction to Technology and Policy
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Frameworks and Models for Technology and Policy students explore perspectives in the policy process — agenda setting, problem definition, framing the terms of debate, formulation and analysis of options, implementation and evaluation of policy outcomes using frameworks including economics and markets, law, and business and management. Methods include cost/benefit analysis, probabilistic risk assessment, and system dynamics. Exercises include developing skills to work on the interface between technology and societal issues; simulation exercises; case studies; and group projects that illustrate issues involving multiple stakeholders with different value structures, high levels of uncertainty, multiple levels of complexity; and value trade-offs that are characteristic of engineering systems. Emphasis on negotiation, team building and group dynamics, and management of multiple actors and leadership.
F. Field

ESD.110j Global Environmental Science and Politics (New)
(Same subject as 12.846j)
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-6
Practical introduction to the international environmental political arena, particularly designed for science and engineering students whose work is potentially relevant to global environmental issues. Covers basic issues in international politics, such as negotiations, North-South conflict, implementation and compliance, and trade. Emphasizes the roles and responsibilities of experts providing scientific assessment reports and in technical advisory bodies. Term projects focus on organizing and presenting scientific information in ways relevant for ongoing global policymaking.
N. Selin

ESD.120j Sustainability Science and Engineering
(Same subject as 12.845j)
Prereq: permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-6 H-LEVEL Grad Credit
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. Selin

ESD.123j Industrial Ecology
(Same subject as 1.814j, 3.560j)
Prereq: ESD.10 or 3.56
G (Spring)
3-0-6 H-LEVEL Grad Credit
Quantitative techniques for life cycle analysis of the impacts of materials extraction, processing use, and recycling; and economic analysis of materials processing, products, and markets. Student teams undertake a major case study of automobile manufacturing using the latest methods of analysis and computer-based models of materials process.
R. Kirchain, J. Clark, F. Field

ESD.124j Energy Systems and Climate Change Mitigation
Prereq: permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores the contributions of energy systems to global greenhouse gas emissions and the potential levers for reducing emissions. Lectures and projects focus on decomposing contributions to greenhouse gas emissions, with emphasis on technology related variables such as per unit cost and carbon intensity of energy. Reviews other performance attributes of energy technologies. Student projects explore pathways for realizing emissions reduction scenarios.
J. Trancik

ESD.128j Global Climate Change: Economics, Science, and Policy
(Same subject as 12.848j, 15.023j)
(Subject meets with 12.348j, 15.026j)
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
G (Spring)
3-0-6
See description under subject 15.023j.
R. G. Prinn, M. D. Webster

ESD.129j Space Policy Seminar
(Same subject as 16.891j)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.891j.
A. L. Weigel

ESD.132j Law, Technology, and Public Policy
(Same subject as 15.655j)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Examination of the relationship between law and technological change, and the ways in which law, economics, and technological change shape public policy. Areas addressed include 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 the distribution of wealth and social justice. Topics covered include 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; and law and economics as competing paradigms to encourage sustainability. Open to freshmen and sophomores with permission of instructor.

N. A. Ashford, C. C. Caldart

ESD.133J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.811J, 11.630J)
(Subject meets with 1.801J, 11.021J, 17.393J)
Prereq: Permission of instructor for undergraduates
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.811J.
N. A. Ashford, C. C. Caldart

ESD.134J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 1.812J, 11.631J)
(Subject meets with 1.802J, 10.805J, 11.022J, ESD.136J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.802J.
N. A. Ashford, C. C. Caldart

ESD.136J Technology, Law, and the Working Environment
(Same subject as 10.805J)
(Subject meets with 1.802J, 1.812J, 11.022J, 11.631J, ESD.134J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 10.805J.
N. A. Ashford, C. C. Caldart

ESD.137J Sustainability, Trade, and the Environment
(Same subject as 1.813J, 11.466J, 15.657J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

The Schumpeterian notion of technological innovation as “the engine of growth” is being challenged as the globalization of trade is increasingly seen as the driving force of industrial economies. With the establishment of the World Trade Organization implementing the GATT, NAFTA, and other trading regimes, serious questions have been raised concerning the effects of global trade on sustainability, which must be viewed broadly 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. Open to freshmen and sophomores with permission of instructor.

R. K. Lester

ESD.151J Chemicals in the Environment: Fate and Transport
(Same subject as 1.725J)
Prereq: Permission of instructor
G (Fall)
3-0-9
See description under subject 1.725J.
H. Hemond, P. Shanahan

ESD.162J Engineering, Economics and Regulation of the Electric Power Sector
(Same subject as 6.695J, 15.032J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Provides an in-depth and interdisciplinary look at electric power systems, focusing on regulation as the link among engineering, economic, legal and environmental viewpoints. Explores a range of topics, such as generation dispatch, demand response, optimal network flows, wholesale and retail electricity supply, renewable generation, risk allocation, reliability of service, tariff design, transmission policy, distributed generation, rural electrification, and environmental sustainability issues, all under both traditional and competitive regulatory frameworks. Background in policy, microeconomics, or engineering required.

I. Perez-Arriaga, R. Schmalensee

ESD.163J Managing Nuclear Technology
(Same subject as 22.812J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.812J.

R. K. Lester

ESD.166J Sustainable Energy
(Same subject as 1.818J, 2.65J, 10.391J, 11.371J, 22.811J)
(Subject meets with 2.650J, 10.291J, 22.081J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 22.811J.
M. W. Golay

ESD.172J X PRIZE Workshop: Grand Challenges in Energy
(Same subject as EC.421J)
Prereq: Permission of instructor
G (Fall)
3-0-6
Uses a project-based approach to examine the intersection of incentives and innovation, drawing on economic models, historic examples, and analytic tools to help develop new prize concepts that can generate revolutionary progress in the energy field. Limited to 30 graduate students by application; select upperclassmen with permission of instructor.

E. Wagner, D. Newman, F. Murray, K. Zolot, J. Shames, C. Cooney

ESD.173J X PRIZE Workshop: Grand Challenges in Health Care
(Same subject as EC.420J, HST.937J)
Prereq: Permission of instructor
G (Spring)
3-0-6
Uses a project-based approach to examine the intersection of incentives and innovation, drawing on economic models, historic examples, and analytic tools to help develop new prize concepts that can generate revolutionary progress in the area of health and medicine. Limited to 30 graduate students by application; select upperclassmen with permission of instructor.

E. Wagner, D. Newman, F. Murray, K. Zolot, J. Shames, C. Cooney

ESD.174J Applications of Technology in Energy and the Environment
Engineering School-Wide Elective Subject
(Offered under: 1.149, 2.65, 10.579, 22.813)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.813.
J. Deutch, R. Lester
ESD.191J Urban and Regional Economics
(Same subject as 1.283J, 11.410J, 14.573J)
Prereq: 14.04, 14.32
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 14.573J.
W. Wheaton

ESD.192J Analyzing and Accounting for Regional Economic Change
(Same subject as 1.284J, 11.481J)
Prereq: 14.03, 14.04
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.481J.
K. R. Polenske

ESD.193J Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 1.285J, 11.482J)
Prereq: 11.481J or permission of instructor
G (Fall)
2-1-9 H-LEVEL Grad Credit
See description under subject 11.482J.
K. R. Polenske

ESD.21J Transportation Systems Analysis: Performance and Optimization
(Same subject as 1.200J, 11.544J)
Prereq: 1.010, permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.200J.
C. Barnhart, A. R. Odoni

ESD.210J Transportation Systems Analysis: Demand and Economics
(Same subject as 1.201J, 11.545J)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.201J.
N. H. M. Wilson, M. Ben-Akiva

ESD.212J Demand Modeling
(Same subject as 1.202J)
Prereq: 1.201 or permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 1.202J.
M. Ben-Akiva

ESD.213J Advanced Demand Modeling
(Same subject as 1.205J)
Prereq: 1.202 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.205J.
M. E. Ben-Akiva

ESD.216J Logistical and Transportation Planning Methods
(Same subject as 1.203J, 6.281J, 15.073J, 16.76J)
Prereq: 6.041
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.203J.
R. C. Larson, A. R. Odoni, A. I. Barnett

ESD.217J The Airline Industry
(Same subject as 1.232J, 15.054J, 16.71J)
Prereq: None
G (Fall)
3-0-9
See description under subject 16.71J.

ESD.221J An Introduction to Intelligent Transportation Systems
(Same subject as 1.212J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-6 H-LEVEL Grad Credit
See description under subject 1.212J.
J. Sussman

ESD.222J Transportation Policy and Environmental Limits
(Same subject as 1.253J, 11.543J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.253J.
J. Coughlin, F. Salvucci

ESD.224J Planning and Design of Airport Systems
(Same subject as 1.231J, 16.781J)
Prereq: Permission of Instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 1.231J.
R. de Neufville, A. R. Odoni

ESD.225J Urban Transportation Planning
(Same subject as 1.252J, 11.540J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.252J.
F. Salvucci, M. Murga

ESD.226J Public Transportation Systems
(Same subject as 1.258J, 11.541J)
Prereq: 1.201 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.258J.
N. H. M. Wilson

ESD.229J Urban Spatial Structure, Transportation, and Telecommunications I
(Same subject as 11.528J)
Prereq: Permission of instructor
G (Spring)
3-1-2 H-LEVEL Grad Credit
See description under subject 11.528J.
Staff

ESD.250 Analytical Methods for Supply Chain Management
Prereq: None
G (Fall)
2-0-1 [P/D/F]
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 Master of Engineering in Logistics students
J. Goentzel, C. Caplice, E. Blanco

ESD.251 Supply Chain Finance (New)
Prereq: None. Coreq: ESD.260 or permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Explores the linkages between supply chain management and financial systems and objectives of the corporation. 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 supply chain valuation, activity-based costing, cash flow projections, working capital management, and trade finance.
J. Goentzel
**ESD.260J Logistics Systems**  
(Same subject as 1.260J, 15.770J)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit

Introduction to supply chain management from both analytical and practical perspectives. Stressing a unified approach, the course allows the student to develop a framework for making intelligent decisions within the supply chain. Key logistics functions are covered to include demand planning, procurement, inventory theory and control, transportation planning and execution, reverse logistics, and flexible contracting. Concepts explored include postponement, portfolio management, dual sourcing, and others. Emphasis is placed on being able to recognize and manage risk, analyze various tradeoffs, and model logistics systems.

J. Goentzel, C. Caplice

**ESD.261J Case Studies in Logistics and Supply Chain Management**  
(Same subject as 1.261J, 15.771J)  
Prereq: Permission of instructor  
G (Spring)  
3-0-6 H-LEVEL Grad Credit

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

**ESD.262J Supply Chain Leadership**  
(Same subject as 1.262J)  
Prereq: ESD.260J or permission of instructor  
G (IAP)  
2-0-7 [P/D/F]

Reinforces supply chain concepts covered in prerequisite coursework 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 and a large-scale, team-based simulation game.

J. Goentzel, C. Caplice

**ESD.263 Logistics Thesis Seminar**  
Prereq: None  
G (Spring)  
2-0-1 [P/D/F]

The thesis process, technical writing, and presentation skills. Seminar organizes students into groups working on parallel topics. Meets intermittently throughout the term. Limited to MEng in Logistics students.

W. Haas, C. Caplice

**ESD.264J Database, Internet, and Systems Integration Technologies**  
(Same subject as 1.264J)  
Prereq: Permission of instructor  
G (Fall)  
5-0-7 H-LEVEL Grad Credit

See description under subject 1.264J.

G. Kocur

**ESD.265J International Supply Chain Management**  
(Same subject as 1.265J, 2.965J, 15.765J)  
Prereq: 1.260, 1.261, 1.262, 15.760, or permission of instructor  
Acad Year 2011–2012: G (Spring; first half of term)  
Acad Year 2012–2013: Not offered  
2-0-4 H-LEVEL Grad Credit

See description under subject 2.965J.

Staff

**ESD.266J Supply Chain Planning**  
(Same subject as 1.266J, 15.762J)  
Prereq: 1.260J, 15.760J, or 15.761J  
G (Spring)  
2-0-4 H-LEVEL Grad Credit

See description under subject 15.762J.

S. C. Graves, D. Simchi-Levi

**ESD.267J Manufacturing System and Supply Chain Design**  
(Same subject as 1.267J, 15.763J)  
Prereq: 1.260, 15.760J, or 15.761J  
G (Spring)  
2-0-4 H-LEVEL Grad Credit

See description under subject 15.763J.

S. C. Graves, D. Simchi-Levi

**ESD.268J Manufacturing System and Supply Chain Design**  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged H-LEVEL Grad Credit  
Can be repeated for credit

Individual advanced study of a topic in transportation systems, selected with the approval of the instructor.

Staff

**ESD.267J Manufacturing System and Supply Chain Design**  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]

Can be repeated for credit

Discussion of current research at various stages of development, including problem definition, literature review, methodology, and evaluation of results. Intended for advanced doctoral students who have passed the general examination.

Staff

**ESD.272J Design and Operation of Logistics Facilities and Networks**  
(Same subject as 1.272J)  
Prereq: 1.260J or permission of instructor  
G (IAP)  
2-0-1

Exploration of the technological and managerial issues involved in the design and operation of distribution and logistics physical facilities and associated information technology in an enterprise wise supply chain. Includes day-long site visits to logistics operations in the local area, as well as day-long software tutorials on commercial-grade software packages used in the design of logistics networks. The curriculum also includes lectures and case studies from faculty and professional logistics consultants focusing on the design and operation of efficient logistics facilities.

C. Caplice

**ESD.273J Logistics and Supply Chain Management**  
(Same subject as 1.273J, 15.762J)  
Prereq: 1.260J or permission of instructor  
G (IAP)  
2-0-4

Survey of Operations Research models and techniques developed for a variety of problems arising in logistical planning of multi-echelon systems. Focus on planning models for production/inventory/distribution strategies in general multi-echelon multi-item systems. Topics include vehicle routing problems, dynamic lot sizing inventory models, stochastic and deterministic multi-echelon inventory systems, the bullwhip effect, pricing models, and integration problems arising in supply chain management. Probability and linear programming experience required.

D. Simchi-Levi
ESD.274| The Theory of Operations Management (New)  
(Same subject as 1.271J, 15.764J)  
Prereq: 15.081J or 6.251J, 6.436J; or permission of instructor  
G (Fall, Spring)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
See description under subject 15.764J.  
Fall: V. Farias  
Spring: R. Levi

ESD.290 Topics in Supply Chain Management  
Prereq: ESD.260J, 1.260J, 15.770J, or permission of instructor  
G (Spring)  
3-0-3 H-LEVEL Grad Credit  
Subject presents a range of advanced topics in integrated logistics and supply chain management. Conducted in a lecture-discussion format, with participation of corporate executives as guest lecturers. Students prepare industry assessment analyses and make formal classroom presentations. Specific topics alternate from year to year, but basic content includes procurement strategies and strategic sourcing, dynamic pricing and revenue management tactics, mitigation of supply chain risk through supply contracts, strategic outsourcing of supply chain functions and operations, management and operation of third party logistics providers, and management of supply chain security.  
Y. Sheffi

ESD.30j Engineering Apollo: The Moon Project as a Complex System  
(Same subject as 16.895J, STS.471J)  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
4-0-8 H-LEVEL Grad Credit  
See description under subject STS.471J.  
L. R. Young, J. Tylko

ESD.30i Probability and Statistics  
Prereq: None  
G (IAP)  
1-0-3 [P/D/F]  
A highly-condensed review of topics from basic probability through calculus-based statistical analysis. It assumes previous probability and statistics course work, and is designed to be an intensive review for incoming SDM students. Limited to SDM students except by permission of instructor.  
J. Orloff

ESD.32j Product Design and Development  
(Same subject as 2.739J, 15.783J)  
Prereq: 2.009, 15.760, 15.761, or permission of instructor  
G (Spring)  
3-3-6 H-LEVEL Grad Credit  
See description under subject 15.783J.  
S. Eppinger, W. P. Seering

ESD.33 Systems Engineering  
Prereq: Limited to SDM students except by permission of instructor  
G (Summer)  
4-0-5 H-LEVEL Grad Credit  
Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem including operations, performance, test, manufacturing, cost, and schedule. This subject emphasizes the links of systems engineering to fundamentals of decision theory, statistics, and optimization. Also introduces the most current, commercially successful techniques for systems engineering.  
Q. Hommes, P. Hale

ESD.34 System Architecture  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Focus on understanding engineering systems using network models. Framing of the interplay between theory and experiment, leading to new knowledge about complex system architecture. Review of network literature, network methods in social science, and recent results in large network analysis. Discussion of key system concepts, including modularity, hierarchy, flexibility, and complexity. Examples of engineering systems, organizations, and social systems. Descriptions of real systems, such as software, railways, telephones, and large social systems. Definition of network metrics and MATLAB implementations of network analysis methods. Readings and discussion of current network research literature, including identification of needed research. Semester-long project analyzing a real system using these methods.  
C. Magee, J. Moses, D. Whitney

ESD.340| Theory of System Architecture  
(Same subject as 16.882J)  
Prereq: ESD.32j or permission of instructor  
G (Fall)  
4-2-6 H-LEVEL Grad Credit  
Covers principles and methods for technical System Architecture. Presents a synthetic view including: the resolution of ambiguity to identify system goals and boundaries; the creative process of mapping form to function; and the analysis of complexity and methods of decomposition and re-integration. Industrial speakers and faculty present examples from various industries. Heuristic and formal methods are presented.  
A. L. Weigel

ESD.341j Architecting & Engineering Software Systems  
(Same subject as 1.125J)  
Prereq: 1.00, 1.124J, or permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Software architecting and design of software-intensive systems. Targeted at future CTOs who must understand both the business and technical issues involved in architecting enterprise-scale systems. Student teams confront technically challenging problems. Lectures and readings cover core database, XML, web server components and browser issues in a distributed web service environment. Enrollment limited.  
J. Williams, D. Hartzband, A. Sanchez

ESD.342 Network Representations of Complex Engineering Systems  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Focus on understanding engineering systems using network models. Framing of the interplay between theory and experiment, leading to new knowledge about complex system architecture. Review of network literature, network methods in social science, and recent results in large network analysis. Discussion of key system concepts, including modularity, hierarchy, flexibility, and complexity. Examples of engineering systems, organizations, and social systems. Descriptions of real systems, such as software, railways, telephones, and large social systems. Definition of network metrics and MATLAB implementations of network analysis methods. Readings and discussion of current network research literature, including identification of needed research. Semester-long project analyzing a real system using these methods.  
C. Magee, J. Moses, D. Whitney

ESD.344 Real Options for Product and Systems Design  
Prereq: None  
G (Spring; second half of term)  
3-0-3  
Theory and practice of implementing flexibility (real options) in the design of products and systems. Topics include: recognition of uncertainty, identification of best opportunities for flexibility, valuation of these options and their effective implementation. Students apply the concepts and procedures to problems of their
choice. Designed to help SDM students launch their theses.
R. de Neufville

