Subject information in this book is accurate as of June 1, 2014. Updated information is available at http://student.mit.edu/catalog/index.cgi.
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 Manager of Staff Diversity and Inclusion, Room E19-215, 617-452-4516. In the absence of the Vice President for Human Resources or the Manager of Staff Diversity and Inclusion, 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 gender identity. MIT continues to advocate for a change in DoD policies and regulations concerning gender identity, and will replace scholarships of students who lose ROTC financial aid because of these DoD policies and regulations.
Degree Charts

Academic Calendar

Subject Key

Course 1  CIVIL AND ENVIRONMENTAL ENGINEERING  11
Course 2  MECHANICAL ENGINEERING  33
Course 3  MATERIALS SCIENCE AND ENGINEERING  57
Course 4  ARCHITECTURE  69
Course 5  CHEMISTRY  92
Course 6  ELECTRICAL ENGINEERING AND COMPUTER SCIENCE  98
Course 7  BIOLOGY  131
Course 8  PHYSICS  147
Course 9  BRAIN AND COGNITIVE SCIENCES  159
Course 10  CHEMICAL ENGINEERING  167
Course 11  URBAN STUDIES AND PLANNING  184
Course 12  EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES  205
Course 14  ECONOMICS  226
Course 15  MANAGEMENT  235
Course 16  AERONAUTICS AND ASTRONAUTICS  266
Course 17  POLITICAL SCIENCE  282
Course 18  MATHEMATICS  297
Course 20  BIOLOGICAL ENGINEERING  312
<table>
<thead>
<tr>
<th>School of Architecture and Planning</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture/Course 4</td>
<td>90</td>
</tr>
<tr>
<td>Planning/Course 11</td>
<td>203</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Engineering</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Engineering/Course 16</td>
<td>279</td>
</tr>
<tr>
<td>Archaeology and Materials/Course 3-C</td>
<td>68</td>
</tr>
<tr>
<td>Biological Engineering/Course 20</td>
<td>319</td>
</tr>
<tr>
<td>Chemical-Biological Engineering/Course 10-B</td>
<td>181</td>
</tr>
<tr>
<td>Chemical Engineering/Course 10</td>
<td>180</td>
</tr>
<tr>
<td>Civil Engineering/Course 1-C</td>
<td>28</td>
</tr>
<tr>
<td>Computer Science and Engineering/Course 6-3</td>
<td>124</td>
</tr>
<tr>
<td>Computer Science and Molecular Biology/Course 6-7</td>
<td>127</td>
</tr>
<tr>
<td>Computer Science and Molecular Biology/Course 6-7P</td>
<td>129</td>
</tr>
<tr>
<td>Electrical Engineering and Computer Science/Course 6-2</td>
<td>124</td>
</tr>
<tr>
<td>Electrical Engineering and Computer Science/Course 6-P</td>
<td>125</td>
</tr>
<tr>
<td>Electrical Science and Engineering/Course 6-1</td>
<td>124</td>
</tr>
<tr>
<td>Engineering as Recommended by the Department of Aeronautics and Astronautics/Course 16-ENG</td>
<td>281</td>
</tr>
<tr>
<td>Engineering as Recommended by the Department of Chemical Engineering/Course 10-ENG</td>
<td>182</td>
</tr>
<tr>
<td>Engineering as Recommended by the Department of Civil and Environmental Engineering Course 1-ENG</td>
<td>31</td>
</tr>
<tr>
<td>Environmental Engineering Science/Course 1-E</td>
<td>29</td>
</tr>
<tr>
<td>Materials Science and Engineering/Course 3</td>
<td>67</td>
</tr>
<tr>
<td>Mechanical and Ocean Engineering/Course 2-OE</td>
<td>56</td>
</tr>
<tr>
<td>Mechanical Engineering/Course 2</td>
<td>53</td>
</tr>
<tr>
<td>Mechanical Engineering/Course 2-A</td>
<td>55</td>
</tr>
<tr>
<td>Nuclear Science and Engineering/Course 22</td>
<td>401</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Humanities, Arts, and Social Sciences</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropology/Course 21A</td>
<td>331</td>
</tr>
<tr>
<td>Comparative Media Studies/Course CMS</td>
<td>429</td>
</tr>
<tr>
<td>Economics/Course 14</td>
<td>234</td>
</tr>
<tr>
<td>Foreign Languages and Literatures/Course 21F</td>
<td>353</td>
</tr>
<tr>
<td>History/Course 21H</td>
<td>362</td>
</tr>
<tr>
<td>Humanities/Course 21</td>
<td>320</td>
</tr>
<tr>
<td>Humanities and Engineering/Course 21E</td>
<td>321</td>
</tr>
<tr>
<td>Humanities and Science/Course 21S</td>
<td>321</td>
</tr>
<tr>
<td>Linguistics and Philosophy/Course 24-2</td>
<td>413</td>
</tr>
<tr>
<td>Literature/Course 21L</td>
<td>372</td>
</tr>
<tr>
<td>Music/Course 21M</td>
<td>383</td>
</tr>
<tr>
<td>Philosophy/Course 24-1</td>
<td>411</td>
</tr>
<tr>
<td>Political Science/Course 17</td>
<td>296</td>
</tr>
<tr>
<td>Science, Technology, and Society/Double Major/Course STS</td>
<td>483</td>
</tr>
<tr>
<td>Writing/Course 21W</td>
<td>393</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MIT Sloan School of Management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Science/Course 15</td>
<td>265</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School of Science</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology/Course 7</td>
<td>141</td>
</tr>
<tr>
<td>Biology/Course 7-A</td>
<td>142</td>
</tr>
<tr>
<td>Brain and Cognitive Sciences/Course 9</td>
<td>165</td>
</tr>
<tr>
<td>Chemistry/Course 5</td>
<td>97</td>
</tr>
<tr>
<td>Computer Science and Molecular Biology/Course 6-7</td>
<td>143</td>
</tr>
<tr>
<td>Computer Science and Molecular Biology/Course 6-7P</td>
<td>145</td>
</tr>
<tr>
<td>Earth, Atmospheric, and Planetary Sciences/Course 12</td>
<td>224</td>
</tr>
<tr>
<td>Mathematics/Course 18</td>
<td>310</td>
</tr>
<tr>
<td>Mathematics with Computer Science/Course 18-C</td>
<td>311</td>
</tr>
<tr>
<td>Physics/Course 8</td>
<td>157</td>
</tr>
</tbody>
</table>
**Labor Day—Holiday**