ESD.351J Air Transportation Systems Architecture
(Same subject as 16.866J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-2-7 H-LEVEL Grad Credit
See description under subject 16.866J.
R. J. Hansman

ESD.352J Space Systems Engineering
(Same subject as 16.89J)
Prereq: 16.851, 16.892, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-2-6 H-LEVEL Grad Credit
See description under subject 16.89J.
E. F. Crawley, D. W. Miller

ESD.355J Concepts in the Engineering of Software
(Same subject as 16.355J)
Prereq: 16.35, ESD.33, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.355J.
N. G. Leveson

ESD.36 System Project Management
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Subject focuses on management principles, methods, and tools to effectively plan and implement successful system and product development projects. Material is divided into four major sections: project preparation, planning, monitoring, and adaptation. Brief review of classical techniques such as CPM and PERT. Emphasis on new methodologies and tools such as Design Structure Matrix (DSM), probabilistic project simulation, as well as project system dynamics (SD). Topics are covered from strategic, tactical, and operational perspectives. Industrial case studies expose factors that are typical drivers of success and failure in complex projects with both hardware and software content. Term projects analyze and evaluate past and ongoing projects in student’s area of interest. Projects used to apply concepts discussed in class.
O. de Weck, J. Lyneis

ESD.361J Cost Estimation and Measurement Systems
(Same subject as 16.866J)
Prereq: ESD.301 or a basic understanding of statistics and permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

Focuses on principles of cost estimation and measurement systems with specific emphasis on parametric models. Theories from the fields of hardware, software, systems engineering, and systems of systems are explored in a variety of contexts (risk assessment, judgment & decision making, performance measurement, process improvement, adoption of new tools in organizations, etc.). Material is divided into five major sections: cost estimation fundamentals, parametric model development calibration, economic principles, measurement systems, and government/policy issues.
R. Valeri

ESD.379 Systems Engineering Taxonomy and Semantics in Commercial Domains
Prereq: None
G (Fall, Spring)
1-0-3 [P/D/F]

The application of systems engineering practices is increasing in commercial enterprises, but the semantics and process frameworks for ‘commercial systems engineering’ often appear to be quite different from the process and taxonomy developed in defense and aerospace, arguably the birthplace of modern systems engineering. Examines how systems engineering practices are employed in commercial industries, including product and service development and delivery. Special project. Limited to 5.
P. Hale

ESD.38J Enterprise Architecting
(Same subject as 16.855J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Examines the enterprise as a holistic and highly networked structure wherein strategic decisions must be made by applying system-level architecting principles and practices. Uses case-based exercises and examples. Team projects investigate a real-world enterprise from multiple perspectives and discuss the interrelationships of these views. Topics include theories, frameworks, and methods for generating and evaluating candidate architectures, selecting a preferred future state architecture, and developing transformation strategies.
D. Nightingale, D. Rhodes

ESD.40 Product Design and Development
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Modern tools and methods for product design and development. Teams of SDM and certificate program students conceive, design, and prototype a physical product. Cases and exercises reinforce key ideas. Topics include product planning, identifying customer needs, concept generation, product architecture, industrial design, concept design, and design-for-manufacturing. Restricted to SDM students or permission of instructor.
M. Yang, P. Hale

ESD.51J Software and Computation for Simulation
(Same subject as 1.124J, 2.091J)
Prereq: 1.00 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.124J.
J. R. Williams

ESD.53J Globalization and the Built Environment
(Same subject as 1.463J, 11.342J)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit
See description under subject 1.463J.
F. Moavenzadeh, D. Wolff

ESD.55 Management of Infrastructure Systems
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Infrastructure systems such as transportation, telecommunication, and electric power systems have become a crucial aspect of modern society. Investigates techniques from control theory and optimization that help develop and manage these systems. Although each system has unique features that need to be understood, course considers how some tools have general applicability. Studies concepts such as stability, robustness, resource allocation, stakeholder equity, and arguments for centralization/decentralization of components. Knowledge of infrastructure systems, control theory, system dynamics, network analysis required.
H. Balakrishnan
ESD.56J Evolution Towards Web 3.0 and the Emergence of Management 3.0
(Same subject as 15.565J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 15.565J.
S. Madnick

ESD.57 Technology-based Business Innovation
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
How to leverage major technology advances to significantly transform a business in the marketplace. Focus on major issues a business must deal with to transform its technical and market strategies successfully, including the organizational and cultural aspects that often cause such business transformations to fail. Draws from concrete experiences of IBM’s major transformation in the late 1990s, when it aggressively embraced the Internet and came up with its e-business strategy.
J. Wladawsky-Berger

ESD.58J Disruptive Technologies: Predator or Prey
(Same subject as 15.365J)
Prereq: None
G (Spring)
3-0-6
See description under subject 15.365J.
J. M. Utterback

ESD.60 Creating High-Velocity Organizations
Prereq: Permission of instructor
G (Summer)
2-0-6
Examines methods standout organizations use to generate and sustain more value, with less effort and fewer resources, than their rivals. Methods illustrated with examples from heavy and high-tech manufacturing, new product development and manufacturing, health care and military. Addresses the role of lean, six sigma, and other quality programs. Preference to students in LGO, SDM, and 2N master’s programs.
S. Spear

ESD.61J Integrating The Lean Enterprise
(Same subject as 16.852J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.852J.
D. Nightingale

ESD.62J Introduction to Lean Six Sigma Methods
(Same subject as 16.660J)
(Subject meets with 16.853)
Prereq: None
U (IAP)
1-1-0 [P/D/F]
See description under subject 16.660J.
A. L. Weigel, E. M. Murman

ESD.63J Control of Manufacturing Processes
(Same subject as 2.830J, 6.780J)
Prereq: 2.008, 6.041, 6.152, or 15.064
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.830J.
D. E. Hardt, D. S. Boning

ESD.64J Product Design
(Same subject as 2.744J)
Prereq: 2.009
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-1-8 H-LEVEL Grad Credit
See description under subject 2.744J.
D. R. Wallace

ESD.65J Aerospace Biomedical and Life Support Engineering
(Same subject as 16.423J, HST.515)
Prereq: 16.400, 16.06, 16.060, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 16.423J.
D. J. Newman

ESD.66J Seminar on Health Care Systems Innovation
(Same subject as HST.926J)
Prereq: Permission of instructor
G (Fall)
2-0-7
Seminar examines how “systems” approaches can be used to address inefficiencies and introduction of innovation into the delivery of health care. Topics include identification of problems in delivery of chronic, acute, and emergency care and possible organizational and technological solutions. Cases, readings, and discussions draw upon experiences in the United States and globally.
S. Finkelstein, J. Coughlin, J. Moses

ESD.67 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject
(Offered under: 1.146, 16.861)
(Subject meets with ESD.710)
Prereq: 1.145 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers theory and methods to identify, value, and implement flexibility in design, also known as “real options.” Topics include definition of uncertainties, simulation of performance for scenarios, screening models to identify desirable flexibility, decision and lattice analysis, and multidimensional economic evaluation. Students demonstrate proficiency through an extended application to a systems design of their choice. Provides a complement to research or thesis projects. Meets with ESD.710 first half of term.
R. de Neufville

ESD.68J Seminar on Health Care Systems
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 16.423J.
D. J. Newman

ESD.69J Principles and Practice of Drug Development
(Same subject as 7.547J, 10.547J, 15.136J, HST.920J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

ESD.70J Engineering Economy Module
(Same subject as 1.145J)
Prereq: None
G (Fall; partial term)
1-0-2 [P/D/F]
Presentation of the spreadsheet mechanics for the efficient calculation of discounted cash flows and related metrics of project worth; the use of data tables as means of exploring sensitivity analysis; and of simulation to develop the value of options. Intensive module designed for students who are not familiar with the efficient use of Excel. Presented intensively over first week of term.
R. de Neufville

ESD.71 Engineering Systems Analysis for Design
Engineering School-Wide Elective Subject
(Offered under: 1.146, 16.861)
(Subject meets with ESD.710)
Prereq: 1.145 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers theory and methods to identify, value, and implement flexibility in design, also known as “real options.” Topics include definition of uncertainties, simulation of performance for scenarios, screening models to identify desirable flexibility, decision and lattice analysis, and multidimensional economic evaluation. Students demonstrate proficiency through an extended application to a systems design of their choice. Provides a complement to research or thesis projects. Meets with ESD.710 first half of term.
R. de Neufville

ESD.710 Risk and Decision Analysis
(Subject meets with 1.146J, 16.861, ESD.71J)
Prereq: 1.145 or permission of instructor
G (Fall; first half of term)
3-0-3 H-LEVEL Grad Credit
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 analy-
sis; and the use of decision analysis to explore alternative strategies and identify optimal initial choices. Applied analysis of practical examples from a variety of engineering systems using spreadsheet and decision analysis software.

M. Webster

ESD.712J Tools for Analysis: Design for Real Estate and Infrastructure Development
(Same subject as 11.434J, 15.428J)
Prereq: None
G (Spring; second half of term)
2-0-4
See description under subject 11.434J.
D. Gelmer, R. de Neufville

ESD.72 Engineering Risk-Benefit Analysis
Engineering School-Wide Elective Subject
(Offered under: 1.155, 2.963, 6.938, 10.816, 16.862, 22.82)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Emphasis on three methodologies pertaining to decision making in the presence of uncertainty: reliability and probabilistic risk assessment (RPRA), decision analysis (DA), and cost-benefit analysis (CBA). Risks of particular interest are those associated with large engineering projects such as the development of new products; the building, maintenance and operation of nuclear reactors and space systems. Presents and interprets some of the frameworks helpful for balancing risks and benefits in the situations that typically involve human safety, potential environmental effects, and large financial and technological uncertainties. Review of elementary probability theory and statistics included.
G. Apostolakis

ESD.721 Engineering Risk-Benefit Analysis (Abridged)
Prereq: Calculus II (GIR)
G (Fall)
3-0-6 H-LEVEL Grad Credit
Abbreviated version of ESD.72 with which it shares the lectures on reliability and probabilistic risk assessment (RPRA) and decision analysis (DA). Cost-benefit analysis is omitted.
G. Apostolakis

ESD.73J Materials Selection, Design, and Economics
(Same subject as 3.57J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 3.57J.
J. Clark

ESD.74 System Dynamics for Engineers
Prereq: Permission of instructor
G (Summer)
3-0-9 H-LEVEL Grad Credit
Introduces the methodology and then develops applications to large-scale engineering systems, such as the design and construction of mega projects; the impacts of organization on system performance; and the interrelationships between technical systems and the social/political context in which such systems operate.
B. Morrison

ESD.750J System Optimization and Analysis for Operations
(Same subject as 2.851J, 15.066J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.066J.
V. Farias

ESD.751J Engineering Probability and Statistics
(Same subject as 15.064J)
Prereq: Calculus II (GIR)
G (Summer)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.064J.
A. I. Barnett, C. Rudin, R. Welsch

ESD.753J Statistical Learning and Data Mining
(Same subject as 15.077J)
Prereq: 6.431, 15.085, or 18.440; 18.06 or 18.700
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.077J.
R. E. Welsch

ESD.754J Data Mining: Finding the Data and Models that Create Value
(Same subject as 15.062J)
Prereq: 15.060 or 15.075
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 15.062J.
R. Welsch

ESD.755J Statistical Reasoning and Data Modeling
(Same subject as 15.074J)
Prereq: 6.431, 15.060, or permission of instructor
G (Spring)
4-0-5 H-LEVEL Grad Credit
See description under subject 15.074J.
R. E. Welsch

ESD.756J Statistical Methods in Experimental Design
(Same subject as 16.470J)
Prereq: 6.041, 16.09, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.470J.
M. L. Cummings

ESD.762 Systems Optimization
Prereq: 1.145 or permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
Application-oriented introduction to systems optimization focusing on understanding system tradeoffs. Introduces modeling methodology (linear, integer and nonlinear programming) and simulation methods, with applications in production planning and scheduling, inventory planning and supply contracts, logistics network design, facility sizing and capacity expansion, yield management, electronic trading and finance.
D. Simchi-Levi

ESD.763 Operations and Supply Chain Management
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Objectives are to develop modeling skills and to provide new concepts and problem-solving tools, applicable to the design and planning of supply chains as well as manufacturing systems.
Staff

ESD.77J Multidisciplinary System Design Optimization
(Same subject as 16.888J)
Prereq: 18.085 or permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
Engineering systems modeling for design and optimization. Selection of design variables, objective functions and constraints. Overview of principles, methods and tools in multidisci-

O. de Weck, K. E. Wilcox

ESD.773J Human Factors Engineering
(Same subject as 16.453J)
(Subject meets with 16.400)
Prereq: 6.041 or permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
See description under subject 16.453J.
M. L. Cummings

ESD.774J Human Supervisory Control of Automated Systems
(Same subject as 16.422J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-1-8 H-LEVEL Grad Credit
See description under subject 16.422J.
Fall: J. A. Shah
Spring: M. L. Cummings

ESD.775J Human-Computer Interface Design Colloquium
(Same subject as 16.475J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
2-0-2
See description under subject 16.475J.
M. L. Cummings

ESD.78J Network Optimization
(Same subject as 6.855J, 15.082J)
Prereq: 6.046, 15.081, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 15.082J.
J. Orlin

ESD.80 Seminar in Technology Policy Research
Prereq: ESD.10
G (Spring)
2-0-1 H-LEVEL Grad Credit
Presentations by students, faculty and guest speakers of ongoing research related to current issues in technology and policy. Specific topics determined by research of participants and by new and important directions in technology and policy.
R. Kirchain

ESD.801 Leadership Development
Prereq: Permission of instructor
G (Fall; partial term)
1-1-1 [P/D/F]
Seminar environment created to develop leadership capabilities. An initial Outward Bound experience builds trust, teamwork and communications. Readings and assignments emphasize the characteristics of great leadership. 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.
D. Newman

ESD.802 SDM Thesis Seminar
Prereq: Permission of instructor
G (Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Designed to assist SDM students in discovering research areas of interest and matching these interests with faculty and organization research projects. At the end of the seminar, the student has faculty advisor, research project, thesis proposal and plan. Restricted to SDM students.
P. Hale

ESD.803 Know Thyself Leadership Workshop
Prereq: None
G (Fall; partial term)
2-0-4
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. Morning section restricted to students in the MLOG program.
S. Saar

ESD.804 Know Thy Team: Leadership Skill Building Seminar
Prereq: None
G (Spring)
2-0-1 [P/D/F]
Provides students with the framework and strategies needed to foster and sustain team effectiveness. Examines research that assesses the effectiveness of teams. Explores team dynamics, with emphasis on understanding the roles of team members and the team leader. Integrates team dynamics into instruction on managing transition, creating a compelling vision, designing a supportive structure, communicating effectively, coaching team members, sustaining performance. Includes role-playing exercises. Restricted to students in the Master of Engineering in Logistics (MLOG) program during IAP.
S. Saar

ESD.81 Independent Study in Transportation and Logistics
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Individual advanced study of a topic in logistics systems selected with the approval of the instructor.
Staff

ESD.811 Technology Policy Internship Seminar
Prereq: ESD.10
G (Fall)
1-1-1 [P/D/F] H-LEVEL Grad Credit
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

ESD.83 Doctoral Seminar in Engineering Systems
Prereq: ESD.10 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Examines core theory and contextual applications of the emerging field of Engineering Systems. Focus on doctoral-level analysis of scholarship on key concepts such as complexity, uncertainty, fragility, and robustness, as well as
ESD.864J Modeling and Assessment for Policy
(Same subject as 12.844J)
Prereq: ESD.10 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Explores how scientific information and quantitatitive 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. Selin

ESD.865 Seminar in Energy Systems Analysis
Prereq: 15.011, 14.003, or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines advanced topics in the modeling and analysis of environmental and energy systems. Topics vary, but may include alternative design of environmental markets, modeling of electric power systems, analysis of alternative fuels, and coupling of environmental and energy systems. Previous coursework in microeconomics required.
M. Webster

ESD.862 Modeling Risk, Dynamics, and Decisions
Prereq: ESD.86 or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
Covers advanced methods for modeling risk and decision-making under uncertainty. Topics include Monte Carlo methods, Markov chain Monte Carlo, dynamic and stochastic optimization, and advanced topics in simulation. Applications drawn primarily from energy and environmental systems modeling.
M. Webster

ESD.863J System Safety
(Same subject as 16.863J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.863J.
N. G. Leveson

ESD.87 Social Science Concepts and Methods
Prereq: ESD.83, ESD.86; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to social science approaches to developing questions, designing research, and collecting data about complex systems. Overview of the different social science paradigms for developing research questions, as well as issues of measurement and research design. Covers various modes of data collection with emphasis on how the different elements of research design contribute to more powerful and persuasive results. Students develop skills in designing and completing social science-based research, as well as in critically assessing related work. Limited to 15.
L. D’Ambrosio, N. Leveson

ESD.875J Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development
(Same subject as 2.875J)
Prereq: 2.008
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.875J.
D. E. Whitney

ESD.88 Engineering Systems Scholarship Seminar
Prereq: None. Coreq: ESD.83 or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
2-0-4 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Develops skills and strategies for publishing in scholarly journals, writing grant proposals, applying for and succeeding in academic jobs, and shaping doctoral and post-doctoral research to further career goals. Includes panel discussions, presentations, workshops, and peer-review. Special emphasis on the landscape of journals and the interdisciplinary acuity necessary for publishing in the broad range of journals that are of interest to engineering systems researchers. Students prepare a paper for submission to a journal.
O. de Weck

SPECIAL SUBJECTS AND RESEARCH

ESD.910, ESD.915 Research in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For research assistants in the Engineering Systems Division 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 ESD.
N. Leveson

ESD.911–ESD.913 Independent Study in Engineering Systems
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Individual research: generally either study, fieldwork, or practicum. Designed to expose student to expert-level material in his/her research domain or context. Supervised by a member of MIT’s teaching staff. Preference to ESD doctoral
students with permission of instructor, advisor, and ESD Academic Office.

N. Leveson

ESD.921 Teaching in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

For teaching assistants in Engineering Systems Division in recognition of educational value derived from satisfactory performance of assigned duties, and for other qualified students interested in teaching as a career. Laboratory, tutorial, or classroom teaching under supervision of a faculty member. Credit for this subject may not be used for any degree granted by ESD.

Information: N. Leveson

ESD.921 Teaching in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Opportunity for study of advanced topics in Engineering Systems Division not otherwise included in the curriculum at MIT. Offerings are initiated by faculty on an ad hoc basis subject to ESD approval.

ESD.520, ESD.522–ESD.524: Information: N. Leveson
ESD.521: E. Wagner

ESD.530–ESD.532 Special Graduate Subject in Engineering Systems Division (ESD.940–ESD.942)
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Opportunity for group study of advanced topics in ESD not otherwise included in the curriculum. Offerings are initiated by faculty on an ad hoc basis subject to ESD approval.