**REGISTRATION DAY—FALL TERM**

Number of class days (Wed, Sep 3, through Wed, Dec 10): 12 Mon, 13 Tue, 15 Wed, 13 Thu, 12 Fri = 65 days

**DEADLINE** to change a Spring Term Exploratory subject to Listener status

**FIRST DAY OF CLASSES**

**DEGREE APPLICATION DEADLINE** for February SB and Advanced Degrees. $50 Late Fee ($85 after December 12).

**REGISTRATION DEADLINE.** Registration for all students must be submitted by this date. $50 Late Fee.

**DEADLINE FOR SECOND-TERM JUNIORS** to submit the HASS Concentration Proposal form. $50 Late Fee.

**DEADLINE FOR FINAL-TERM SENIORS** to submit the HASS Concentration Completion form. $50 Late Fee.

**First quarter Physical Education classes begin**

**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 to drop half-term subjects offered in first half of term

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 June and September 2015 degree candidates to apply for double major

Deadline for completing cross-registration. $50 Late Fee for petitions received after this date.

**Columbus Day—Holiday**

**DROP DATE.** Last day to cancel subjects from Registration

Last day to change a subject from Credit to Listener

Last day to add a time-arranged subject that started after beginning of the term

Last day to add half-term subjects offered in second half of term

Last day to petition for December Advanced Standing Exam (given during Final Exam Period)

**Veterans Day—Holiday**

**Thanksgiving Vacation**
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mon</td>
<td>Online preregistration for Spring Term and IAP begins</td>
</tr>
<tr>
<td>5 Fri</td>
<td>Subjects with final exam—No test may be given and no assignment, term paper, or oral presentation shall fall due after this date.</td>
</tr>
<tr>
<td>5 Fri</td>
<td>Subjects with no final exam—Undergraduate Subjects: No test may be given and at most one assignment may fall due between this date and the end of the last scheduled class period in the subject. Graduate Subjects: Either one in-class test may be given or one assignment may fall due between this date and the end of the last regularly scheduled class in the subject.</td>
</tr>
<tr>
<td>10 Wed</td>
<td>LAST DAY OF CLASSES - Last day to drop half-term subjects offered in the second half of term</td>
</tr>
<tr>
<td>12 Fri</td>
<td>Final Exam Period</td>
</tr>
<tr>
<td>15–19 Mon–Fri</td>
<td>Grade deadline. Grades must be submitted according to due date indicated</td>
</tr>
<tr>
<td>16–30 Tue–Tue</td>
<td>Spring preregistration deadline. Continuing students must initiate online preregistration by 5 pm on this date. $50 Late Fee ($85 after January 20).</td>
</tr>
<tr>
<td>31 Wed</td>
<td>DEADLINE FOR CONTINUING STUDENTS to select preferences for fall CI-H/CI-HW subjects.</td>
</tr>
<tr>
<td></td>
<td>IAP PREREGISTRATION DEADLINE. Deadline for all students to preregister for IAP</td>
</tr>
<tr>
<td></td>
<td>Term Summaries of Fall Term grades available to departments</td>
</tr>
<tr>
<td>5 Mon</td>
<td>First day of January Independent Activities Period</td>
</tr>
<tr>
<td>7–8 Wed–Thu</td>
<td>CAP Grades Meetings</td>
</tr>
<tr>
<td>9 Fri</td>
<td>Thesis due for doctoral degrees</td>
</tr>
<tr>
<td>13 Tue</td>
<td>Last day to petition for January Advanced Standing Exam</td>
</tr>
<tr>
<td>16 Fri</td>
<td>Graduate Academic Performance Grades Meeting</td>
</tr>
<tr>
<td>19 Mon</td>
<td>Thesis due for degrees other than doctoral</td>
</tr>
<tr>
<td>20 Tue</td>
<td>LAST DAY TO GO OFF THE FEBRUARY DEGREE LIST</td>
</tr>
<tr>
<td>21–22 Wed–Thu</td>
<td>Martin Luther King, Jr. Day—Holiday</td>
</tr>
<tr>
<td>26 Mon</td>
<td>5 PM FINAL DEADLINE FOR CONTINUING STUDENTS TO PREREISTER ON-LINE FOR SPRING. $85 Late Fee.</td>
</tr>
<tr>
<td>29 Thu</td>
<td>CAP Deferred Action Meetings</td>
</tr>
<tr>
<td>30 Fri</td>
<td>English Evaluation Test for international students, 9 am–12 pm</td>
</tr>
<tr>
<td></td>
<td>Last day of January Independent Activities Period</td>
</tr>
<tr>
<td>2 Mon</td>
<td>Registration Day—Spring Term</td>
</tr>
<tr>
<td></td>
<td>Number of class days (Tue, Feb 3, through Thu, May 14): 12 Mon, 12 Tue, 14 Wed, 14 Thu, 13 Fri=65 days</td>
</tr>
<tr>
<td>3 Tue</td>
<td>Deadline to change a Fall Term Exploratory subject to Listener status</td>
</tr>
<tr>
<td>4 Wed</td>
<td>First day of classes</td>
</tr>
<tr>
<td>6 Fri</td>
<td>Grade deadline. Grades for IAP must be submitted by this date</td>
</tr>
<tr>
<td></td>
<td>Registration deadline. Registration for all students must be submitted by this date. $50 Late Fee.</td>
</tr>
<tr>
<td></td>
<td>Degree application deadline for June SB and Advanced Degrees. $50 Late Fee ($85 Late Fee after April 3).</td>
</tr>
</tbody>
</table>
MARCH

5  M  T  W  T  F  S
1  2  3  4  5  6  7
8  9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30 31

6  Fri

**DEADLINE FOR SECOND-TERM JUNIORS** to submit the HASS Concentration Proposal form. $50 Late Fee.

**DEADLINE FOR FINAL-TERM SENIORS** to submit the HASS Concentration Completion form. $50 Late Fee.

Term Summaries of grades for IAP available to departments

9  Mon
Third quarter Physical Education classes begin

10  Tue
Graduate Academic Performance Meeting

13  Fri
CAP February Degree Candidates Meeting

15  Sun
Last day to sign up for family health insurance or waive individual coverage for spring, E23-308

16  Mon
Presidents Day—Holiday

17  Tue
**MONDAY SCHEDULE OF CLASSES TO BE HELD**

18  Wed
Faculty Officers recommend degrees to Corporation (Degree Award Date)

20  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 to drop half-term subjects offered in first half of term

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 2016 degree candidates to apply for a double major

Deadline for completing cross-registration. $50 Late Fee for petitions approved after this date.

23–27  Mon–Fri
Spring Vacation

APRIL

5  M  T  W  T  F  S
1  2  3  4  5  6  7
8  9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30

1  Wed
Fourth quarter Physical Education classes begin

3  Fri
Last day to submit Advanced Degree Thesis Title. $85 Late Fee.

16–19  Thu–Sun
Campus Preview Weekend

20–21  Mon–Tue
Patriots Day—Vacation

23  Thu
**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

MAY

5  M  T  W  T  F  S
1  2
3  4  5  6  7  8  9
10 11 12 13 14 15 16
17 18 19 20 21 22 23
24 25 26 27 28 29 30
31

1  Fri
**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**—Undergraduate Subjects: No test may be given and at most one assignment may fall due between this date and the end of the last scheduled class period in the subject.

Graduate Subjects: Either one in-class test may be given or one assignment may fall due between this date and the end of the last regularly scheduled class in the subject.