Information: N. Leveson
COURSE HST

HEALTH SCIENCES AND TECHNOLOGY

IMPORTANT NOTES regarding preclinical subjects (HST.011–HST.185 and HST.191):

Students not enrolled in an HST degree program may take preclinical subjects if space is available. Non-HST students are limited to one HST preclinical course and must provide justification for enrolling in this course. They must obtain permission from the course director and the Associate Master of HST at HMS.

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.011 Human Functional Anatomy
(Subject meets with HST.010)
Prereq: Permission of instructor
G (Fall)
3-11-10 H-LEVEL Grad Credit

Lectures, detailed laboratory dissections, and projections 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 limited to graduate students.
L. Gehrke

HST.021 Musculoskeletal Pathophysiology
(Subject meets with HST.020)
Prereq: Permission of Instructor
G (IAP)
3-0-3 H-LEVEL Grad Credit

Growth and development of normal bone and joints, the process of mineralization, the biochemistry 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. Boussein, M. Seton

HST.031 Human Pathology
(Subject meets with HST.030)
Prereq: Permission of instructor; Biology (GIR), Physics I (GIR), or Physics II (GIR)
G (Fall)
4-4-8 H-LEVEL Grad Credit

Credit cannot also be received for HST.034

Introduction to the functional structure of normal cells and tissues, pathologic principles of cellular adaptation and injury, inflammatory, 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

HST.035 Principles and Practice of Human Pathology
(Subject meets with HST.034)
Prereq: 7.01, 7.05; or permission of instructor
G (Spring)
4-2-10 H-LEVEL Grad Credit

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.
K. Badizadegan, G. Tearney

HST.041 Mechanisms of Microbial Pathogenesis
(Subject meets with HST.040)
Prereq: Biology (GIR), 7.05, permission of instructor
G (Fall)
3-6-5 H-LEVEL Grad Credit

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, permission of instructor
G (Spring)
6-0-6 H-LEVEL Grad Credit

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, A. Goldfine

HST.071 Human Reproductive Biology
(Subject meets with HST.070)
Prereq: Biology (GIR), 7.05, permission of instructor
G (Fall; first half of term)
2-4-3 H-LEVEL Grad Credit

Lectures and clinical case discussions designed to provide the student with a clear understanding of the physiology, endocrinology, and pa-
HST.081 Hematology
(Subject meets with HST.080)
Prereq: 7.05, permission of instructor
G (Spring; second half of term)
3-6-4 H-LEVEL Grad Credit

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.
E. Edelman

HST.091 Cardiovascular Pathophysiology
(Subject meets with HST.090)
Prereq: HST.030 or HST.031; permission of instructor
G (Spring)
3-3-9 H-LEVEL Grad Credit

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.
H. F. Bunn, N. Berliner

HST.101 Respiratory Pathophysiology
(Subject meets with HST.100)
Prereq: Biology (GIR), 7.05, Physics I (GIR), permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

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 pathophysiological 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

HST.111 Renal Pathophysiology
(Subject meets with HST.110)
Prereq: Biology (GIR), 7.05, permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

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

HST.121 Gastroenterology
(Subject meets with HST.120)
Prereq: Biology (GIR), 7.05, Physics I (GIR), permission of instructor
G (Fall; second half of term)
3-6-4 H-LEVEL Grad Credit

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.
M. C. Carey

HST.131 Introduction to Neuroscience
(Subject meets with HST.130)
Prereq: Permission of instructor
G (Fall)
6-3-6 H-LEVEL Grad Credit

A comprehensive introductory course in neuroscience, exploring the brain on levels ranging from molecules and cells through neural systems, perception, memory, and behavior. Some aspects of clinical neuroscience, within neuropharmacology, pathophysiology, and neurology. Lectures are 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.
R. H. Masland

HST.140 Molecular Medicine
Prereq: 7.05
G (Fall)
2-0-4 [P/D/F] H-LEVEL Grad Credit

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.

HST.147 Human Biochemistry and Metabolic Diseases
(Subject meets with HST.146)
Prereq: Permission of instructor
G (Fall, IAP)
3-0-3 H-LEVEL Grad Credit

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 that are introduced by clinician-scientists. Only HST students may register under HST.146, graded P/D/F. Enrollment limited.
D. Cohen, R. Mitchell

HST.151 Principles of Pharmacology
(Subject meets with HST.150)
Prereq: Biology (GIR), 7.05, Physics I (GIR)
G (Spring; first half of term)
3-0-9 H-LEVEL Grad Credit

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. BEP students must register for HST.151 (graded) other HST students may register under HST.150 (P/D/F). Course follows HMS calendar. Restricted to HST MD, HST MEMP or HST BEP students.
C. Rosow, G. Forman, G. Strichartz
HST.161 Molecular Biology and Genetics in Modern Medicine
(Subject meets with HST.160)
Prereq: Biology (GIR), 7.05
G (Fall; partial term)
6-0-6 H-LEVEL Grad Credit
Foundation for understanding the relationship between molecular biology, developmental biology, genetics, genomics, bioinformatics, and medicine. Develops explicit connections between basic research, medical understanding, and the perspective of patients. Principles of human genetics reviewed. 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, including an introduction to bioinformatics. Extends beyond basic principles to current research activity in human genetics. Only HST students may register under HST.160, graded P/D/F.
A. Giersch, D. Housman

S. Pillai

HST.176 Cellular and Molecular Immunology
(Subject meets with HST.175)
Prereq: 7.05
G (Fall)
4-0-8 H-LEVEL Grad Credit
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.
HST.191 Introduction to Biostatistics and Epidemiology
(Subject meets with HST.190)
Prereq: Calculus II (GIR)
G (IAP)
3-0-3 H-LEVEL Grad Credit
Fundamentals of biostatistics and epidemiology. Trains students how to comprehend, critique and communicate findings from biomedical literature. How to assess the importance of chance in the interpretation of experimental data. Topics include probability theory, normal sampling, chi-squared and t-tests, analysis of variance, linear regression and survival analysis, as well as how to perform elementary calculations using the statistical package STATA. How to identify and prevent bias in observational studies. Causal inference, types of bias (confounding, selection and information bias), key study designs (randomized trials, cohort and case-control studies, and screening programs). Only HST students may register under HST.190, graded P/D/F. Enrollment limited; restricted to medical and graduate students.
R. Betensky, M. Herman

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 in HST where the teaching assignment is approved for academic credit by the department.
Staff

HST.198 Independent Study in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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, as well as a substantive paper. Minimum 12 units required.
Consult HST Faculty

HST.199 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 research assistants in HST where the assigned research is approved for academic credit by the department. Hours are arranged with research supervisor.
S. Pillai, R. L. Moas, S. P. Balk, M. L. Bulyk, A. Rozensweig

HST.200 Introduction to Clinical Medicine
Prereq: Permission of instructor
G (Spring)
9-25-12 [P/D/F] H-LEVEL Grad Credit
February through May, Monday, Wednesday, Friday. Students learn the basic skills involved in examination of the patient and are introduced to history taking and patient interview. Students exposed to clinical problems in medicine, surgery, and pediatrics in groups of two or three students under one faculty member. Findings reported through history taking and oral presentation of the cases to the class. An intensive subject serving as prerequisite to clinical clerkships. Restricted to MD program students.
W. Goessling

HST.201 Introduction to Clinical Medicine and Medical Engineering I
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-20-0 [P/D/F] H-LEVEL Grad Credit
Develops 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 during IAP, and one at West Roxbury VA Hospital beginning in summer. Restricted to MEMP students.
R. G. Mark, V. Pronio-Stelluto, J. Strymish

HST.202 Introduction to Clinical Medicine and Medical Engineering II
Prereq: HST.201
G (Fall, IAP, Spring, Summer)
0-20-0 [P/D/F] H-LEVEL Grad Credit
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.
V. Pronio-Stelluto, R. G. Mark, J. Strymish

HST.203 Clinical Experience in Medical Engineering and Medical Physics
Prereq: HST.201, HST.202
G (Fall, IAP, Spring, Summer)
0-12-0 [P/D/F] H-LEVEL Grad Credit
An individually arranged full-time one-month directed study in a clinical environment where active medical engineering/medical physics investigation is in progress. Students engage in patient care, particularly those aspects that interface closely with technology. Students also focus on in-depth exploration of the technical and research area. A project proposal is required at time of registration. Term paper required.
E. N. Brown
HST.204 Industrial Experience in Medical Engineering and Medical Physics
Prereq: HST.572
G (fall, IAP, Spring, Summer)
0-12-0 [P/D/F] H-LEVEL Grad Credit
An individually arranged full-time eight week (or longer) internship in an industrial environment in the field of medical engineering/medical physics. Students participate in a clinically related research and/or development project. Students required to attend a series of industry-related seminars during the term before the internship. A term paper and final presentation are required. May not be repeated for credit.

J. Weaver

HST.205 Enterprise Experience in Medical Engineering & Medical Physics
Prereq: HST.572
G (Fall, IAP, Spring, Summer)
0-12-0 [P/D/F]
An individually arranged full-time one-month directed study in a commercial environment where active medical engineering/medical physics commercialization is in progress. Students are actively engaged in biomedical enterprise, particularly the due diligence process that critically examines the medical need, market size, patient and/or physician technology foundation, intellectual property, reimbursement issue and competition from existing and pending biomedical technologies. Term paper required

J. C. Weaver

HST.211 Biomedical Enterprise Clinical Experience I
Prereq: Permission of instructor
G (IAP)
3-0-3 H-LEVEL Grad Credit
Provides a survey of key biomedical research needs from academic-clinicians active in medical care. Exposes students to medical, surgical, operating room and intensive care unit physicians. Focuses on patient interaction. Examines both drug and technology development in specialties of medicine. Develops the knowledge base needed for elective clinical experiences. Students investigate and present clinical problems in a biomedical area of their interest. Restricted to HST students.

W. Zapol, R. Anderson

HST.212 Biomedical Enterprise Clinical Experience II
Prereq: HST.211
G (Spring)
3-0-3 H-LEVEL Grad Credit
Students interact with academic physicians who have successfully developed technologies and drugs that are now FDA-approved and in widespread clinical use. Explores how, where, when and why biomedical enterprise and medical practice intersect. Clinical experiences in offices, wards, ICU and the ORs of the Massachusetts General Hospital illustrate problems requiring solution. Students analyze the successes and failures of biomedical enterprises, and develop the knowledge and skill base needed for elective clinical experiences. Restricted to HST students.

W. Zapol, R. Anderson

HST.220 Introduction to the Care of Patients
Prereq: Permission of instructor
G (IAP, Spring)
2-0-2 [P/D/F] H-LEVEL Grad Credit
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.

W. M. Kettyle, MIT Medical Department Staff

HST.240 Translational Medicine Preceptorship
Prereq: 7.01, HST.035
G (Fall, Spring)
0-12-0 H-LEVEL Grad Credit
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.

R. Sackstein, E. Edelman

HST.410J Projects in Microscale Engineering for the Life Sciences
(Same subject as 6.07J)
Prereq: None
U (Spring)
2-4-3
A project-based introduction to manipulating and characterizing cells and biological molecules using microfabricated tools. In the first half of the term, students perform laboratory exercises designed to introduce the design, manufacture, and use of microfluidic channels; techniques for sorting and manipulating cells and biomolecules; and making quantitative measurements using optical detection and fluorescent labeling. In the second half of the term, students work in small groups to design and test a microfluidic device to solve a real-world problem of their choosing. Includes exercises in written and oral communication and team building. Limited to 20; preference to freshmen.

D. Freeman, M. Gray, A. Aranyosi

HST.422J A Clinical Approach to the Human Brain
(Same subject as 9.22J)
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9
See description under subject 9.22J.

T. N. Byrne

HST.424J Diseases of the Nervous System
(Same subject as 9.24J)
Prereq: 9.01
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9
See description under subject 9.24J.

T. N. Byrne

HST.450J Biological Physics
(Same subject as 8.593J)
Prereq: 8.044 recommended but not necessary
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
4-0-8 H-LEVEL Grad Credit
See description under subject 8.593J.

G. Benedek
HST.452J Statistical Physics in Biology  
(Same subject as 8.592J)  
Prereq: 8.333 or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 8.592J.  
M. Kardar, L. Mirny

HST.457J Introduction to Molecular Simulations  
(Same subject as 6.502J)  
(Subject meets with 6.582J, HST.557J)  
Prereq: Physics II (GIR); 18.03 or 18.06; 6.041 or 6.042; or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: U (Fall)  
3-0-9  
See description under subject 6.582J.  
C. M. Stultz

HST.460J Statistics for Neuroscience Research  
(Same subject as 9.073J)  
Prereq: 9.07 or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-0-9  
See description under subject 9.073J.  
E. N. Brown

HST.491 Reviewing Biomedical Literature  
Prereq: None  
U (Spring)  
1-0-2  
Can be repeated for credit  
Assessing the value and validity of select journal articles from biomedical literature. Detailed student presentations in a standard or journal review format. Limited to 15.  
D. S. Kohane

HST.500 Frontiers in (Bio)Medical Engineering and Physics  
Prereq: None  
G (Spring)  
3-0-9  
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, C. Stultz, S. Jhaveri

HST.505 Laboratory in Molecular and Cellular Sciences  
Prereq: Biochemistry or cell biology  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (AP)  
3-4-5 H-LEVEL Grad Credit  
Provides laboratory training in state-of-the-art experimental approaches and techniques in molecular and cellular sciences. Lab training is reinforced with didactic lectures which stress the theory behind these methodologies. Topics include mammalian cell culture; tissue engineering; DNA cloning; gene transfer and gene therapy; transgenic animals; protein purification and analysis; and microscopy. Emphasis on the quantitative aspects of these methodologies. Students learn how to incorporate these approaches into an interdisciplinary research strategy aimed at addressing important questions in biomedical research.  
J. Shah, J. Chen, U. Demirci, J. Karp

HST.506J Computational Systems Biology  
(Same subject as 6.874J)  
(Subject meets with 6.802J)  
Prereq: Biology (GIR); 18.440 or 6.041  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 6.802.  
D. K. Gifford, T. S. Jaakkola

HST.509 Computational and Functional Genomics  
(Same subject as 6.878J)  
(Subject meets with 6.047)  
Prereq: 6.006, 6.041, Biology (GIR); or permission of instructor  
G (Fall)  
4-0-8 H-LEVEL Grad Credit  
Provides in-depth quantitative understanding of evolutionary and population genetics, comparative genomics, and structural genomics and proteomics. Each module consists of a series of lectures, a journal club discussion of high impact publications, and a lecture providing clinical correlates. Homework assignments and final projects aim to develop understanding of genomic data from evolutionary principles.  
L. Mirny, I. Kohane, S. Sunyaev

HST.510 Genomics and Computational Biology  
Prereq: Permission of instructor  
Acad Year 2011–2012: G (Fall)  
Acad Year 2012–2013: Not offered  
3-0-9 H-LEVEL Grad Credit  
Integrates knowledge, research tools in new aspects of bioengineering, personalized medicine and genetically modified organisms. Interplays of biophysical, ecological, economic, and social/ethical modeling are explored through multidisciplinary teams of students, and individual brief reports. Follows Harvard FAS calendar.  
G. Church

HST.514J Sensory-Neural Systems: Spatial Orientation from End Organs to Behavior and Adaptation  
(Same subject as 16.430J)  
Prereq: Neuroscience or systems engineering or permission of instructor  
Acad Year 2011–2012: G (Spring)  
Acad Year 2012–2013: Not offered  
3-0-9 H-LEVEL Grad Credit  
See description under subject 16.430J.  
L. Young, C. Oman

HST.515J Aerospace Biomedical and Life Support Engineering  
(Same subject as 16.423J, ESD.65J)  
Prereq: 16.400, 16.06, 16.060, or permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
3-1-8 H-LEVEL Grad Credit  
See description under subject 16.423J.  
D. J. Newman
HST.516 Circadian Biology: From Cellular Oscillations to Sleep Regulation  
Prereq: Biological sciences  
G (Fall)  
4-0-8 H-LEVEL Grad Credit  
Properties, mechanisms, and functional roles of circadian rhythms in organisms ranging from unicells to mammals. Cellular and molecular components, regulation of gene expression and physiological functions, genetic and biochemical analyses of circadian rhythms, and neurobiology of the mammalian circadian pacemaker. Mathematics and modeling of oscillatory systems and applications to circadian rhythms. Experimental studies of human rhythms, including the sleep-wake cycle and hormone rhythms, with applications to sleep disorders. Follows Harvard FAS calendar.  
J. W. Hastings, C. A. Czeisler

HST.521 Biomaterials, Tissue Engineering, and Regenerative Therapeutics  
Prereq: HST.031 or permission of instructor  
G (Spring)  
4-0-5 H-LEVEL Grad Credit  
Covers the structure, properties and therapeutic applications of biomaterials, as well as the opportunities and scientific and technological challenges of tissue engineering. Provides an interdisciplinary biological-engineering approach in an academic/corporate context, and probes mechanisms and methods of evaluation of tissue/biomaterials and patient/device interactions. Assesses current outcomes and challenges, and cutting-edge technological solutions to medical problems. Additional topics include novel proteomic and genomic strategies, 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.523J Cell-Matrix Mechanics  
(Same subject as 2.785J, 3.97J, 20.411J)  
Prereq: 2.001, Chemistry (GIR), Biology (GIR); or permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 2.785J.  
I. V. Yannas, M. Spector

HST.524J Design of Medical Devices and Implants  
(Same subject as 2.782J, 3.961J, 20.451J)  
Prereq: Chemistry (GIR), Biology (GIR), Physics I (GIR); or permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 2.782J.  
I. V. Yannas, M. Spector

HST.525J Tumor Pathophysiology and Transport Phenomena: A Systems Biology Approach  
(Same subject as 10.548J)  
Prereq: 18.03; 10.301  
Acad Year 2011–2012: G (Fall)  
Acad Year 2012–2013: Not offered  
2-0-4 H-LEVEL Grad Credit  
Tumor pathophysiology plays a central role in the growth, invasion, metastasis and treatment of solid tumors. Principles of transport phenomena are applied to develop a systems level, quantitative understanding of angiogenesis, blood flow and microcirculation, metabolism and microenvironment, transport and binding of small and large molecules, movement of cancer and immune cells, metastatic process, and treatment response.  
R. K. Jain

HST.527 Blood Vessels and Endothelial Phenotypes in Health and Disease  
Prereq: Permission of instructor  
G (Spring)  
2-0-4 [P/D/F] H-LEVEL Grad Credit  
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, evolution

HST.531 Medical Physics of Proton Radiation Therapy  
Prereq: None  
G (Spring)  
2-0-4  
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.  
D. Craft, J. Unkelbach

HST.535 Principles and Practice of Tissue Engineering  
Prereq: None  
G (Fall)  
2-0-6  
Leaders in the field present the principles and practice of tissue engineering (and regenerative medicine). Topics include the principles underlying strategies for employing select exogenous cells, biomaterial scaffolds, soluble regulators or their genes, and mechanical loading for the regeneration of tissues and organs in vitro and in vivo. Differentiated cell types and stem cells are compared and contrasted for this application, as are natural and synthetic scaffolds. Covers the rationale for employing selected growth factors and examines the methods for incorporating their genes into the scaffolds. Discusses the influence of environmental factors, including mechanical loading and culture conditions. Presents methods for fabricating tissue-engineered products and devices for implantation. Addresses the federal regulatory status of tissue-engineered products, as well as strategies for introducing such products into the clinic. Examples of procedures currently employed clinically are analyzed as case stud-

423  
subjects HST.452J to HST.535
**HEALTH SCIENCES AND TECHNOLOGY**

**K. K. Parker**

Follows Harvard FAS schedule.