**THESIS DUE** for degrees other than doctoral
<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 Thu</td>
<td>Last day of classes</td>
<td>Last day to drop half-term subjects offered in the second half of term</td>
</tr>
<tr>
<td>18–22 Mon–Fri</td>
<td>Final exam period</td>
<td></td>
</tr>
<tr>
<td>19–26 Tue–Tue</td>
<td>Grade deadline. Grades must be submitted according to due date indicated</td>
<td></td>
</tr>
<tr>
<td>22 Fri</td>
<td>Last day to go off the June degree list</td>
<td></td>
</tr>
<tr>
<td>25 Mon</td>
<td>Memorial Day—Holiday</td>
<td></td>
</tr>
<tr>
<td>28 Thu</td>
<td>Term Summaries of Spring Term grades delivered to departments</td>
<td></td>
</tr>
<tr>
<td>29 Fri</td>
<td>Summer session preregistration deadline.</td>
<td>Deadline for all students to preregister online for Summer Session. $50 Late Fee.</td>
</tr>
<tr>
<td>1 Mon</td>
<td>CAP June Degree Candidates Meeting</td>
<td></td>
</tr>
<tr>
<td>1 Mon</td>
<td>CAP Grades Meeting</td>
<td></td>
</tr>
<tr>
<td>1 Mon</td>
<td>Graduate Academic Performance Meeting</td>
<td></td>
</tr>
<tr>
<td>1 Mon</td>
<td>Faculty Officers recommend degrees to Corporation</td>
<td></td>
</tr>
<tr>
<td>2 Tue</td>
<td>Online registration opens for all students</td>
<td></td>
</tr>
<tr>
<td>4 Thu</td>
<td>Doctoral Hooding Ceremony</td>
<td></td>
</tr>
<tr>
<td>5 Fri</td>
<td>Commencement</td>
<td></td>
</tr>
<tr>
<td>8 Mon</td>
<td>First day of classes for regular Summer Session</td>
<td></td>
</tr>
<tr>
<td>10–11 Wed–Thu</td>
<td>CAP Deferred Action Meetings</td>
<td></td>
</tr>
<tr>
<td>12 Fri</td>
<td>Degree application deadline for September SB and Advanced Degrees. $50 Late Fee ($85 after July 11).</td>
<td>Registration deadline. Registration for all students must be submitted by this date. $50 Late Fee.</td>
</tr>
<tr>
<td>15 Mon</td>
<td>Fall preregistration deadline. Continuing students must initiate online preregistration by this date. $50 Late Fee ($85 after August 18).</td>
<td>Deadline for continuing students to select preferences for fall CI-H/CI-HW subjects.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 8 (Mon) – Aug 18 (Tues) Summer Session (incl. exam period). Theses due for all September degree candidates, Fri, Aug 7.</td>
<td></td>
</tr>
</tbody>
</table>

The Academic Calendar is available at http://web.mit.edu/registrar/calendar/.

Projected key dates for future academic years are available at 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](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, 7.015, 7.016
- Calculus I (GIR): 18.01, 18.01A, 18.014
- Calculus II (GIR): 18.02, 18.02A, 18.022, 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 “2014–2015: Not offered” or “2015–2016: 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.

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

<table>
<thead>
<tr>
<th>name</th>
<th>information</th>
<th>content</th>
<th>instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.125J Architecting and Engineering Software Systems</td>
<td>(Same subject as ESD.341) Prereq: 1.00, 1.124J, or permission of instructor G (Fall) 3-0-9 H-LEVEL Grad Credit</td>
<td>Software architecting and design of software-intensive systems. Targeted at future CTOs who must understand both business and technical issues. Student teams confront technically challenging problems. Enrollment limited.</td>
<td>J. Williams, A. Sanchez</td>
</tr>
</tbody>
</table>
COURSE 1

CIVIL AND ENVIRONMENTAL ENGINEERING

FUNDAMENTALS

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

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

Presents the fundamentals of object-based software design and development, computational methods and sensing for engineering, and scientific and managerial applications. Covers design of Web based software, graphical user interfaces, numerical methods, streams, threads, sensors, and data structures. Students use the JavaScript programming language to complete weekly software assignments. Laptop computers available on loan. Students taking graduate version 1.002 complete additional assignments.

J. R. Williams

1.000 Computer Programming for Scientific and Engineering Applications (New)
Prereq: None. Coreq: 18.03
U (Fall)
3-2-7 REST

Presents the fundamentals of computing and computer programming (procedural and object-oriented programming) in an engineering context. Introduces logical operations, floating-point arithmetic, data structures, induction, iteration, and recursion. Computational methods for interpolation, regression, root finding, sorting, searching, and the solution of linear systems of equations and ordinary differential equations. Control of sensors and visualization of scientific data. Draws examples from engineering and scientific applications. Students use the MATLAB programming environment to complete weekly assignments.

R. Juanes

1.007 EES-Lab: Engineering for Environment and Sustainability
Prereq: None
U (Spring)
1-2-6

Provides a practical introduction to key topics, current research and state-of-the-art tools in engineering for sustainability. Addresses engineering problems associated with the built and natural environments, with a focus on design of novel solutions to grand challenges related to energy, the environment, and sustainable societal growth. Organized around three themes: sustainable cities, energy and climate, and air, water, and health. Each week involves a lab or field trip related to a specific topic; examples include assessing the viability of sequestration, monitoring urban air pollution, collecting and observing the microorganisms that drive oceans' vital cycles, measuring the energy efficiency of buildings, and taking a boat on the Charles River for water quality measurements. Culminates in a field trip to Cape Cod.

Staff

1.010 Uncertainty in Engineering
Prereq: Calculus II (GIR)
U (Fall)
3-2-7

Introduction to probability and statistics for engineering applications. Topics in probability include events and their probability, Total Probability and Bayes’ Theorems, discrete and continuous random variables and vectors, Bernoulli Trial Sequence and Poisson point process, functions of random variables and vectors and conditional uncertainty analysis using full-distribution and second-moment uncertainty representation. Topics in statistics include estimation of distribution parameters, hypothesis testing, and simple linear regression. Concepts illustrated with examples from various areas of engineering and everyday life.

D. Veneziano

1.011 Project Evaluation and Management
Prereq: None
U (Spring)
3-0-9

Introduction to engineering projects as complex sociotechnical systems. Studies economic, financial, social and environmental influences and multi-disciplinary approaches for their analysis, design, construction, and management. Applies techniques such as benefit-cost analysis and lifecycle costing to develop a better understanding of these relationships. Students work in teams on a term project studying a large-scale infrastructure project in depth. Instruction and practice in oral and written communication provided.

J. Sussman, R. J. Schuhmann

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

Synthesizes prior design education through a term-long design project, concurrent implementation project, 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 term-long project, which must 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 the design project is a related project involving actual implementation and analysis. Lectures on a variety of related civil and environmental engineering concepts, and engineering practice and ethics, are also part of the subject. Instruction and practice in oral and written communication are an integral part of the multiple design stages.

C. Heald, J. Kroll
1.015 Design of Electromechanical Robotic Systems
(Same subject as 2.017J)
Prereq: 2.003 or 2.03; Coreq: 2.005, 2.05 and 2.051, or 2.016; 2.671
U (Spring)
3-3-6 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
Acad Year 2014–2015; Not offered
Acad Year 2015–2016: U (Spring)
3-1-5
Students work in small groups, under the guidance of researchers from MIT, to pursue specific aspects of the year’s Terrascope problem. Teams design and build prototypes, graphic displays and other tools to communicate their findings and display them in a Bazaar of Ideas open to the MIT community. Some teams develop particular solutions, others work to provide deeper understanding of the issues, and others focus on ways to communicate these ideas with the general public. Students’ work is evaluated by independent experts. Offers students an opportunity to develop ideas from the fall term and to work in labs across MIT. Limited to Terrascope students.
C. Harvey

1.018A Fundamentals of Ecology I (New)
(Same subject as 7.30AJ, 12.031A)
Prereq: None
U (Fall; first half of term)
2-0-4
Fundamentals of ecology, considering Earth as an integrated dynamic living system. Coevolution of the biosphere and geosphere, biogeochemical cycles, metabolic diversity, primary productivity, competition and the niche, trophic dynamics and food webs, population growth and limiting factors. Combination of 1.018A and 1.018B counts as REST subject.
S. Chisholm, M. Follows

1.018B Fundamentals of Ecology II (New)
(Same subject as 7.30BJ, 12.031B)
Prereq: 1.018A
U (Fall; second half of term)
2-0-4
S. Chisholm, M. Follows

1.020 Principles of Energy and Water Sustainability
Prereq: Physics I (GIR); Coreq: 18.03 or permission of instructor
U (Spring)
3-2-7
Introduces a systems approach to modeling, analysis, and decision-making problems for water and energy sustainability; formulation of models based on physical, environmental, social, and economic principles; and economic evaluation of design. Covers applications of mass balance, energy balance, and economic and lifecycle concepts. Uses numerical models to integrate concepts and to assess environmental impacts of human activities.
S. Amin

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

1.022 Urban Networks (New)
Prereq: 1.00 or 1.000; 1.010
U (Spring; first half of term)
3-0-3
Introduces the structure and evolution of networks with examples from engineering, applied mathematics, computer science, and statistical physics. Includes analysis of real world datasets focused on identifying important nodes in networks, detecting communities, tracing network flows, and modeling and visualization of spatial networks.
M. Gonzalez

1.032 Geometrics and Geomechanics (Subject meets with 1.361, 1.366)
Prereq: 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.
O. Buyukozturk, L. C. Jen

1.035 Mechanics of Structures and Soils
Prereq: 1.050, 18.03
U (Fall)
5-3-10
J. Germaine, P. Ghisbain, A. Whittle

1.036 Structural and Geotechnical Engineering Design
Prereq: 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

1.041 Transportation Systems Modeling
(Same subject as ESD.01J)
Prereq: 1.00 or 1.000; 1.1010
U (Spring)
3-1-8
Introduces basic concepts of transportation systems modeling, data analysis and visualization techniques. Covers fundamental analytical and simulation-based methodologies. Topics include time-space diagrams, cumulative plots,
queuing theory, network science, data analysis, and their applications. Provides students with an understanding of the current challenges and opportunities in different areas of transportation.