Programming experience highly recommended.

**MATLAB programming experience required.**

The cardiac tissue microenvironment is reviewed as well as structure-function relationships, mechanisms of slow conduction and conduction block, and arrhythmias. Relevant clinical trials data are reviewed as well as structure-function relationships in the heart and cancer. Includes a practical demonstration of SPECT and PET-CT imaging at the Massachusetts General Hospital. Considers the ways in which these imaging techniques are rooted in physics, engineering, and mathematics.

**G. El Fakhri**

**HST.544J Fields, Forces, and Flows in Biological Systems**

(Same subject as 2.79J, 6.561J, 10.539J, 20.430J)

Prereq: 2.005, 10.302, or permission of instructor

G (Fall)

3-0-9 H-LEVEL Grad Credit

See description under subject 20.430J.

**M. Bathe, A. J. Grodzinsky**

**HST.545 Physiological Systems Analysis**

Prereq: Physics II (GIR), 18.03

U (Fall)

3-3-6

Surveys systems theory with applications from bioengineering and physiology. Analysis: modeling real systems as discrete elements; nonlinear systems; the complementary nature of time and frequency methods; feedback; stability; biological oscillations. Applications: muscle dynamics and nerve function; cardiovascular regulation. Laboratory sessions address use of computer models including neural models; feedback control systems; properties of frog muscle; cardiovascular function. Follows Harvard FAS calendar.

**D. M. Merfeld**

**HST.546J Radiation Biophysics**

(Same subject as 22.55J)

Prereq: 22.055

G (Spring)

3-0-9 H-LEVEL Grad Credit

See description under subject 22.55J.

**J. C. Yanch**

**HST.547J Molecular Simulations**

(Same subject as 6.582J)

Prereq: Physics II (GIR), 18.03 or 18.06; 6.041 or 6.042; or permission of instructor

U (Fall)

3-2-6

Surveys the physical, mathematical and instrumentation basics of positron emission tomography (PET) 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.

**S. Stufflebeam, D. Boas**

**HST.548J Noninvasive Imaging in Biology and Medicine**

(Same subject as 9.173J, 20.483J, 22.56J)

Prereq: 18.03, 8.03, or permission of instructor

Acad Year 2011–2012: Not offered

Acad Year 2012–2013: G (Spring)

3-0-9 H-LEVEL Grad Credit

See description under subject 22.56J.

**A. Jasanoff**

**HST.549J Imaging Biophysics and Clinical Applications**

Prereq: 18.03, 8.03; or permission of instructor

Acad Year 2011–2012: G (Spring)

Acad Year 2012–2013: Not offered

2-1-9 H-LEVEL Grad Credit

Introduction to the connections and distinctions among various imaging modalities (ultrasound, MRI, PET, optical), common goals 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.

**S. Stufflebeam, D. Boas**

**HST.550J Molecular Imaging using SPECT and PET-CT**

Prereq: None

G (Fall)

3-0-9

Covers the physical, mathematical and instrumentation basics of positron emission tomography (PET) and single photon emission tomography (SPECT). Topics include particles and photon interactions, nuclear counting statistics, gamma cameras, and computed tomography as it pertains to SPECT and PET (including PET-CT, PET-MR, and time-of-flight PET). Discusses the clinical applications of PET in molecular imaging of the brain, the heart, and cancer. Includes a practical demonstration of SPECT and PET-CT imaging at the Massachusetts General Hospital. Considers the ways in which these imaging techniques are rooted in physics, engineering, and mathematics.

**G. El Fakhri**

**HST.551J Cellular Biophysics**

(Same subject as 2.794J, 6.521J, 20.470J)

Prereq: Physics II (GIR), 18.03, 6.002, 6.003, 6.071, 10.301, 20.110, or permission of instructor

G (Fall)

5-2-5 H-LEVEL Grad Credit

Meets with undergraduate subject 6.021J. Requires the completion of more advanced homework problems and/or an additional project.

**M. Krieger, D. Sabatini**

**HST.552J Quantitative Systems Physiology**

(Same subject as 2.792J, 6.022J, 20.371J)

Prereq: Physics II (GIR), 18.03, 6.002, 6.003, 6.071, 10.301, 20.110, or permission of instructor

U (Spring)

4-2-6

See description under subject 6.022J.

**R. G. Mark, C. M. Stultz**

**HST.553 Cardiac Biophysics**

Prereq: 6.021

Acad Year 2011–2012: Not offered

Acad Year 2012–2013: G (Fall)

3-0-9 H-LEVEL Grad Credit

A quantitative exploration of cardiac impulse propagation and conduction abnormalities. Membrane ion channels, the cardiac action potential, biophysical principles of propagation, propagation in cellular networks, mechanisms of slow conduction and conduction block, and arrhythmias. Relevant clinical trials data are reviewed as well as structure-function relationships in the cardiac tissue microenvironment. MATLAB programming experience required. C programming experience highly recommended. Follows Harvard FAS schedule.

**K. K. Parker**

**HST.554J Human Physiology**

(Same subject as 7.20J)

Prereq: 7.05

U (Fall)

5-0-7

See description under subject 7.20J.

**M. Krieger, D. Sabatini**

**HST.555J Molecular Simulations**

(Same subject as 6.582J)

Prereq: Physics II (GIR), 18.03 or 18.06; 6.041 or 6.042; or permission of instructor

G (Fall)

3-0-9 H-LEVEL Grad Credit

See description under subject 6.582J.

**C. M. Stultz**

**HST.556J Computational Biophysics**

(Same subject as 22.55J)

Prereq: 22.055

G (Spring)

3-0-9 H-LEVEL Grad Credit

See description under subject 22.55J.

**J. C. Yanch**

**HST.557J Molecular Imaging using SPECT and PET-CT**

Prereq: None

G (Fall)

3-0-9

Covers the physical, mathematical and instrumentation basics of positron emission tomography (PET) and single photon emission tomography (SPECT). Topics include particles and photon interactions, nuclear counting statistics, gamma cameras, and computed tomography as it pertains to SPECT and PET (including PET-CT, PET-MR, and time-of-flight PET). Discusses the clinical applications of PET in molecular imaging of the brain, the heart, and cancer. Includes a practical demonstration of SPECT and PET-CT imaging at the Massachusetts General Hospital. Considers the ways in which these imaging techniques are rooted in physics, engineering, and mathematics.

**G. El Fakhri**
HST.569 Biomedical Optics
Prereq: Calculus
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
4-0-8 H-LEVEL Grad Credit

Introduction to physics and engineering of optical technologies and their applications in medicine and biology. Propagation of light in tissue, bright field, dark field, phase contrast, DIC, fluorescence, Raman, confocal, two-photon, low-coherence, spectral microscopy, and speckle. Current trends in microscopy and optical imaging. Subject is appropriate for upper level undergraduates and graduate students in life sciences as well as engineering. Subject consists of lectures, seminars and occasional guest lectures. Grading based on mid-term and final report. Report analyzes a specific technological need in medicine or biology and proposes a solution. The opportunity to pursue the implementation of the solution as a project in the following term is available.

B. Vakoc, B. E. Bouma, G. J. Tearney, S. H. Yun

HST.572 Future Medical Technologies
Prereq: Permission of instructor
G (Spring)
2-0-4 [P/D/F]

Subject helps medical and graduate students to develop an understanding of the limitations of current medical technology and the process of creating and transferring new medical technology from research into actual use (commercialization). Topics include pharmaceuticals, drug delivery, and medical devices. In a seminar setting, students interact with biomedical scientists, engineers, and entrepreneurs directly involved in creating new companies based on future technologies. Students may find this subject helpful in evaluating possible theses. Open to advanced undergraduates with permission of instructor.

J. C. Weaver

HST.576 Topics in Neural Signal Processing
(Same subject as 9.272J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9

See description under subject 9.272J.
E. N. Brown

HST.580J Data Acquisition and Image Reconstruction in MRI
(Same subject as 6.556J)
Prereq: 6.011
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 6.556J.
E. Adalsteinsson

HST.582J Biomedical Signal and Image Processing
(Same subject as 6.555J, 16.456J)
Prereq: 6.003, 2.004, 16.004, or 18.085
G (Spring)
3-6-3 H-LEVEL Grad Credit

Fundamentals of digital signal processing with particular emphasis on problems in biomedical research and clinical medicine. Basic principles and algorithms for data acquisition, imaging, filtering, and feature extraction. Laboratory projects provide practical experience in processing physiological data, with examples from cardiology, speech processing, and medical imaging. 6 Engineering Design Points.

J. Greenberg, E. Adalsteinsson, W. Wells, G. Clifford

HST.583 Functional Magnetic Resonance Imaging: Data Acquisition and Analysis
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
Units arranged H-LEVEL Grad Credit

Provides information relevant to the conduct and interpretation of human brain mapping studies. In-depth coverage of the physics of image formation, mechanisms of image contrast, and the physiological basis for image signals. Parenchymal and cerebrovascular neuroanatomy and application of sophisticated structural analysis algorithms for segmentation and registration of functional data discussed. Additional topics include fMRI experimental design including block design, event related and exploratory data analysis methods, and building and applying statistical models for fMRI data. Human subject issues including informed consent, institutional review board requirements and safety in the high field environment are presented. Twice weekly lectures and weekly laboratory and discussion sessions. Laboratory will include fMRI data acquisition sessions and data analysis workshops. Assignments include reading of both textbook chapters and primary literature as well as fMRI data analysis in the laboratory. Probability, linear algebra, differential equations, and introductory or college-level subjects in neurobiology, physiology, and physics required.


HST.584J Magnetic Resonance Analytic, Biochemical, and Imaging Techniques
(Same subject as 22.561J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-12 H-LEVEL Grad Credit

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, B. Rosen

HST.590 Biomedical Engineering Seminar Series
Prereq: None
G (Fall, IAP, Spring)
1-0-0 [P/D/F]

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.

Fall: HST Faculty
Spring: HST Faculty

HST.594 Translational Medicine Seminars
Prereq: None
G (Fall, Spring)
1-0-0 [P/D/F]

Can be repeated for credit

Speakers involved in the translation of basic medically relevant modern biology (molecular genetics, cell biology, genomics, proteomics) into applications for the diagnosis or treatment of disease discuss the process, successes and challenges. Examples from different areas of medicine illustrate topics covered: what is translational research; why it is often conducted as a bidirectional process; the difficulties in extrapolating preclinical data to humans; issues related to patient enrollment, compliance and rights; study design and protocol management; funding; availability of suitable grade therapeutic reagents. The multidisciplinary nature
of the enterprise are highlighted, including the management of industry and academic center relationships. Limited to 25; preference to GEMS, then HMS Leder and MIT.

Fall: R. Sackstein
Spring: R. Sackstein

HST.598 Research in Health Sciences and Technology
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

For undergraduates desiring to carry on substantial projects of their own choosing in biomedical sciences or engineering. Work may be of experimental, theoretical, or design nature. A project proposal is required at time of registration.

Consult 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 research in HST, in cases where the assigned research is approved for academic credit by the department. Hours arranged with research supervisor.

Consult HST Faculty

HST.710J Speech Communication
(Same subject as 6.541J, 24.968J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit

See description under subject 6.541J.
L. D. Braida, R. E. Hillman, S. Shattuck-Hufnagel

HST.712J Laboratory on the Physiology, Acoustics, and Perception of Speech
(Same subject as 6.542J, 24.966J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
2-2-8 H-LEVEL Grad Credit

See description under subject 6.542J.
L. D. Braida, S. Shattuck-Hufnagel

HST.714J Acoustics of Speech and Hearing
(Same subject as 6.551J)
Prereq: 8.03, 6.003; or permission of instructor
G (Fall)
4-1-7 H-LEVEL Grad Credit

See description under subject 6.551J.

HST.716J Signal Processing by the Auditory System: Perception
(Same subject as 6.552J)
Prereq: 6.003; 6.041 or 6.431; or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 6.552J.
L. D. Braida

HST.718 Anatomy of Speech and Hearing
Prereq: Biology (GIR), permission of instructor
G (IAP)
2-2-8 H-LEVEL Grad Credit

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.720 Physiology of the Ear
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit

Physical and physiological mechanisms underlying the transduction and analysis of acoustic signals in the auditory periphery. Topics include the acoustic, mechanical, and hydrodynamics of sound transmission; the biophysical basis for cochlear amplification; the production of otoacoustic emissions; the physiology of hair-cell transduction and synaptic transmission; efferent feedback control; the analysis and coding of simple and complex sounds by the inner ear; and the physiological bases for hearing disorders. Based primarily on reading and discussions of original research literature.

J. J. Guinan, J. J. Rosowski, C. A. Shera

HST.721 The Peripheral Auditory System
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit

Experimental approaches to the study of hearing and deafness, presented through lectures, laboratory exercises and discussions of the primary literature on the auditory periphery. Topics include inner ear development; functional anatomy of the inner ear; cochlear mechanics and micromechanics; mechano-electric transduction by hair cells; outer hair cells' electromotility and the cochlear amplifier; otoacoustic emissions, synaptic transmission; stimulus coding in auditory nerve responses; efferent control of cochlear function; damage and repair of hair-cell organs; and sensorineural hearing loss.

M. C. Liberman, J. C. Adams, R. A. Eatock

HST.722J Brain Mechanisms for Hearing and Speech
(Same subject as 9.044J)
Prereq: HST.723 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

An advanced subject covering anatomical, physiological, behavioral, and computational studies of the central nervous system relevant to speech and hearing. Students learn primarily by discussions of scientific papers on topics of current interest. Recent topics include neural circuits in the auditory brainstem, organization and processing in the auditory cortex, auditory reflexes and descending systems, functional imaging of the human auditory system, quantitative methods for relating neural responses to behavior, speech motor control, and cortical representation of language.

M. C. Brown, B. Delgutte, F. Guenther, J. Melcher

HST.723J Neural Coding and Perception of Sound
(Same subject as 9.285J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit

Neural structures and mechanisms mediating the detection, localization, and recognition of sounds. Discussion of how acoustic signals are coded by auditory neurons, the impact of these codes on behavioral performance, and the circuitry and cellular mechanisms underlying signal transformations. Topics include temporal coding, neural maps and feature detectors, learning and plasticity, and feedback control. General principles are conveyed by theme discussions of auditory masking, sound localization, musical pitch, cochlear implants, and auditory scene analysis.


HST.724 Clinical Aspects of Speech and Hearing
Prereq: HST.718 or permission of instructor
G (Spring)
5-5-2 H-LEVEL Grad Credit

Clinical approach to speech and hearing disorders as practiced by physicians, audiologists, speech clinicians, rehabilitation specialists, pathologists, and bioengineers. Includes observation of patient care in the clinic and operating
HST.725 Music Perception and Cognition
Prereq: HST.723 or permission of instructor
Acad Year 2011−2012: Not offered
Acad Year 2012−2013: G (Spring)
4-0-8 H-LEVEL Grad Credit
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.728J Automatic Speech Recognition
(Same subject as 6.345J)
Prereq: 6.003, 6.041, or permission of instructor
Acad Year 2011−2012: Not offered
Acad Year 2012−2013: G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 6.345J.
V. W. Zue, J. R. Glass

HST.729 Advanced Speech and Audio Processing
Prereq: 6.003
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to advanced speech and audio processing, including both mathematical models and practical applications thereof. Time-frequency analysis, synthesis, modification, and coding of information-carrying natural sound signals; relevant aspects of acoustics and auditory perception; fundamental contemporary applications and methodologies. Students are required to prepare a substantial term project at a level on par with current research in the field. Follows Harvard FAS schedule.

HST.730 Molecular Biology of the Auditory System
Prereq: Biology (GIR)
Acad Year 2011−2012: 6 (Fall)
Acad Year 2012−2013: Not offered
3-0-9 H-LEVEL Grad Credit
Focuses on molecular approaches to function and dysfunction of the cochlea, based on readings and discussion of research literature. Lectures by course director and local experts in the field. Includes discussion of hair bundle genes, gene expression, deafness mutations, stem cells in hearing research, and animal models for hearing research.
A. Edge

HST.750 Modeling Issues in Hearing and Speech
Prereq: HST.714, HST.721
Acad Year 2011−2012: Not offered
Acad Year 2012−2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
Explores the theory and practice of scientific modeling in the context of auditory and speech biophysics. Based on seminar-style discussions of the research literature, subject draws on examples from hearing and speech (cochlear and vocal-fold mechanics) and explores general, meta-theoretical issues that transcend the particular subject matter. Examples include: What is a model? What is the process of model building? What are the different approaches to modeling? What is the relationship between theory and experiment? How are models tested? What constitutes a good model?
C. A. Shera, J. R. Melcher

HST.771-HST.779 Research in the Speech and Hearing Sciences
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Research on topics in theoretical, experimental, or clinical aspects of Speech and Hearing Sciences arranged on an individual basis with a research supervisor. At the time of registration, a project proposal endorsed by the supervisor is required. At the end of the term, a concise written progress report along with a brief written evaluation by the supervisor must be submitted.
L. D. Braida

HST.780 Independent Study in Speech and Hearing Sciences
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Can be repeated for credit
Opportunity for independent study of speech and hearing sciences under regular supervision by an SHBT faculty member. Projects require prior approval, as well as a substantive paper. Minimum 12 units required.
Consult L. D. Braida

HST.790 Research Approaches to Speech and Hearing
Prereq: 6.021J, 7.20 or 9.00
G (Spring)
6-0-6 H-LEVEL Grad Credit
Approaches and techniques of speech and hearing research are analyzed through the preparation of a mock thesis proposal. Professional responsibilities of scientists and issues such as standards for conducting research, integrity in science, and criteria for human and animal studies examined in detail. A written mock thesis proposal required.
D. K. Eddington

HST.791 Speech and Hearing Laboratories Visits
Prereq: None
G (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit
A weekly meeting to acquaint first-year students in the Speech and Hearing Bioscience and Technology Program with research opportunities. Meetings at different laboratories are hosted by faculty members of the program. These informal, introductory visits are designed to acquaint students with the kinds of work done in each laboratory.
L. D. Braida

HST.905 Introduction to Health Care Management
Prereq: None
G (Spring)
2-0-4
Introduction to the academic disciplines of business management with illustration from examples in various medical care settings. Topics include economics of health care; evolving role of physicians and other medical professionals; ethics of business decisions in a clinical context; underlying concepts in financial, marketing, and operations management in health institutions; and the management of risk in health-related enterprise. Presentations by carefully selected
multidisciplinary faculty group from the Harvard and MIT communities. Student projects address current issues occasioned by the rapidly changing health care environment. Meets at Harvard Medical School. Limited to graduate and medical students.

S. Finkelstein, P. L. Slavin

HST.906 Roles of Physicians and Engineers in Rapidly Improving Patient Care
Prereq: Permission of instructor
G (Spring)
2-0-0 [P/D/F]
Pragmatic, case-based experience for MDs and PhDs surveying career opportunities in academia, pharmaceutical, medical device and biotech companies, with the intention of developing new diagnostics, medical devices or technology-based treatments to address unmet clinical needs. Covers the life cycle of medical innovations and related topics of FDA regulations, intellectual property, impact plans, technology transfer, licensing deals, and start-ups. Explores the model of Boston’s Center for Integration of Medicine and Innovative Technology (CIMIT) in bringing together and facilitating clinicians and engineers to make transformational change in the current paradigm of patient care by applying sophisticated technologies from other industries to unsolved clinical problems. Case studies and practical experiences enable students to apply the coursework in the context of actual projects in two signature CIMIT initiatives—NeuroHealth and Integrated Clinical Environment.

S. Schachter, J. Collins

HST.916J Case Studies and Strategies in Drug Discovery and Development
(Same subject as 7.549J, 15.137J, 20.486J)
Prereq: Permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
See description under subject 20.486J.

S. R. Tannenbaum, A. J. Sinskey, A. Wood

HST.918J Economics of the Health Care Industries
(Same subject as 15.141J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 15.141J.

E. R. Berndt

HST.920J Principles and Practice of Drug Development
(Same subject as 7.547J, 10.547J, 15.136J, ESD.69J)
Prereq: Permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 15.136J.

T. J. Allen, C. L. Cooney, S. N. Finkelstein, R. H. Rubin, A. J. Sinskey, G. K. Raja

HST.922 Enabling Technology Innovation in Healthcare and the Life Sciences
(Subject meets with HST.921)
Prereq: None
G (Spring)
2-0-7
Innovative, trans-faculty subject teaches how information technologies are reshaping and redefining the health care marketplace through improved economies of scale, greater technical efficiencies in the delivery of care to patients, advanced tools for patient education and self-care, network integrated decision support tools for clinicians, and the emergence of e-commerce in health care. Students ordinarily also register for HST.923 or HST.924, the lab component of this subject. Undergraduates require permission of instructor. Only HST students may register under HST.921, graded P/D/F.

S. E. Locke, B. P. Bergeron, J. Blander, D. Z. Sands, J. A. Cartreine

HST.924 Enabling Technology Innovation in Healthcare and the Life Sciences
(Subject meets with HST.921)
Prereq: None
G (Spring)
2-0-7
Innovative, trans-faculty subject teaches how information technologies are reshaping and redefining the health care marketplace through improved economies of scale, greater technical efficiencies in the delivery of care to patients, advanced tools for patient education and self-care, network integrated decision support tools for clinicians, and the emergence of e-commerce in health care. Students ordinarily also register for HST.923 or HST.924, the lab component of this subject. Undergraduates require permission of instructor. Only HST students may register under HST.921, graded P/D/F.

S. E. Locke, B. P. Bergeron, J. Blander, D. Z. Sands, J. A. Cartreine

HST.926J Seminar on Health Care Systems Innovation
(Same subject as ESD.69J)
Prereq: Permission of instructor
G (Fall)
2-0-7
See description under subject ESD.69J.

S. Finkelstein, J. Coughlin, J. Moses

HST.934J Introduction to Global Medicine: Bioscience, Technologies, Disparities, Strategies
(Same subject as STS.449J)
Prereq: None
G (Spring)
2-0-1 [P/D/F]
Exploration of basic themes in social medicine via a specific examination of issues in global medicine. The course takes as its challenge to understand new paradigms for global health that focus on providing complex medical services to treat complicated health conditions (e.g. multi-drug resistant TB, HIV/AIDS, and mental health problems) in low resource settings. Special attention given to the development of new technologies or adapting existing technologies in ways that enable new solutions to global health problems, as well as overcoming barriers to translation of medical technologies for use in settings of great need. Addresses classic themes of social inequalities and health disparities, and issues such as patenting and the development and delivery of pharmaceuticals or other biotechnologies in international context. Presentations by Harvard faculty involved in global health, basic or clinical research with a global reach, or medical humanitarian activities, in addition to class discussion.

M. J. Good, M. M. Fischer, B. Good, D. Jones

HST.937J X PRIZE Workshop: Grand Challenges in Health Care
(Same subject as EC.420J, ESD.173J)
Prereq: Permission of instructor
G (Spring)
3-0-6
See description under subject ESD.173J.

E. Wagner, D. Newman, F. Murray, K. Zolot, J. Shames, C. Cooney

HST.939J Designing and Sustaining Technology Innovation for Global Health Practice
(Same subject as 15.127J)
Prereq: None
G (Spring)
Units arranged
Course trains students to think and act like global health leaders and entrepreneurs. Looks
at the business of running a social venture and how to plan and provide access to life-saving medicines and essential services in international and domestic settings. Considers specific case studies for influential and leading edge technologies for health services delivery, as well as human resources, and pharmaceutical and diagnostic design in resource-poor settings. Features lectures and skills-based tutorial sessions led by industry, foundation, and academic leaders. Lectures provide the foundation for a design project that may involve creation of a market or business plan, product design specification, or research study. Limited to 24.

U. Demirci, J. Blander

HST.940J Bioinformatics: Principles, Methods and Applications
(Same subject as 10.555J)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 10.555J.
Gr. Stephanopoulos, I. Rigoutsos

HST.949J Computational Evolutionary Biology
(Same subject as 6.877J)
Subject meets with 6.048
Prereq: 6.046J, 6.047, 7.36, 6.807, or HST.508; or permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-3-6 H-LEVEL Grad Credit
See description under subject 6.048.
R. C. Berwick

HST.950J Biomedical Computing
(Same subject as 6.872J)
Prereq: 6.034
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.872J.
P. Szolovits, I. Kohane

HST.960 At the Limits of Medicine: Philosophy, Religion, Literature
Prereq: None
G (IAP)
1-0-3 [P/D/F]
Critical examination of modern culture’s view of human beings (and God) and what it reveals about its attitude toward death. Students explore two descriptions of modern deaths, two essays contemplating the egocentric nature of man, the radical secularization of the concept of man in the 19th century, and two alternative views that restitute human goodness without religion or sentimentality.
S. Klingenstein

HST.971J Strategic Decision Making in the Life Sciences
(Same subject as 15.363J)
Prereq: None
G (Spring)
3-0-6
See description under subject 15.363J.
J. Fleming, A. Zarur

HST.973J Evaluating a Biomedical Business Concept
(Same subject as 15.124J)
Prereq: HST.971
G (Spring)
1-0-2 H-LEVEL Grad Credit
Teams of students evaluate a clinical need and develop an effective process for turning this need into a business. Topics include alternative solutions, intellectual property protection, market opportunity, regulatory and reimbursement hurdles, competitive threats, and potential return on investment. Students are encouraged to interview clinicians, potential customers and other stakeholders, as well as consultants and competitors. Teams present a series of analyses and solutions to each of the critical issues faced. Enrollment limited.

HST.975J Clinical Trials in Biomedical Enterprise
(Same subject as 15.121J)
Prereq: None
G (Fall)
2-0-4
Clinical trials have become one of the leading barriers to success in the introduction of new products and services for the healthcare industry. Subject enables healthcare managers to ask the important questions surrounding a decision to pursue a clinical trial. Deciding to participate in a clinical trial can sometimes result in expensive, long-term corporate commitments, which can have a significant impact on the company’s success or failure, particularly in the case of smaller companies. Subject explores issues related to determining whether a clinical trial is needed to significantly further the important goals of the company. Topics include the design, implementation, analysis and presentation of clinical trials. Case scenarios are presented by professionals in the field, and students are asked to develop their own outline plan and clinical trial study plan from the sample cases provided. Enrollment limited.
H. Golub

HST.977J Critical Reading and Technical Assessment of Biomedical Information
(Same subject as 15.122J)
Prereq: SB degree in Biological Science or permission of instructor
G (Spring; first half of term)
1-0-2 H-LEVEL Grad Credit
Gain experience in critical reading of scientific literature, including patents, journal articles and FDA labels, with an emphasis on analyzing clinical controversies and emerging technologies in subject areas that have been or could become sources of entrepreneurial activity. Students required to analyze a variety of topics in the scientific literature, including screening for and cost-effectiveness of early detection of cancer, therapeutic opportunities in oncology, evaluation of immunotoxins and antibody therapies, and new prospects for the treatment of autoimmune disorders. To support the discussion of these topics, outside experts may be invited to participate as facilitators.
S. Lapidus, S. Sengupta

HST.979J Dynamics of Biomedical Technologies
(Same subject as 15.123J)
Prereq: None
G (Fall, Spring)
2-0-1 [P/D/F]
Can be repeated for credit
Covers topics in biomedical enterprise. Provides instruction on how to identify research problems in the area; to develop testable hypotheses regarding such problems and design strategies for testing them; and, when applicable, to report progress in implementing these strategies. Includes presentations by individuals drawn from the biomedical industry, by faculty who study the industry, and by students. Enrollment may be limited.
R. Cohen, R. Anders, C. Berke, T. Dagi

HST.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 MIT faculty advisor.
R. Sasisekharan
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

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 Division of Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal, signed by the faculty supervisor. A summary report must be submitted at the end of each term.

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 Division of Health Sciences and Technology, and may continue over several terms. Registration requires submission of a written proposal, signed by the faculty supervisor. A summary report must be submitted at the end of each term.

J. Greenberg

HST.S14–HST.S15 Special Subject: Health Sciences and Technology (HST.S185)
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

HST.S16–HST.S17 Special Subject: Health Sciences and Technology (HST.S187)
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

HST.S18–HST.S19 Special Subject: Health Sciences and Technology (HST.S189)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 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.S46–HST.S47 Special Subject: Health Sciences and Technology (HST.S486–HST.S487)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

HST.S48–HST.S49 Special Subject: Health Sciences and Technology (HST.S488–HST.S489)
Prereq: None
U (Fall, IAP, Spring, Summer)
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.

HST Faculty

HST.S56–HST.S57 Special Subject: Medical Engineering and Medical Physics (HST.S586–HST.S587)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
3-2-11 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

HST.S58–HST.S59 Special Subject: Medical Engineering and Medical Physics (HST.S588–HST.S589)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 MEMP faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

HST Faculty

HST.S76–HST.S77 Special Subject: Speech and Hearing Sciences (HST.S786–HST.S787)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

HST.S78–HST.S79 Special Subject: Speech and Hearing Sciences (HST.S788–HST.S789)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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.

L. D. Braida

HST.S96–HST.S97 Special Subject: Biomedical Enterprise (HST.S986–HST.S987)
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

HST.S98–HST.S99 Special Subject: Biomedical Enterprise (HST.S988–HST.S989)
Prereq: permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Opportunity for group study of advanced subjects related to biomedical enterprise 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.

R. J. Cohen
UNDERGRADUATE SUBJECTS

MAS.110 Fundamentals of Computational Media Design
Prereq: None
U (Fall)
3-3-6 HASS-A (HASS-E); 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 Media Arts and Sciences freshman program.
V. M. Bove, Jr.

MAS.111 Introduction to Doing Research in Media Arts & Sciences
Prereq: None
U (Spring)
1-4-1 [P/D/F]
Intended for students pursuing research projects at the Media Laboratory. Topics include 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 with preference given 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)
3-0-9
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, multi-spectral, 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 Camera Culture
(Subject meets with MAS.532)
Prereq: Permission of instructor
U (Spring)
2-0-7
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.160 Signals, Systems, and Information for Media Technology
(Subject meets with MAS.510)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
4-0-8
Fundamentals of signals and information theory with emphasis on modeling audio/visual messages and physiologically derived signals, and the human source or recipient. Linear systems, difference equations, Z-transforms, sampling and sampling rate conversion, convolution, filtering, modulation, Fourier analysis, entropy, noise, Shannon’s fundamental theorems. Additional topics may include data compression, filter design, and feature detection. Meets with graduate subjects MAS.510 and MAS.511 but assignments differ.
V. M. Bove, Jr., R. W. Picard

MAS.234J Sensory and Social Orders
(Same subject as 9.34J)
Prereq: 9.00 or permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-6
See description under subject 9.34J.
W. A. Richards

MAS.235J Anigrafs
(Same subject as 9.37J)
Prereq: 9.34 or permission of instructor
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-6
See description under subject 9.37J.
W. A. Richards

MAS.402J Instrumentation and Measurement for Biological Systems
(Same subject as 2.673J, 20.309J)
(Subject meets with 20.409)
Prereq: Biology (GIR), Physics II (GIR), 6.00, 18.03; 2.001, 20.310, or 6.02; or permission of instructor; Coreq: 20.330
U (Fall)
Spring: E. Boyden, S. Wasserman
Fall: S. Manalis, P. T. So, S. Wasserman
3-6-3
See description under subject 20.309.

MAS.490 Independent Study in Media Arts and Sciences
Prereq: Permission of instructor
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

MAS.491 Independent Study in Media Arts and Sciences
Prereq: Permission of instructor
U (Fall, Spring, Summer)
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, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

MAS.URG Undergraduate Research in Media Arts and Sciences
Prereq: None
U (Fall, 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

GRADUATE SUBJECTS

MAS.510 Signals, Systems, and Information for Media Technology
(Subject meets with MAS.160)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
2-0-4
Fundamentals of signals and information theory with emphasis on modeling audio/visual messages and physiologically derived signals, including sampling, sampling rate conversion, reconstruction, quantization, Fourier analysis, entropy, and noise. Shannon’s fundamental theorems. Meets the first half of the term with MAS.160, but assignments differ.
V. M. Bove, Jr., R. W. Picard

MAS.511 Signals, Systems, and Information for Media Technology
Prereq: MAS.510 or 6.003, or permission of instructor
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
2-0-4
Fundamentals of signal processing and linear systems theory as applied to audio/visual messages and physiologically-derived signals. Linear systems, difference equation, Z-transforms, convolution, filtering. Additional topics may include filter design, feature detection, communication systems. Meets the second half of the term with subject MAS.160, but assignments differ.
V. M. Bove, Jr., R. W. Picard

MAS.531 Computational Camera and Photography
(Subject meets with MAS.131)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.131.
R. Raskar

MAS.532 Camera Culture
(Subject meets with MAS.132)
Prereq: Permission of instructor
G (Spring)
2-0-7
See description under subject MAS.132.
R. Raskar

MAS.533 Imaging Ventures: Cameras, Displays, and Visual Computing
Prereq: Permission of Instructor
G (Spring)
0-9-0 H-LEVEL Grad Credit
Project-oriented seminar covers the opportunities and challenges for businesses based on emerging 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.551J Design Without Boundaries
(Same subject as 4.556J)
Prereq: None
G (Spring)
Units arranged
Can be repeated for credit
Provides opportunities to pursue real-world design projects that cross traditional disciplinary boundaries, apply advanced technologies, and address significant social issues. Among the projects to be explored are the design of smart villages and smart communities, mobile communication project, and the development of new types of urban personal transportation systems. Students work in multidisciplinary teams and are expected to contribute to conceptualization, development, modeling and prototyping.
F. Casalegno

MAS.552J New Urban Village: Mobility-on-Demand
(Same subject as 4.557J)
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor
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.
K. Larson

MAS.571 Social Television: Creating New Connected Media Experiences
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines television distribution and how digital technology is changing the way television fits into society. Takes a systemic look at the various ways television is currently distributed, with a particular emphasis on emerging technologies that place it in a social context. Explores the multiple facets of the social television experience, from video technology fundamentals and challenges, to user interfaces, content consumption, and business cases. Student teams work on a term project to develop a prototype of a new social television application.
H. Holtzman, M. Motpetit

MAS.581 Networks, Complexity, and Their Applications (New)
Prereq: None
G (Spring)
12-0-0
Develops an understanding of conceptual and methodological tools (e.g., network analysis, chaos theory and fractals, evolutionary theory, and self-organized criticality) for the empirical analysis of large systems. Discusses in detail applications of network science, including social networks and the understanding of countries’ export structures, the identification of potential priority sectors, industrial policy, and structural transformations. Provides analytical tools and
perspectives for use in problem-solving situations. Lectures and discussions occasionally complemented by outside speakers. Limited to 35.

C. Hidalgo

MAS.600 Human 2.0 (New)
Prereq: Permission of instructor
G (Spring)
0-9-0 H-LEVEL Grad Credit

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 the physically challenged as well as persons with normal, intact physiologies. 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.622J Pattern Recognition and Analysis
(Same subject as 1.126J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

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 Affective Computing
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
2-0-10 H-LEVEL Grad Credit

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.664J Media Lab Entrepreneurship: Digital Innovations
(Same subject as 15.376J)
Prereq: None
G (Spring)
3-0-6
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 personal health care, mobile transactions, and new media.
A. Pentland, J. Bonsen, F. Moss

MAS.665J Development Ventures
(Same subject as 15.375J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

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 emerging technologies in MIT labs and beyond. Students develop a business plan executive summary suitable for submission in the MIT $100K Entrepreneurship Competition $1K Warm-Up. Limited to 25.
A. Pentland, J. Bonsen

MAS.672 New Paradigms for Human-Computer Interaction
Prereq: Permission of instructor
G (Spring)
2-8-2 H-LEVEL Grad Credit

Focuses on radically novel approaches to human-computer interaction. Students read and discuss seminal papers from the fields of ubiquitous computing, mixed reality, augmented reality, wearables, location-aware computing, ambient intelligence, ambient interfaces, tangible interfaces, e-textiles, smart networked objects, ambient interfaces, sentient architecture, software agents, and others. Students required to participate in the discussion of the weekly readings, to engage in the design of several prototypes, and to complete one larger design and implementation project. Limited to 16.
P. Maes, H. Ishii

MAS.680 Design For Empowerment (New)
Prereq: Permission of instructor
G (Fall)
4-4-4 H-LEVEL Grad Credit

Aims to understand, contribute to, and support communities of people who design, build, and hack their own devices. Focuses on tools that enable non-experts to design and build computational and electronic systems. Students investigate software and hardware toolkits, open-source technologies, fabrication processes, and new manufacturing and distribution models.
P. Maes, H. Ishii

MAS.690 Independent Study in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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.712 Creative Learning Technologies
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
2-0-7 H-LEVEL Grad Credit
Can be repeated for credit

Focuses on current research in innovative educational technologies and creative learning environments. Students contribute directly to ongoing research projects through design activi-
ties and field tests. Students work in groups on final project.

**M. Resnick**

**MAS.714J Technologies for Creative Learning**  
(Same subject as STS.445J)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Explores how new technologies can engage people in creative learning experiences and transform the ways we think about learning. Students experiment with new learning technologies and discuss the underlying educational ideas, analyze design strategies for creating new technologies, and examine how and what people learn as they use them.