C. Osorio

1.044J Fundamentals of Energy in Buildings
(Same subject as 2.66J, 4.42J)
Prereq: Physics I (GIR), Calculus II (GIR)
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-2-7 REST
See description under subject 4.42J.
L. R. Glicksman

1.050J Solid Mechanics
Prereq: 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

1.053J Dynamics and Control I
(Same subject as 2.003J)
Prereq: Physics I (GIR), 18.03, or permission of instructor; Coreq: 2.066 or 1.020
U (Fall, Spring)
4-1-7 REST
See description under subject 2.003J.
J. K. Vandiver, N. C. Makris, N. M. Patrikalakis, T. Peacock, D. Gossard, K. Turitsyn

1.054J 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 containment. Students taking graduate version complete additional assignments.
O. Buyukozturk

1.056J Building Structural Systems I
(Same subject as 4.440J)
Subject meets with 4.462
Prereq: Calculus II (GIR)
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

1.060A Fluid Mechanics I (New)
Prereq: Permission of Instructor or Coreq: 18.03
U (Spring; first half of term)
2-1-3
R. Stocker

1.060B Fluid Mechanics II (New)
Prereq: 1.060A
U (Spring; second half of term)
2-1-3
R. Stocker

1.061A Transport Processes in the Environment I (New)
Prereq: 1.060A
U (Fall; first half of term)
2-1-3
Introduction to mass transport in environmental flows. Covers derivation and solution to the differential form of mass conservation, hydraulic models for environmental systems, residence time distribution, and molecular and turbulent diffusion for continuous and point sources. Meets with 1.61 first half of term.
H. Nepf

1.061B Transport Processes in the Environment II (New)
Prereq: 1.061A
U (Fall; second half of term)
2-1-3
Continues mass transport in environmental flows, with emphasis on river and lake systems. Studies dispersion, boundary layers, bed-water exchange, air-water exchange, and particle transport. Meets with 1.61 second half of term.
H. Nepf

1.062J Nonlinear Dynamics: Continuum Systems (New)
(Same subject as 12.207J, 18.354J)
Prereq: 18.03 or 18.034; Physics II (GIR)
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit (H except 1, 18)
General mathematical principles of continuum systems. From microscopic to macroscopic descriptions in the form of linear or nonlinear (partial) differential equations. Exact solutions, dimensional analysis, calculus of variations and singular perturbation methods. Stability, waves and pattern formation in continuum systems. Subject matter illustrated using natural fluid and solid systems found, for example, in geophysics and biology.
J. Dunkel

1.064J Physical Limnology
(Subject meets with 1.64)
Prereq: 1.061B
U (Spring)
Not offered regularly; consult department
3-0-9
Provides an introduction to physical processes occurring in lakes and shallow surface water systems with emphasis on mechanisms affecting fate and transport. Topics include internal waves, differential heating and cooling, boundary mixing, turbulent mixing, and influence of vegetation. Begins with a review of Navier-
Stokes equation. Students taking graduate version complete additional assignments.

H. Nepf

1.070A Introduction to Hydrology and Water Resources (New)
(Same subject as 12.320A)
Prereq: 1.060A; Coreq: 1.061A, 1.106
U (Fall; first half of term)
2-0-4

Water in the environment; Water resource systems; The hydrologic cycle at its role in the climate system; Surface water and energy balance; evaporation and transpiration through vegetation; Precipitation formation, infiltration, storm runoff, and flood processes; Groundwater aquifers, subsurface flow and the hydraulics of wells.

D. Entekhabi

1.070B Introduction to Hydrology Modeling (New)
(Same subject as 12.320B)
Prereq: 1.070A
U (Fall; second half of term)
2-0-4

Develops understanding of numerical modeling of aquifers, groundwater flow and contaminant transport, as well as uncertainty and risk analysis for water resources.

D. Entekhabi

1.071 Global Change Science
(Same subject as 12.300)
Prereq: 18.03
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
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

1.072 Groundwater Hydrology
(Subject meets with 1.72)
Prereq: 1.061B
U (Fall)
3-1-8

Presents the fundamentals of subsurface flow and transport, emphasizing the role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater. Topics include Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, storage properties, regional circulation, unsaturated flow, recharge, stream-aquifer interaction, well hydraulics, flow through fractured rock, numerical models, groundwater quality, contaminant transport processes, dispersion, decay, and adsorption. Includes laboratory and computer demonstrations. Students taking graduate version complete additional assignments.

C. Harvey

1.073 Introduction to Environmental Data Analysis (New)
Prereq: 1.010
U (Spring; first half of term)
2-0-4

Covers theory and practical methods for the analysis of univariate data sets. Topics include basics of statistical inference, analysis of trends and stationarity; Gaussian stochastic processes, covariance and correlation analysis, and introduction to spectral analysis. Students analyze data collected from the civil, environment, and systems domains.

E. A. B. Eltahir

1.074 Multivariate Data Analysis (New)
Prereq: 1.010
U (Spring; second half of term)
2-0-4

Introduction to statistical multivariate analysis methods and their applications to analyze data and mathematical models. Topics include sampling, experimental design, regression analysis, specification testing, dimension reduction, categorical data analysis, classification and clustering.

M. Ben-Akiva

1.080A Environmental Chemistry I (New)
Prereq: Chemistry (GIR)
U (Spring; first half of term)
2-0-4

Introduction to environmental chemistry with a focus on using thermodynamics to understand processes governing chemical behaviors in natural and engineered systems. Topics include vaporization, gas-solution partitioning, salt and mineral dissolution/precipitation, acid-base chemistry, metal complexation, adsorption via ion exchange, and absorption within natural organic matter and organism tissues. Process formulations are combined in box models to compare with observations.

P. M. Gschwend

1.080B Environmental Chemistry II (New)
Prereq: 1.080A
U (Spring; second half of term)
2-0-4

Intermediate topics in environmental chemistry requiring kinetics to understand processes governing biogeochemical behaviors in natural and engineered systems. Topics include radiochemistry, redox chemistry, surface chemistry and surface complexation. Introduction to geochemical modeling using reactive transport software; process formulations are combined in chemical fate models to compare with observations of concentrations as a function of space and time.

B. D. Kocar

1.081J Environmental Cancer Risks, Prevention, and Therapy
(Same subject as 20.104J)
Prereq: Calculus II (GIR), Biology (GIR), Chemistry (GIR)
U (Spring)
3-0-9

See description under subject 20.104J.

W. Thilly, R. McCunney

1.082 Ethics for Engineers
Engineering School-Wide Elective Subject
(Offered under: 1.082, 2.900, 10.01)
Prereq: None
U (Fall)
2-0-4

See description under subject 10.01.

D. Doneson, B. L. Trout

1.083A Environmental Health Engineering and Biology I (New)
Prereq: Biology (GIR), Chemistry (GIR), 1.061A
U (Spring; first half of term)
2-0-4

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.

J. Thompson

1.083B Environmental Health Engineering and Biology II (New)
Prereq: 1.083A
U (Spring; second half of term)
2-0-4

Covers 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.
J. Thompson

1.084J Systems Microbiology
(Same subject as 20.106J)
Prereq: Chemistry (GIR), Biology (GIR)
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9
See description under subject 20.106J.
J. Runstadler

1.085J Air Pollution
(Same subject as 12.336J)
Prereq: 18.03
U (Fall)
3-0-9
Provides a working knowledge of basic air quality issues, with emphasis on a multidisciplinary approach to investigating the sources and effects of pollution. Topics include emission sources; atmospheric chemistry and removal processes; meteorological phenomena and their impact on pollution transport at local to global scales; air pollution control technologies; health effects; and regulatory standards. Discusses regional and global issues, such as acid rain, ozone depletion and air quality connections to climate change.
C. Heald

1.089 Environmental Microbiology
(Same subject meets with 1.89)
Prereq: Biology (GIR)
U (Fall)
3-0-9
Provides 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. 7.014 recommended as prerequisite; students taking graduate version complete additional assignments.
J. R. Thompson

1.091J Traveling Research Environmental Experience (TREX): Fieldwork (New)
Prereq: Permission of instructor
U (IAP)
3-0-3
Introduction to environmental fieldwork and research, with a focus on data collection and analysis. Subject spans three weeks, including two weeks of fieldwork, and involves one or more environmental research projects. Location varies year-to-year, though recent projects have focused on the Big Island of Hawaii. Students interested in focusing more deeply on interpretation and communication of results should instead enroll in 1.092 (which continues into the spring). Meets with 1.092 during IAP. Limited to Course 1 students.
J. Kroll

1.092 Traveling Research Environmental Experience (TREX): Fieldwork, Analysis, and Communication
Prereq: Permission of instructor
U (IAP, Spring)
5-2-5
Introduction to environmental fieldwork and research, covering data collection and analysis, interpretation of results, and science communication. Students conduct fieldwork during IAP, focusing on one or more environmental research projects. Spring term activities involve research in support of the fieldwork, with instruction and practice in oral and written communication. Includes a survey of the relevant peer-reviewed literature; laboratory measurements of field samples and/or instrumental response; data analysis and interpretation; and dissemination of results. Culminates in presentation of the research projects, and write-ups of the research in manuscript form. Meets with 1.091 during IAP. Limited to Course 1 majors and minors.
J. Kroll