**M. Resnick, S. Turkle**

**MAS.731J The Society of Mind**  
(Same subject as 6.868J)  
Prereq: Must have read *The Society of Mind* and *The Emotion Machine*; permission of instructor  
G (Spring)  
2-0-10 H-LEVEL Grad Credit  
See description under subject 6.868J.

**M. Minsky**

**MAS.750 Human-Robot Interaction**  
Prereq: Permission of instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Fall)  
2-0-7 H-LEVEL Grad Credit  
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.

**T. Machover**

**MAS.761 Common Sense Reasoning for Interactive Applications**  
Prereq: None  
G (Fall)  
3-0-9  
Explores how computer applications can be made easier to use, and more helpful, by using a database of general knowledge about people and everyday activities, along with some novel automated reasoning techniques. Readings and critiques assess the state of the art in common sense knowledge. Involves a project to construct innovative prototype applications. Limited to 25.

**H. Lieberman**

**MAS.771 Autism Theory and Technology**  
Prereq: Permission of Instructor  
Acad Year 2011–2012: Not offered  
Acad Year 2012–2013: G (Spring)  
2-0-10 H-LEVEL Grad Credit  
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.790 Independent Study in Media Arts and Sciences**  
Prereq: Permission of instructor  
G (Fall)  
Units arranged H-LEVEL Grad Credit  
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.825J Musical Aesthetics and Media Technology**  
(Same subject as 21M.581J)  
Prereq: Permission of instructor  
G (Fall)  
3-3-6 H-LEVEL Grad Credit  
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.

**J. Paradiso**

**MAS.826J Projects in Media and Music**  
(Same subject as 21M.581J)  
Prereq: MAS.825J  
G (Spring)  
3-3-6 H-LEVEL Grad Credit  
Can be repeated for credit with permission of instructor  
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.

**T. Machover**

**MAS.834 Tangible Interfaces**  
Prereq: Permission of instructor  
G (Fall)  
3-3-6 H-LEVEL Grad Credit  
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 H-LEVEL Grad Credit  
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 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
N. Gershenfeld

MAS.864 The Nature of Mathematical Modeling
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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 inference. Emphasis on efficient practical implementation of these ideas.
N. Gershenfeld

MAS.881J Principles of Neuroengineering
(Same subject as 9.422J, 20.452J)
Prereq: 8.03, 6.003, 9.01; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers principles underlying current and future technologies for brain analysis and engineering, for neurology, psychiatry, and neuroscience. Focuses on using biophysical, biochemical, and anatomical models to understand technology design constraints governing ability to observe and alter brain function. Topics include functional magnetic resonance imaging, electromagnetic recording/stimulation, neuropharmacology, optical cellular imaging, and gene/stem-cell therapy. Design projects by student teams. Limited to 28.
E. S. Boyden, III

MAS.883J Neurotechnology Ventures
(Same subject as 9.455J, 15.128J, 20.454J)
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
Focuses on using biophysical, biochemical, and anatomical models to understand technology design constraints governing ability to observe and alter brain function. Topics include functional magnetic resonance imaging, electromagnetic recording/stimulation, neuropharmacology, optical cellular imaging, and gene/stem-cell therapy. Design projects by student teams. Limited to 28.
E. S. Boyden, III

MAS.890 Independent Study in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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

General

MAS.910 Research in Media Technology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
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 is limited by the availability of suitable teaching assignments.
Staff

MAS.921 Proseminar in Media Arts and Sciences
Prereq: Permission of instructor
G (Fall)
3-0-9 [P/D/F] H-LEVEL Grad Credit
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.
M. Resnick

MAS.940 Preparation for SM Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Selection of thesis topic, definition of method of approach, and preparation of thesis proposal. Independent study supplemented by individual...
conferences with faculty. In some cases, coregistration with 21W.793 or equivalent required.

Staff

**MAS.945 Media Arts and Sciences General Exam**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
0-12-0 [P/D/F] H-LEVEL Grad Credit
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 PhD Thesis**
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
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.960 Special Subject in Media Technology**
(AS.960)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

**MAS.961–MAS.968 Special Subject in Media Technology**
(MAS.961–MAS.968)
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

**MAS.969 Special Subject in Media Technology**
(MAS.969)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
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 H-LEVEL Grad Credit
Can be repeated for credit

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

Staff
D'ARBELOFF-FUNDED PILOT SUBJECTS

2.00A Fundamentals of Engineering Design: Explore Space, Sea and Earth
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-3-3

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 millfoil, 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.

A. H. Techet, D. Newman

2.00B Toy Product Design
Prereq: None
U (Spring)
3-5-1

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, B. Kudrowitz

3.003 Principles of Engineering Practice
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
1-2-6

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 freshmen.

L. Kimerling, R. Kirchian, C. Weaver, W. Uricchio, H. Einstein

5.92 Projects in Energy
Prereq: Permission of instructor
U (Spring)
3-2-4

Explores energy issues in the context of real-world problems. Projects may focus on the MIT campus, local communities, or distant locations. Faculty and staff work with student teams on projects that have potential to affect local energy management. Students participate in multiple phases of project design and implementation, including developing research questions, gathering and analyzing data, articulating conclusions and recommendations, and presenting findings. Emphasis on effective teamwork. Preference to freshmen and sophomores.

Staff

6.07J Projects in Microscale Engineering for the Life Sciences
Prereq: None
U (Spring)
2-4-3

A project-based introduction to manipulating and characterizing cells and biological molecules using microfabricated tools. In the first half of the term, students perform laboratory exercises designed to introduce the design, manufacture, and use of microfluidic channels; techniques for sorting and manipulating cells and biomolecules; and making quantitative measurements using optical detection and fluorescent labeling. In the second half of the term, students work in small groups to design and test a microfluidic device to solve a real-world problem of their choosing. Includes exercises in written and oral communication and team building. Limited to 20; preference to freshmen.

D. Freeman, M. Gray, A. Aranyosi

12.000 Solving Complex Problems
Prereq: None
U (Fall)
1-2-6

Provides an opportunity for entering freshmen to gain first-hand 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.

S. A. Bowring

16.00 Introduction to Aerospace and Design
Prereq: None
U (Spring)
3-1-5

The fundamental concepts and approaches of aerospace engineering are highlighted through lectures on aeronautics, astronautics, and design. Active learning aerospace modules make use of information technology. Student teams are immersed in a hands-on, lighter-than-air (LTA) vehicle design project where they design, build, and fly radio-controlled LTA vehicles. The connections between theory and practice are realized in the design exercises. Required design reviews precede the LTA race competition. The performance, weight, and principle characteristics of the LTA vehicles are estimated and illustrated using physics, mathematics, and chemistry known to freshmen, the emphasis...
being on the application of this knowledge to aerospace engineering and design rather than on exposure to new science and mathematics. Includes exercises in written and oral communication and team building.

J. A. Hoffman

16.00AJ Fundamentals of Engineering Design: Explore Space, Sea and Earth
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-3-3

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.

A. H. Techet, D. Newman

20.020 Introduction to Biological Engineering Design Using Synthetic Biology
Prereq: None
U (Spring)
3-3-3

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

HST.410J Projects in Microscale Engineering for the Life Sciences
Prereq: None
U (Spring)
2-4-3

A project-based introduction to manipulating and characterizing cells and biological molecules using microfabricated tools. In the first half of the term, students perform laboratory exercises designed to introduce the design, manufacture, and use of microfluidic channels; techniques for sorting and manipulating cells and biomolecules; and making quantitative measurements using optical detection and fluorescent labeling. In the second half of the term, students work in small groups to design and test a microfluidic device to solve a real-world problem of their choosing. Includes exercises in written and oral communication and team building. Limited to 20; preference to freshmen.

D. Freeman, M. Gray, A. Aranyosi
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 The Foundations of the United States Air Force
Prereq: None. Coreq: AS.111
U (Fall) 1-0-1

AS.102 The Foundations of the United States Air Force
Prereq: AS.101 or permission of instructor; Coreq: AS.112
U (Spring) 1-0-1
Survey designed to introduce students to the United States Air Force and Air Force Reserve Officer Training Corps. Topics include mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, group leadership problems, and an introduction to communication skills. AS.102 is a continuation of AS.101.
D. Hugh

AS.111 Leadership Laboratory
Prereq: None. Coreq: AS.101
U (Fall) 0-2-2 [P/D/F]

AS.112 Leadership Laboratory
Prereq: AS.111 or permission of instructor; Coreq: AS.102
U (Spring) 0-2-2 [P/D/F]
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.
D. Sawicki

AS.201 The Evolution of USAF Air and Space Power
Prereq: AS.102 or permission of instructor; Coreq: AS.211
U (Fall) 1-0-1

AS.202 The Evolution of USAF Air and Space Power
Prereq: AS.201 or permission of instructor; Coreq: AS.212
U (Spring) 1-0-1
Survey designed to facilitate the transition from Air Force ROTC cadet to Air Force ROTC officer candidate. Topics include Air Force heritage and leaders, Quality Air Force, an introduction to ethics and values, introduction to leadership, group leadership problems, and continuing application of communication skills. AS.202 is a continuation of AS.201.
T. Weibel

AS.211 Leadership Laboratory
Prereq: AS.112 or permission of instructor; Coreq: AS.201
U (Fall) 0-2-2 [P/D/F]

AS.212 Leadership Laboratory
Prereq: AS.211 or permission of instructor; Coreq: AS.202
U (Spring) 0-2-2 [P/D/F]
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.
D. Sawicki

AS.301 Air Force Leadership Studies
Prereq: AS.202 or permission of instructor; Coreq: AS.311
U (Fall) 3-0-6

AS.302 Air Force Leadership Studies
Prereq: AS.301 or permission of instructor; Coreq: AS.312
U (Spring) 3-0-3
Study of leadership, quality management fundamentals, professional knowledge, Air Force doctrine, leadership ethics, and communication skills required of an Air Force junior officer. Case studies are used to examine Air Force leadership and management situations as a means of demonstrating and exercising practical application of the concepts being studied. AS.302 is a continuation of AS.301.
D. Sawicki

AS.311 Leadership Laboratory
Prereq: AS.212 or permission of instructor; Coreq: AS.301
U (Fall) 0-2-4 [P/D/F]

AS.312 Leadership Laboratory
Prereq: AS.311 or permission of instructor; Coreq: AS.302
U (Spring) 0-2-4 [P/D/F]
AS.401 National Security Affairs/Preparation for Active Duty
Prereq: AS.302 or permission of instructor; Coreq: AS.411
U (Fall) 3-0-9

AS.402 National Security Affairs/Preparation for Active Duty
Prereq: AS.401 or permission of instructor; Coreq: AS.412
U (Spring) 3-0-3

AS.411 Leadership Laboratory
Prereq: AS.312 or permission of instructor; Coreq: AS.401
U (Fall) 0-2-4 [P/D/F]
AS.412 Leadership Laboratory
Prereq: AS.411 or permission of instructor; Coreq: AS.402
U (Spring) 0-2-4 [P/D/F]

AS.511 Leadership Laboratory
Prereq: AS.412 Leadership Laboratory; Coreq: AS.402
Coreq: AS.412
U (Spring) 1-4-1

AS.512 Leadership Laboratory
Prereq: AS.511 or permission of instructor
U (Spring) 0-2-4 [P/D/F]

MILITARY SCIENCE

MS.101 Leadership and Personal Development
Prereq: None
U (Fall) 1-4-1
Introduction to the personal challenges and competencies critical for effective leadership.

MS.102 Introduction to Tactical Leadership
Prereq: MS.101 or permission of instructor
U (Spring) 1-4-1
Overview of leadership fundamentals such as setting direction, problem solving, listening, presenting briefs, providing feedback, and effective writing skills. Students explore dimensions of leadership values, attributes, skills, and actions in the context of practical, hands-on, and interactive exercises. Professor of Military Science role models and the building of stronger relationships among students through common experience and practical interaction are critical aspects of the teambuilding and leadership exercises.

MS.201 Innovative Team Leadership
Prereq: MS.102 or permission of instructor
U (Fall) 1-4-1
Explores the dimensions of tactical leadership strategies and styles by examining team dynamics and two historical leadership theories that form the basis of the Army leadership framework. Instruction covers aspects of personal motivation and teambuilding in the context of planning, executing, and assessing team exercises and participation in Leadership Labs. Focus is on continued development of leadership values and attributes through an understanding of Army rank, structure, and duties and basic aspects of land navigation and squad tactics. Case studies provide context for learning the Soldier’s Creed and Warrior Ethos as they apply in the Contemporary Operating Environment.

MS.202 Foundations of Tactical Leadership
Prereq: MS.201 or permission of instructor
U (Spring) 1-4-1
Examines the challenges of leading teams in the Contemporary Operating Environment. Highlights dimensions of terrain analysis, patrolling, and operation orders. Further study of the theoretical basis of the Army leadership framework explores the dynamics of adaptive leadership in the context of military operations. Students are taught greater self-awareness as they assess their own leadership styles and practice communication and team building skills. Contemporary Operating Environment case studies give insight into the importance and practice of teamwork and tactics in real-world scenarios.

AS.401 Leadership Laboratory
Prereq: AS.401 or permission of instructor; Coreq: AS.411
U (Fall) 0-2-4 [P/D/F]
AS.402 Leadership Laboratory
Prereq: AS.401 or permission of instructor; Coreq: AS.402
U (Spring) 0-2-4 [P/D/F]

AS.511 Leadership Laboratory
Prereq: AS.412 or permission of instructor; Coreq: AS.411
Coreq: AS.412
U (Spring) 1-4-1

AS.512 Leadership Laboratory
Prereq: AS.511 or permission of instructor
U (Spring) 0-2-4 [P/D/F]

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. Includes interviews, guidance, and information to increase the understanding, motivation, and performance of other cadets.

AS.412 is a continuation of AS.401.
D. Sawicki

AS.511 Leadership Laboratory
Prereq: AS.412 Leadership Laboratory; Coreq: AS.402
Coreq: AS.412
U (Spring) 1-4-1

AS.512 Leadership Laboratory
Prereq: AS.511 or permission of instructor
U (Spring) 0-2-4 [P/D/F]

Consists of activities classified as advanced leadership experiences to continue developing critical leadership, managerial and communications skills along with maintaining an active, physical lifestyle needed in today’s Air Force.

AS.512 is a continuation of AS.511.
D. Sawicki

MS.101 Leadership and Personal Development
Prereq: None
U (Fall) 1-4-1
Introduction to the personal challenges and competencies critical for effective leadership.

MS.102 Introduction to Tactical Leadership
Prereq: MS.101 or permission of instructor
U (Spring) 1-4-1
Overview of leadership fundamentals such as setting direction, problem solving, listening, presenting briefs, providing feedback, and effective writing skills. Students explore dimensions of leadership values, attributes, skills, and actions in the context of practical, hands-on, and interactive exercises. Professor of Military Science role models and the building of stronger relationships among students through common experience and practical interaction are critical aspects of the teambuilding and leadership exercises.

MS.201 Innovative Team Leadership
Prereq: MS.102 or permission of instructor
U (Fall) 1-4-1
Explores the dimensions of tactical leadership strategies and styles by examining team dynamics and two historical leadership theories that form the basis of the Army leadership framework. Instruction covers aspects of personal motivation and teambuilding in the context of planning, executing, and assessing team exercises and participation in Leadership Labs. Focus is on continued development of leadership values and attributes through an understanding of Army rank, structure, and duties and basic aspects of land navigation and squad tactics. Case studies provide context for learning the Soldier’s Creed and Warrior Ethos as they apply in the Contemporary Operating Environment.

R. Hinkle

MS.202 Foundations of Tactical Leadership
Prereq: MS.201 or permission of instructor
U (Spring) 1-4-1
Examines the challenges of leading teams in the Contemporary Operating Environment. Highlights dimensions of terrain analysis, patrolling, and operation orders. Further study of the theoretical basis of the Army leadership framework explores the dynamics of adaptive leadership in the context of military operations. Students are taught greater self-awareness as they assess their own leadership styles and practice communication and team building skills. Contemporary Operating Environment case studies give insight into the importance and practice of teamwork and tactics in real-world scenarios.
R. Hinkle

MS.301 Adaptive Team Leadership
Prereq: MS.202 or permission of instructor
U (Fall) 2-3-1
Challenges students to study, practice, and evaluate adaptive leadership skills as they are presented with the demands of preparing for the ROTC Leader Development Assessment Course (LDAC). Scenarios related to small unit tactical operations are used to develop self-awareness and critical thinking skills. Students receive systematic and specific feedback on their leadership abilities. Students are taught to analyze and evaluate their own leadership values, attributes, skills, and actions. Primary attention is given to preparation for LDAC and the development of leadership abilities.
W. Morgan, A. Cook

MS.302 Leadership in Changing Environments
Prereq: MS.301
U (Spring) 2-3-1
Increasingly intense situational leadership challenges are applied to build student awareness and skills in leading tactical operations. Students are taught to lead up to platoon-level after covering squad-level tactics in MS.301. Course provides review of aspects of combat, stability, and support operations. Students will conduct military briefings and develop proficiency in garrison operation orders. The focus is on exploring, evaluating, and developing skills in decision making, persuading, and motivating team members in the Contemporary Operating Environment. Students are evaluated on what they know and do as leaders as they prepare to attend the Leadership Development Assessment Course (LDAC).
W. Morgan, A. Cook
MS.311 Leadership Laboratory I  
Prereq: MS.302 or permission of instructor;  
Coreq: MS.301  
U (Fall)  
0-2-1  
Collective training in fundamentals of small unit tactics, drill and ceremony, and the practice of individual military skills under field conditions off campus. Includes one weekend of field adventure training focused on teambuilding through completion of leaders reaction course, obstacle course, marksmanship, and rappelling.  
W. Morgan, A. Cook

MS.312 Leadership Laboratory II  
Prereq: MS.311, Coreq: MS.302  
U (Spring)  
0-2-1  
Continues the development of skills taught in MS.311. Prepares students for the Leadership Development and Assessment Course (LDAC) the following summer. Provides multiple venues for student evaluation under the Leadership Development Program (LDP). Culminates in a weekend Field Training Exercise (FTX), practicing platoon tactics, land navigation, command and control, and patrolling. Voluntary opportunities exist for airborne school, air assault school, mountain warfare school, and advanced marksmanship training.  
W. Morgan, A. Cook

MS.401 Developing Adaptive Leaders  
Prereq: MS.302  
U (Fall)  
1-3-5  
Develops student proficiency in planning, executing, and assessing complex operations, functioning as a member of a staff, and providing leadership-performance feedback to subordinates. Students are given situational opportunities to assess risk, make ethical decisions, and provide coaching to fellow ROTC students. Students are measured by their ability to both give and receive systematic and specific feedback on leadership abilities. Students analyze and evaluate the leadership values, attributes, skills, and actions of MS.301 and MS.302 students while simultaneously considering their own leadership skills. Attention is given to preparation for the Basic Officer Leadership Course II (BOLC II) and the development of leadership abilities.  
T. Hall

MS.402 Leadership in a Complex World  
Prereq: MS.401  
U (Spring)  
1-3-5  
Explores the dynamics of leading in the complex situations of current military operations in the Contemporary Operating Environment. Students examine differences in customs and courtesies, military law, principles of war, and rules of engagement in the face of international terrorism. Instruction also covers aspects of interacting with nongovernmental organizations, civilians on the battlefield, and host nation support. Significant emphasis is placed on preparing students for their first unit of assignment as Army Second Lieutenants. Case studies, scenarios, and other exercises are used to prepare students to face the complex ethical and practical demands of leading as commissioned officers in the US Army/Amy Reserves or Army National Guard.  
T. Hall

MS.411 Advanced Leadership Laboratory I  
Prereq: MS.312, Coreq: MS.401/15.305  
U (Fall)  
0-2-4  
Designed to develop technical, tactical, and leadership skills while assessing officership potential. Through assignment to leadership positions in both command and staff capacities, students actively participate in the planning and execution of training within the program, directing and controlling the corps of cadets, enhancing oral and written communications, and the application of troop-leading procedures and mission analysis.  
T. Hall

MS.412 Advanced Leadership Laboratory II  
Prereq: MS.411  
U (Spring)  
0-2-4  
Continuation of MS.411. Prepares students for the Basic Officer Leadership Course II and III (BOLC II and III) the following summer/fall/spring. Continued student development and evaluation under the Leadership Development Program (LDP). Culminates in a second weekend Field Training Exercise (FTX) practicing platoon tactics, land navigation, command and control, and patrolling. Includes preparation for the transition from student to Second Lieutenant in the US Army/Army Reserves or Army National Guard.  
T. Hall

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 [P/D/F]  
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.  
C. Milne

NS.101 Introduction to Naval Science  
Prereq: None  
U (Fall)  
2-0-1  
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.  
S. Ford

NS.102 Naval Ships Systems  
Prereq: None  
U (Fall)  
3-0-3  
Lecture series on technological fundamentals of applied and planned naval ships Systems from an engineering viewpoint. Topics include stability, propulsion, ship control and systems.  
J. Ransom

NS.200 Naval Science Leadership Seminar  
(Subject meets with NS.100, NS.300, NS.400)  
Prereq: None  
U (Fall, Spring)  
0-2-2 [P/D/F]  
See description under subject NS.100.  
C. Milne
NS.201 Naval Weapons Systems  
Prereq: Physics I (GIR), Calculus II (GIR) recommended  
U (Spring)  
3-0-3  
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.  
S. Ford

NS.202 Seapower and Maritime Affairs  
Prereq: None  
U (Spring)  
2-0-2  
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. It 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.  
J. Ransom

NS.300 Naval Science Leadership Seminar  
(Subject meets with NS.100, NS.200, NS.400)  
Prereq: None  
U (Fall, Spring)  
0-2-2 [P/D/F]  
See description under subject NS.100.  
C. Milne

NS.301 Coastal Piloting and Celestial Navigation  
Prereq: Recommended second class cruise  
U (Spring)  
2-2-4  
Comprehensive study of the theory, principles, and procedures of piloting and celestial navigation, including mathematics of navigation, practical work involving navigational instruments, sight reduction by pro forma and computerized methods, charts, publications, and voyage planning.  
D. Kramer

NS.302 Navigation and Naval Operations  
Prereq: Recommended second class cruise and  
NS.301  
U (Fall)  
3-0-3  
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.  
D. Kramer

NS.310 Evolution of Warfare  
Prereq: None  
U (Fall)  
2-0-4  
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.  
C. Milne

NS.400 Naval Science Leadership Seminar  
(Subject meets with NS.100, NS.200, NS.300)  
Prereq: None  
U (Fall, Spring)  
0-2-2 [P/D/F]  
See description under subject NS.100.  
C. Milne

NS.401 Leadership and Management I  
Prereq: NS.101  
U (Fall)  
3-0-3  
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.  
T. Fohr

NS.402 Leadership and Ethics  
Prereq: None  
U (Spring)  
3-0-3  
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.  
C. Stevens

NS.410 Evolution of Expeditionary Doctrine  
Prereq: None  
U (Spring)  
2-0-4  
Historical and tactical analysis of expeditionary doctrine, from its roots in amphibious warfare to current actions and future developments. Seeks to define the concept, explore its doctrinal origins, and trace its evolution as an element of naval policy throughout and beyond the 20th century. Case study approach used to provide the prospective Marine Corps officer with the fundamentals of expeditionary maneuver warfare on doctrinal, strategic, operational, tactical and technological levels.  
C. Milne
INTERPHASE: PRE-FRESHMAN SUMMER PROGRAM

SP.100 Interphase
Prereq: Commitment to register as a freshman in the Fall
U (Summer)
Units arranged

A seven-week academic skills-honing program, Interphase is designed to enhance the preparedness of students entering MIT in the fall term. The program has a dual focus: academic readiness and general educational development. The program involves calculus, chemistry, physical education, physics, writing, and supporting academic activities, including small-group learning. The 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. The summer experience gives them increased opportunity to prepare for the rigors of an MIT full-subject load.

T. Stevens

SEMINAR XL

SEM.XL1 Program XL: You Can Be a Success at MIT
Prereq: First-year undergraduate standing
U (Fall)
Units arranged [P/D/F]

SEM.XL2 Program XL: You Can Be a Success at MIT
Prereq: First-year undergraduate standing
U (Spring)
Units arranged [P/D/F]

An academic enrichment program for first-year students, XL utilizes the innovative and effective small-group learning concept to enhance students' 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. The study groups help students to reinforce concepts learned in the regular curriculum, and help them to gain mastery of concepts and problems that are often more challenging than those dealt with during lecture. The small study group format emphasizes the full participation of each student with the facilitator acting as a 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, which helps to maximize their own learning. 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.

S. Mingwa

TERRASCOPE

SP.35UR Undergraduate Research in Terrascope
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

Staff

SP.360 Terrascope Radio
Prereq: None. Coreq: 1.016
U (Spring)
3-3-6 HASS-A (HASS-E); 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 12. Terrascope students only.

A. W. Epstein

FRESHMAN/ALUMNI SUMMER INTERNSHIP PROGRAM

SP.800 Freshman/Alumni Summer Internship Program
Prereq: None
U (Spring)
Units arranged

Prepares freshmen for summer internships in various companies. Includes workshops on leadership skill development, interviewing, communications, negotiation, and dynamics in the workplace. Upon acceptance to the program, students have readings, writings, discussion, and role-playing exercises. Attendance at the workshops is mandatory.

A. Steinberg

SP.801 Freshman/Alumni Summer Internship Program II
Prereq: SP.800
U (Fall)
Units arranged

Students who have completed the subject requirements for SP.800 and worked in an approved internship polish their communication skills further by writing reflection papers and giving a formal presentation about their experiences upon their return in the fall.

A. Steinberg
The rise of the biomedical research industry, and the evolution of hospitals and the medical profession, examines changing patterns of disease, the causes of morbidity and mortality, evolution of medical theory and practice, development of hospitals and the medical profession, the rise of the biomedical research industry, and the ethics of health care in America.

Staff

ST.006j Bioethics
(Same subject as 24.06j)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-D 2); CI-H
See description under subject 24.06j.
C. Hare

ST.007 Technology in History
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 5); CI-H
Covers theories of the interactions between historical and technological change; relations between the histories of science and 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.
C. Mavhunga, R. H. Williams

ST.008 Technology and Experience
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E); CI-H
Introduction to the “inner history” of technology: how it affects intimate aspects of human experience from sociological, psychological and anthropological perspectives. Topics include how the internet transforms our experience of time, space, privacy, and social engagement; how entertainment media affects attention, emotion, and creativity; how medical technologies alter the experience of illness, reproduction, and mortality; how pharmaceuticals reshape identity, mood, pain, and pleasure.
In-class discussion of readings, short written assignments, final project.
H. R. Shell

ST.009 Evolution and Society
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 4); 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

ST.010 Neuroscience and Society
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-D 4); CI-H
Explores social relevance of neuroscience, considering how emerging areas of brain research reflect and reshape social attitudes and agendas. Topics include brain imaging and popular media; neuroscience of empathy, trust, and moral reasoning; new fields of neuroeconomics and neuromarketing; ethical implications of neurotechnologies such as cognitive enhancement pharmaceuticals; neuroscience in the courtroom; and neuroscientific recasting of social problems such as addiction and violence.
Guest lectures by neuroscientists, class discussion, and weekly readings in neuroscience, popular media, and science studies.
N. Schüll

ST.011 Ethics and Politics in Science and Technology
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 2); CI-H
Focuses on controversial scientific episodes with emphasis on the social dimensions at play. Using case studies, class shows how debates take place in the context of a wide range of factors influencing scientists’ opinions and decisions. Topics include debates about the scientific method, environmental controversies, biomedical research, genetic engineering, (mis)use of human subjects, scientific misconduct, and whistleblowing. Students work in small groups. For their final projects, groups are encouraged to pick one such controversy and document it.
V. Lepinay
Tier II Subjects

STS.025| Making the Modern World: The Industrial Revolution in Global Perspective
(Same subject as 21H.285)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)

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.027| The Civil War and the Emergence of Modern America: 1861-1890 (New)
(Same subject as 21H.205)
(Subject meets with STS.427)
Prereq: Permission of instructor
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)

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.029| The Civil War and Reconstruction
(Same subject as 21H.204)
(Subject meets with STS.423)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-H (HASS-E)

See description under subject 21H.204).

M. R. Smith

STS.032| Energy, Environment, and Society
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E); CI-H

Examines national and global energy debates, namely energy security, climate change, and energy access. Explores technological, market, environmental, cultural and political “fixes” to the energy question, as well as a wide variety of energy forms and stakeholders. Evaluates development, nuclear security, environment ethics, and conflicts between energy and food security. Includes debates, presentations, group projects (in class and in the Cambridge community), grant-writing, and individual written assignments.

C. Mavhunga

STS.034| Science Communication: A Practical Guide
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E); 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 topics such as climate change and evolution. Projects focus on speaking and writing, being an expert witness, preparing briefings for policy-makers, writing blogs, and giving live interviews for broadcast, as well as the creation of an interactive exhibit for display in the MIT Museum.

J. Durant

STS.039| Technology and Imagination
Prereq: None
Acad Year 2011–2012: U (Spring)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)

Explores the meanings of “technology” and “imagination,” the ways that technologies stimulate imagination, and the ways that imagination stimulates technological development and use. Draws upon the history of technology and science, literary and cultural theory, and imaginative writing. Readings range from Romantic poets to recent novels. Topics include scientific instrumentation, utopianism, and space travel. Students are encouraged to relate class materials to popular culture, including visual and on-line media. Limited to 25.

R. H. Williams

STS.042| Einstein, Oppenheimer, Feynman: Physics in the 20th Century
(Same subject as 8.225)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

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
U (Fall)
2-0-7 HASS-S (HASS-E)

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 20; no listeners.

S. Turkle

STS.044| Technology and Self: Things and Thinking
(Subject meets with STS.444)
Prereq: None
U (Fall)
2-0-7 HASS-S (HASS-E)

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 20; no listeners.

S. Turkle
V. Lepinay

Markets. Limited to 25.

economics on the question of technologies in
Review and discussion of these new studies with
the role of technologies, theories, and models in the creation of new markets. Review and discussion of these new studies with economics on the question of technologies in markets. Limited to 25.

STS.046J The Science of Race, Sex, and Gender
(Same subject as 21A.242J, WGS.225J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject WGS.225J.
A. Sur, S. Helmreich

STS.048 African Americans in Science, Technology, and Medicine
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
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.050 The History of MIT
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
Examines the history of MIT through the lens of the broader history of science and technology, and vice versa. Examines the impact of MIT's history of science and technology, and vice versa. Examines the impact of MIT's history of science and technology, and vice versa. Covers the history of MIT from its founding in 1861 to the present. Topics include the role of MIT in scientific, technological, and industrial development; the role of MIT in intellectual and organizational development; and MIT's relationship with Boston, the federal government, and industry. Guest lecturers discuss recent history. Includes short papers, presentations, and final paper.
M. R. Smith, D. Douglas

STS.051 Finance: Culture, Technologies, and Markets
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
Introduction to a rapidly growing literature in new economic sociology, social studies of finance, and an anthropology of markets. The more recent interest for these modalities has cast new light on the role of technologies, theories, and models in the creation of new markets. Review and discussion of these new studies with economics on the question of technologies in markets. Limited to 25.
V. Lepinay

STS.056 Science and the Cinema: Experiments on Film
Prereq: None
U (Spring)
2-1-9 HASS-A (HASS-E)
Examines the linked histories of science and cinema beginning from 1895. Introduces themes from the fields of STS and media studies. Mandatory weekly screening sessions alternate among feature-length films, series of short films and direct engagement with technologies of filmic production, screening and visual analysis. Some screening materials available for out-of-class viewing. Assignments include short papers, a collaborative media project, midterm and final. Evaluation includes attendance at screenings and participation in collaborative assignments and classroom discussion. Limited to 40.
H. R. Shell

STS.060J The Anthropology of Biology
(Same subject as 21A.355J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.355J.
S. Helmreich

STS.062J Drugs, Politics, and Culture
(Same subject as 21A.344J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.344J.
Staff

STS.064J DV Lab: Documenting Science through Video and New Media
(Same subject as 21A.339J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
Examines the technical factors that make weapons and military forces effective and the increasingly countervailing influence of political, economic, and bureaucratic forces that often lead to weapons of both greater cost and lower effectiveness. Examines the challenges in evaluating technology maturity. Discusses defense spending and the role of the military-industrial complex. Case studies include the F-22 Raptor; MX long-range ballistic missile; missile defense systems, such as the Airborne Laser; the Future Combat System. Students choose, analyze, and report on own case studies.
T. Postol, S. Gershonov

STS.065J The Anthropology of Sound
(Same subject as 21A.360J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.360J.
S. Helmreich

STS.068J Advanced DV Lab: Documenting Science through Video and New Media
(Same subject as 21A.349J)
Prereq: 21A.339J or permission of instructor
U (Spring)
3-3-6 HASS-S (HASS-E)
See description under subject 21A.349J.
C. Walley, C. Boebel

STS.070J Language and Technology (New)
(Same subject as 24.913J, 21A.335J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E); CI-H
See description under subject 21A.335J.
G. Jones

STS.072J Nuclear Forces and Missile Defenses
(Same subject as 17.475J)
(Subject meets with 17.476J, STS.435J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
Introduces the assessment of strategic nuclear forces. Emphasizes the development of force requirements. Methods for analyzing alternative force postures in terms of missions, effectiveness, and cost. The history of the US-Soviet strategic competition provides the backdrop against which the evolution of nuclear strategy and forces is considered. Students taking the graduate version are expected to complete additional assignments.
T. Pastol

STS.073 Technology and Politics in the Acquisition of Military Systems
(Subject meets with STS.421)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
Examines the technical factors that make weapons and military forces effective and the increasingly countervailing influence of political, economic, and bureaucratic forces that often lead to weapons of both greater cost and lower effectiveness. Examines the challenges in evaluating technology maturity. Discusses defense spending and the role of the military-industrial complex. Case studies include the F-22 Raptor; MX long-range ballistic missile; missile defense systems, such as the Airborne Laser; the Future Combat System. Students choose, analyze, and report on own case studies.
T. Pastol, S. Gershonov
STS.074J Art, Craft, Science
(Same subject as 21A.370J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.370J.
K. Oye

STS.075J Technology and Culture
(Same subject as 21A.340J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.340J.
K. Downes

STS.076J Technology and Policy of Weapons Systems
(Same subject as 17.477J)
Prereq: None
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-S (HASS-E)
Examines in detail the technology of nuclear weapons systems. Topics include nuclear weapons design, effects, targeting, and delivery; ballistic and air breathing missile propulsion and guidance; communications and early warning techniques and systems; and anti-missile, air, and submarine systems. Combines the discussion of technical materials with the national security policy issues raised by the capabilities of these technologies. Considers security issues from the distinct and often conflicting perspectives of technologists, military planners, and political leaders. Subject fulfills the undergraduate public policy requirement in the Political Science major and minor.
T. Postol

STS.077J Science, Technology, and Public Policy
(Same subject as 17.309J, ESD.082J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
4-0-8 HASS-S (HASS-E); CI-H
See description under subject 17.309J.
K. Oye

STS.085 Ethics and the Law on the Electronic Frontier
(Subject meets with 6.805, STS.487)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-S (HASS-E)
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. Extensive use of the internet for readings and other materials. 6.805 meets with STS.085 but does not carry HASS credit. 6.805 may be used as an Engineering Concentration Elective. Enrollment limited.
H. Abelson, M. Fischer, D. Weitzner

STS.086J Cultures of Computing
(Same subject as 21A.350J, WGS.276J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.350J.
S. Helmreich

STS.087 Biography in Science
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
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

STS.088J Wealth, Environment, and Health in Africa
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
Examines how villagers in rural and urban Africa talk about and connect issues of wealth, environment, and health. Considers the health and wealth functions of the environment; in particu-
STS.260 Introduction to Science, Technology, and Society
Prereq: None
G (Fall)
3-0-9
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.
H. R. Shell, R. H. Williams

Advanced Seminars
STS.310 History of Science
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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.
D. I. Kaiser

STS.320J Environmental Conflict and Social Change
(Same subject as 21A.800J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 21A.800J.
C. Walley

STS.330J History and Anthropology of Medicine and Biology
(Same subject as 21A.830J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit
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

STS.340 Introduction to the History of Technology
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.
R. H. Williams

STS.360J Ethnography
(Same subject as 21A.820J)
Prereq: Permission of instructor; Coreq: 21A.750J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.390 Research Seminar in Science, Technology, and Society
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Designed to prepare students to write a piece of original scholarship in historical or social studies of science and technology. Students select a research topic and conduct preliminary research (including identifying potential primary sources, data, and appropriate methodology) before the term begins. Students practice crafting constructive criticism of their peers’ work-in-progress. Students complete an original article of publishable quality by the conclusion of the seminar.
H. R. Shell

G R A D U A T E S U B J E C T S

Required Introductory Subjects
STS.250J Social Theory and Analysis
(Same subject as 21A.750J)
Prereq: None
G (Fall)
3-0-9
See description under subject 21A.750J.
M. Fischer
STS.419 Global Science, Technology and Society
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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. Examines new forms of science and technology institutions, harmonization and intellectual property constraints, and distributed knowledge. Discusses MIT’s role in global STS issues and challenges students to think about how they can effectively apply their expertise in their home countries. Open to upperclassmen with permission of instructor.
M. Fischer

STS.421 Technology and Politics in the Acquisition of Military Systems
(Subject meets with STS.073)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9

Examines the technical factors that make weapons and military forces effective and the increasingly countervailing influence of political, economic, and bureaucratic forces that often lead to weapons of both greater cost and lower effectiveness. Examines the challenges in evaluating technology maturity. Discusses defense spending and the role of the military-industrial complex. Case studies of weapon systems include the F-22 Raptor; MX long-range ballistic missile; the B-2 strategic bomber; missile defense systems from the 1980s to the present; laser weapons, including the mid-infrared laser (MIRACL), space based (SBL) and the airborne laser (ABL) systems; the Future Combat System; and the Bradley fighting vehicle. Students choose, analyze, and report on own case studies.
T. Postol, S. Ghoshroy

STS.423 Technology in the Civil War Era
(Subject meets with 21H.204J, STS.029J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

A broad-ranging introduction to the American Civil War that uses technology and technological change as the primary units of analysis. Particular emphasis placed on the industrialization of warfare and its larger impact in the postwar period. Seminar organized around weekly readings. Topics include transportation (rail and wagon), communications (telegraphy), manufacturing (armaments, clothing, shoes, drugs), food production (grains and canned goods), battlefield surgery and medical care.
M. R. Smith

STS.427 The Civil War and the Emergence of Modern America: 1861–1890 (New)
(Subject meets with 21H.205J, STS.027J)
Prereq: Permission of instructor
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9

See description under subject STS.027J.
M. R. Smith

STS.429 Food and Power
(Same subject as 21A.840J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

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 recommended.
H. Paxson

STS.433 Technology, War, and the American Experience: 1650–1950
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9 H-LEVEL Grad Credit

Analyzes the development, deployment, and impacts of technology in warfare, focusing primarily on American military affairs from the industrial revolution to the post-World War II period. Also explores how and why the military played a role in American industrialization and influenced the larger economy and society, taking into consideration current discussions among political economists and historians. Open to upperclassmen with permission of instructor.
M. R. Smith

STS.434 Mobility & Global Society
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9

Examines the interaction of transport, communication, and bodies (people, animals, insects, and microbes). Explores the origins of transport systems (from walking, wagons and automobiles, to canoes, ships, and aircraft), then studies the communication media triggered by, or existing in parallel with, each system. Transport examples include runners, the use of sound and visual signals, telegraph, telephone, cell phone, and the Internet. Communication mediums include “useful” and “deadly/scary” technology, information and substances.
C. Mavhunga

STS.435J Nuclear Forces and Missile Defenses
(Same subject as 17.476J)
(Subject meets with 17.475J, STS.072J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduces the assessment of strategic nuclear forces. Emphasizes the development of force requirements and methods for analyzing alternative force postures in terms of missions, effectiveness, and cost. The history of the US-Soviet strategic competition provides the backdrop against which the evolution of nuclear strategy and forces is considered. Students taking graduate version are expected to complete additional assignments.
T. Postol

STS.436 Cold War Science
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9

Examines the history and legacy of the Cold War on American science. 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 the physical sciences and social sciences were conducted during the postwar decades, investigating possible epistemic effects on forms of knowledge. Subject closes by considering the place of science in the post-Cold War era. Open to undergraduates with permission.
D. I. Kaiser
STS.443 Technology and Self: Science, Technology, and Memoir
(Subject meets with STS.043)
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
See description under subject STS.043.
S. Turkle

STS.444 Technology and Self: Things and Thinking
(Subject meets with STS.044)
Prereq: Permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
Explores aspects of this topic in conjunction with ongoing activities of the MIT Initiative on Technology and Self, which looks at the social and psychological dimensions of our increasingly intimate relationship with technology. These may include seminars with psychologists and psychiatrists on child and adult clinical cases, the study of the way objects carry ideas, and the ways in which robotics, psychopharmacology, and genomics affect thinking about mind. Graduate students complete additional assignments. Limited to 20; no listeners.
S. Turkle

STS.445 Technologies for Creative Learning
(Same subject as MAS.714J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.714J.
M. Resnick, S. Turkle

STS.449J Introduction to Global Medicine: Bioscience, Technologies, Disparities, Strategies
(Same subject as HST.934J)
Prereq: None
G (Spring)
2-0-1 P/D/F
See description under subject HST.934J.
M. J. Good, M. M. Fischer, B. Good, D. Jones

STS.454 Science and Technology in the Museum Environment
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9
Examines the ways museums preserve the material culture of science and technology and present it distinctively to a mass audience. Focuses on challenges and opportunities of preserving and presenting science and technology in the museum environment. Students review recent work in museum studies as it relates specifically to science, medicine, and technology; review a major gallery or exhibition locally; and have an opportunity to participate in a collections- or communications-related research project in the MIT Museum.
S. Turkle

STS.462 Social and Political Implications of Technology
Prereq: None
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9
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.464 Technology and the Literary Imagination
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9
The industrial transformation of 19th- and 20th-century Western society and culture as depicted in imaginative literature (chiefly Anglo-American). Special emphasis on the role of technology and its emergence as a pivotal word and concept.
R. H. Williams

STS.468 Social Studies of Neuroscience
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
Explores how contemporary neuroscience lends itself to new understandings of society and new kinds of intervention in social domains such as education, consumption, and law. Topics include neuroimaging, neuroeconomics, neuromarketing, neuroethics, neuropsychology, neuropsychiatric development, and the neuroscientific recasting of social problems such as addiction and learning disabilities. Specific areas of focus will be chosen according to student interests. Evaluates different research methods and analytical frameworks for studying the emergence and social effects of new knowledge in neuroscience.
N. Schüll

STS.471J Engineering Apollo: The Moon Project as a Complex System
(Same subject as 16.895J, ESD.30J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
4-0-8 H-LEVEL Grad Credit
A 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. Emphasis is on 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.
L. R. Young, J. Tylko

STS.477J Writing: Science, Technology, and Society
(Same subject as 21W.820J)
Prereq: 21H.991J
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit
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.482J Science, Technology, and Public Policy
(Same subject as 17.310J, ESD.103J)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 17.310J.
K. Oye
STS.486 Bridging the Digital Divide: Information Technology and Development
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Spring)
3-0-9

Information technology (IT) is intended to alleviate poverty, help poor people meet fundamental needs, rectify injustices, reduce corruption, and enable citizens of developing countries to assert their fundamental rights. But no agreed-upon theoretical framework justifies this enthusiasm, and a number of critiques have emerged. Equally important, there are virtually no empirical studies of the effectiveness of introducing sophisticated information technologies into developing countries. First half of subject examines theoretical arguments, pro and con, about IT for development. Second half focuses on case studies, primarily from South Asia. Open to undergraduates with permission.

K. Keniston

STS.487 Ethics and the Law on the Electronic Frontier
(Subject meets with 6.805, STS.085)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject STS.085.
H. Abelson, M. Fischer, D. Weitzner

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.901–STS.904 Independent Study in Science, Technology, and Society
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
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 H-LEVEL Grad Credit
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

Research

STS.901–STS.904 Independent Study in Science, Technology, and Society
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
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 H-LEVEL Grad Credit
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
### Bachelor of Science in Science, Technology, and Society/Double Major/Course STS

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
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</thead>
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<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
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<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
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</tr>
</tbody>
</table>

#### Communication Requirement
The program includes a Communication Requirement of 4 subjects:
- 2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H);
- 2 subjects designated as Communication Intensive in the Major (CI-M).

#### PLUS Departmental Program

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Subjects</td>
</tr>
<tr>
<td>One STS Tier I subject</td>
</tr>
<tr>
<td>One STS Tier II subject</td>
</tr>
<tr>
<td>STS.091 Critical Issues in STS, 12, HASS-E, CI-M *</td>
</tr>
<tr>
<td>STS.THT Undergraduate Thesis Tutorial, 6</td>
</tr>
<tr>
<td>STS.THU Undergraduate Thesis, 12, CI-M *</td>
</tr>
</tbody>
</table>

| Restricted Electives | 102–108 |
| A coherent group of five elective subjects in STS, plus four subjects related to the historical and social study of science and technology (three of which can be satisfied by HASS GIRs), in consultation with the STS undergraduate officer. |

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(27–36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>54–66</td>
</tr>
</tbody>
</table>

| Total Units Beyond the GIRs Required for SB Degree     | 180     |

*No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student’s departmental program will count toward one or the other, but not both.*

**Notes**
- *Prerequisites and corequisites are listed in the subject description.
- The full major in Science, Technology, and Society (STS) may be pursued only as a second major program in conjunction with another degree program in a field of engineering or science, or in other fields on a case-by-case basis.
- For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
Management in Engineering
(Offered under: 2.96, 6.930, 10.806, 16.653)
Prereq: None
U (Fall)
3-1-8
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

Engineering Risk-Benefit Analysis
(Offered under: 1.155, 2.963, 6.938, 10.816, 16.862, 22.82, ESD.72)
Prereq: Calculus II (GIR)
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Emphasis on three methodologies pertaining to decision making in the presence of uncertainty: reliability and probabilistic risk assessment (RPRA), decision analysis (DA), and cost-benefit analysis (CBA). Risks of particular interest are those associated with large engineering projects such as the development of new products; the building, maintenance and operation of nuclear reactors and space systems. Presents and interprets some of the frameworks helpful for balancing risks and benefits in the situations that typically involve human safety, potential environmental effects, and large financial and technological uncertainties. Review of elementary probability theory and statistics included.

G. Apostolakis

Engineering Systems Analysis for Design
(Subject meets with ESD.710)
Prereq: 1.145 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Covers theory and methods to identify, value, and implement flexibility in design, also known as “real options.” Topics include definition of uncertainties, simulation of performance for scenarios, screening models to identify desirable flexibility, decision and lattice analysis, and multidimensional economic evaluation. Students demonstrate proficiency through an extended application to a systems design of their choice. Provides a complement to research or thesis projects. Meets with ESD.710 first half of term.

R. de Neufville

Applications of Technology in Energy and the Environment
(Offers under: 1.149, 2.63, 5.00, 10.579, 22.813, ESD.174)
Prereq: Permission of instructor
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduces advanced undergraduates or graduate students in the School of Engineering and Science to the integration of technical, economic, political, and environmental consideration required for the successful implementation of new technology. Case studies are drawn from the energy and environment sectors with some emphasis on analytic techniques that serve as a “tool box” for students. Technologies considered include fossil, nuclear, solar, wind, fuel cell and energy conservation. International aspects, such as weapons proliferation and global climate effects, also discussed. Enrollment limited.

J. Deutch, R. Lester

UPOP Summer Practice Experience
(Offers under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 22.EPE)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit

Immerses engineering sophomores in the world of professional engineering experience by providing guided instruction in all aspects of the job acquisition process. Students complete a 10–12 week internship assignment during the summer, which includes maintaining a structured journal of observations and experiences, meeting with UPOP staff members, writing essays, and completing a self-evaluation. May be repeated twice for credit; spring term can be taken only in conjunction with fall term.

S. Luperfoy

UPOP Reflective Learning Experience
(Offers under: 1.EPR, 2.EPR, 3.EPR, 6.EPR, 10.EPR, 16.EPR, 22.EPR)
Prereq: 2.EPE or permission of instructor
U (Fall)
0-0-3 [P/D/F]

Reflective learning experiences for engineering juniors that serve as the culmination of their sophomore year in the UPOP program. Students review their internship experiences through written and oral presentations and receive small-group and individualized coaching to reinforce the cognitive link between all aspects of the UPOP experience and their disciplinary field of study.

S. Luperfoy

Innovation Teams
(Offers under: 10, 807J, 15.371J)
Prereq: 15.911 or permission of instructor
G (Fall, Spring)
4-4-4

Students work in teams to develop commercialization strategies for innovative research projects generated in MIT laboratories. Projects cover critical aspects of commercialization, from selecting the target application and market for the technology to developing an intellectual property strategy and performing a competitive analysis. Instruction provided in communication and teamwork skills, as well as analysis of the challenges and benefits of technology transfer. Includes lectures, guest speakers, and extensive team coaching. Designed primarily for students in engineering, science, and management. Applications, resumes, and a brief statement of interest are required prior to registration.

F. Murray, L. Perez-Breva

Introduction to Modeling and Simulation
(Offers under: 1.021, 3.021, 10.333, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Spring)
4-0-8 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 phys-
ics, 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, J. Grossman

**UPOP IAP Workshop**
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (IAP)
3-0-0 [P/D/F]

Introduction to professional development skills for engineering practice. Experiential learning modules prepare sophomores for success in summer internship and beyond. Faculty and senior engineering professionals recruited from industry guide teams through learning activities, which include creative simulations, team competitions, oral presentations, and group problem-solving. Enrollment limited.

S. Luperfoy
UNDERGRADUATE SUBJECTS

WGS.101 Introduction to Women’s and Gender Studies (SP.401)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H (HASS-D 4); 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 (SP.409)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 4); 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, cyber-culture, activism, and human rights. Limited to 25 when Writing Tutor is assigned to the class. Otherwise, limited to 18.

A. Sur

WGS.110 Sexual and Gender Identities (SP.406)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

Introduces scholarly debates about sexual identities, gender identities and expressions, and sexual orientation and its representation in various media. Topics may include lesbian, gay, bisexual, and transgender (LGBT) sexual identities as well as their histories in Western and non-Western cultures; queer theory and theories of identity; the origins of social movements for equality; issues of race and diversity within LGBT communities; questions of visibility and media representation; and the politics of sexual orientation in contemporary American institutions. Materials include secondary readings in history, philosophy and cultural theory as well as novels and plays, films and television programs, community studies, oral histories, and legal cases.

K. Surkan

WGS.111 Gender and Media Studies (SP.414)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

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 (New)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)

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.

K. Surkan

WGS.140] Race and Identity in American Literature (New)
(Same subject as 21L.504J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)

See description under subject 21L.504J.

W. Kelley

WGS.141] International Women’s Voices (New)
(Same subject as 21F.022J, 21L.522J)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 1); CI-H

See description under subject 21L.522J.

M. Resnick

WGS.141] International Women’s Voices (New)
(Same subject as 21H.320J, 21L.504J)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-D 1); CI-H

See description under subject 21H.320J.

C. Capozzola

WGS.161] Gender and the Law in US History (New)
(Same subject as 21H.320J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)

See description under subject 21H.320J.

WGS.170] Identity and Difference (New)
(Same subject as 21A.218J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E); CI-H

See description under subject 21A.218J.

J. Jackson

WGS.172] Rethinking the Family, Sex, and Gender (New)
(Same subject as 21A.232J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)

See description under subject 21A.232J.

H. Paxson
WGS.190J Black Matters: Introduction to Black Studies (New)
Prereq: None
U (Spring)
3-0-9 HASS-A; HASS-H (HASS-D 4); CI-H
See description under subject 24.912J.
A. Braithwaite, M. DeGraff

WGS.192J Theater and Cultural Diversity in the US (New)
(Same subject as 21M.621J)
Prereq: None
U (Spring)
3-0-9 HASS-A (HASS-D 3)
See description under subject 21M.621J.
Staff

WGS.220 Women and Gender in the Middle East and North Africa (New)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
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. Ecmekcioğlu

WGS.221 Women in the Developing World (SP.427)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
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.225J The Science of Race, Sex, and Gender (SP.640)
(Same subject as 21A.242J, STS.046J)
Prereq: None
U (Fall)
3-0-9 HASS-S (HASS-E)
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, S. Helmreich

WGS.228J Psychology of Gender and Race (New)
(Same subject as 9.75J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 9.75J.
C. Kapungu

WGS.231J Writing about Race (New)
(Same subject as 21W.742J)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-D 2); CI-H
See description under subject 21W.742J.
K. Ragusa

WGS.233J New Culture of Gender: Queer France (New)
(Same subject as 21F.325J)
Prereq: One intermediate subject in French
Acad Year 2011–2012: U (Fall)
Acad Year 2012–2013: Not offered
3-0-9 HASS-H (HASS-E)
Can be repeated for credit
See description under subject 21F.325J.
B. Perreau

WGS.234J The Invention of French Theory: A History of Transatlantic Intellectual Life since 1945 (New number WGS.237)
(Same subject as 21F.068J)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
See description under subject 21F.068J.
E. C. James

WGS.235J Classics of Chinese Literature in Translation (New)
(Same subject as 21F.044J, 21L.044J)
(Same subject meets with 21F.195)
Prereq: None
U (Fall)
3-0-9 HASS-H (HASS-E)
See description under subject 21F.044J.
E. Teng

WGS.236J East Asian Culture: From Zen to Pop (New)
(Same subject as 21F.030J)
(Same subject meets with 21F.193)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Spring)
3-0-9 HASS-H (HASS-E)
See description under subject 21F.030J.
E. Teng

WGS.237J Race and Gender in Asian America (WGS.234)
(Same subject as 21F.069J, 21H.312J)
Prereq: None
U (Spring)
3-0-9 HASS-H (HASS-E)
See description under subject 21F.069J.
C. Vo

WGS.240J Jane Austen (New)
(Same subject as 21L.473J)
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H (HASS-E)
See description under subject 21L.473J.
R. Perry

WGS.270J Violence, Human Rights, and Justice (New)
(Same subject as 21A.225J)
Prereq: None
U (Spring)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.225J.
E. C. James

WGS.271J Dilemmas in Biomedical Ethics: Playing God or Doing Good? (New)
(Same subject as 21A.216J)
Prereq: None
Acad Year 2011–2012: Not offered
Acad Year 2012–2013: U (Fall)
3-0-9 HASS-S (HASS-E)
See description under subject 21A.216J.
E. C. James
Students must plan a course of study with a member of the Women's and Gender Studies faculty. Before registering for this subject, students who wish to study topics not covered in the regular Women’s and Gender Studies offerings must apply to the Graduate Consortium in Women’s Studies (SP .690).

Individual supervised work for undergraduate 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 credit is 6 units, but exceptional 9-unit projects occasionally approved.

Staff

WGS.605 WGS Graduate Independent Study (SP.405)

Prereq: Permission of instructor
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.400 WGS Undergraduate Independent Study (SP.404)

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

Staff

WGS.615 Feminist Inquiry: Strategies for Effective Scholarship (SP.693)

Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall)
3-0-9
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.610 Seminar in Feminist Issues (SP.692)

Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall)
3-0-9
Can be repeated for credit

Syllabi vary depending on instructors. Limited to 10.

Information: Graduate Consortium in Women’s Studies

G R A D U A T E S U B J E C T S

WGS.600 Workshop for Dissertation Writers in Women’s and Gender Studies (SP.690)

Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall, Spring)
3-0-9
Can be repeated for credit

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

Information: Graduate Program in Women’s Studies
WGS.640 Studies in Women’s Life Narratives (SP.691)
Prereq: Must apply to the Graduate Consortium in Women’s Studies
Acad Year 2011–2012: G (Fall)
Acad Year 2012–2013: Not offered
3-0-9 H-LEVEL Grad Credit
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 (SP.694)
Prereq: Application to the Graduate Consortium in Women’s Studies
G (Spring)
3-0-9 H-LEVEL Grad Credit
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 (SP.680)
Prereq: None
G (Fall)
3-0-9
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 (SP.695)
Prereq: Must apply to the Graduate Consortium in Women’s Studies
Acad Year 2011–2012: G (Spring)
Acad Year 2012–2013: Not offered
3-0-9
Can be repeated for credit
Syllabi vary depending on instructors.
*Information: Graduate Consortium in Women’s Studies*