1.093 Introduction to Computer-Aided Design
Prereq: Permission of instructor
U (IAP)
2-0-2
Introduces concepts of computer-aided design (CAD) though the use of modeling software. Provides the basic skills applicable to various CAD programs. Students create 2-D wireframe geometry, 3-D solid models, and produce dimensioned drawings. Licensed software provided for class use. Limited to 20; preference to Course 1 students.
Staff

1.095 Teaching Practicum in Civil and Environmental Engineering
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

1.096 Environmental Fluid Transport Processes and Hydrology Laboratory
Prereq: None. Coreq: 1.061A, 1.070A
U (Fall)
0-4-2 1/2 Institute LAB
Fundamentals of mass transport and flow measurements in the context of environmental systems. Topics include measurement uncertainty, propagation of error, diffusion, dispersion, air-water exchange, dissolution, gravity currents, particle transport, and transport in porous media. Includes formal lab reports. Enrollment limited; preference to 1-ENG and 1-E students.
H. Nepf

UNDERGRADUATE LABORATORY SUBJECTS

1.101 Introduction to Civil and Environmental Engineering Design I
Prereq: None
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. Enrollment limited; preference to Course 1 majors and minors.
H. H. Einstein

1.102 Introduction to Civil and Environmental Engineering Design II
Prereq: Physics II (GIR); or Coreq: 1.060B and permission of instructor
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. Includes a major team project involving use and application of sensors, as well as environmentally-friendly, and energy-effective or energy-producing designs. Develops practical, teamwork and communication skills. Enrollment limited; preference to Course 1 majors and minors.
H. F. Hemond

1.106 Environmental Fluid Transport Processes and Hydrology Laboratory
Prereq: None. Coreq: 1.061A, 1.070A
U (Fall)
0-4-2 1/2 Institute LAB
Fundamentals of mass transport and flow measurements in the context of environmental systems. Topics include measurement uncertainty, propagation of error, diffusion, dispersion, air-water exchange, dissolution, gravity currents, particle transport, and transport in porous media. Includes formal lab reports. Enrollment limited; preference to 1-ENG and 1-E students.
H. Nepf
1.107 Environmental Chemistry and Biology Laboratory
Prereq: 1.018A or permission of instructor;
Coreq: 1.080A
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. Enrollment limited; preference to 1-E students.
J. R. Williams, B. Kocar

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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 distributed computing. Treatment of basic topics, such as queuing, sorting and searching 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, A. Sanchez

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. R. Williams, A. Sanchez

1.126J Pattern Recognition and Analysis
(Same subject as MAS.622J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.622J.
R. W. Picard

1.128J Computational Geometry
(Same subject as 2.089J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: 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: Permission of instructor
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 1.351, 1.541, 1.56J, 1.63, 1.691.

ENGINEERING SYSTEMS, ECONOMICS, AND OPTIMIZATION

1.142J Robust Modeling, Optimization, and Computation
(Same subject as 15.094J)
Prereq: 18.06 or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.094J.
D. Bertsimas

1.145J Engineering Economy Module
(Same subject as ESD.70J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
(Offered under: 1.146, 16.861, ESD.71)
(Same subject with ESD.710)
Prereq: 1.145 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.71.
R. de Neufville

See also 1.202J, 1.203J, 1.283J, 1.731. For management of engineering systems, see also 1.462J–1.472J.
ENGINEERING RISK ASSESSMENT AND PROBABILISTIC ANALYSIS

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


D. Veneziano

1.153 Transportation Policy, the Environment, and Livable Communities
(Subject meets with 1.253J, 11.543J, ESD.222J)
Prereq: 1.011 U (Spring)
3-0-9

Examines the economic and political conflict between transportation and the environment. Investigates the role of government regulation, green business and transportation policy as a facilitator of economic development and environmental sustainability. Analyzes a variety of international policy problems, including government-business relations, the role of interest groups, non-governmental organizations, and the public and media in the regulation of the automobile; sustainable development; global warming; politics of risk and siting of transport facilities; environmental justice; equity; as well as transportation and public health in the urban metropolis. Provides students with an opportunity to apply transportation and planning methods to develop policy alternatives in the context of environmental politics. Students taking graduate version complete additional assignments.

J. Coughlin

See also 1.203J.

TRANSPORTATION

1.200J Transportation Systems Analysis: Performance and Optimization
(Same subject as 11.544J, ESD.211J)
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.
A. R. Odoni, C. Osorio

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

Covers the key principles governing transportation systems planning and management. Introduces the microeconomic concepts central to transportation systems. Topics include economic theories of the firm, consumer, and market, demand models, discrete choice analysis, cost models and production functions, and pricing theory. Applications to transportation systems—including congestion pricing, technological change, resource allocation, market structure and regulation, revenue forecasting, public and private transportation finance, and project evaluation—cover urban passenger transportation, freight, maritime, aviation, and intelligent transportation systems.
R. C. Larson, A. R. Odoni, A. I. Barnett

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

Introduces methods for modeling individual travels at a country scale. Reviews basic concepts of data analysis, modeling, and visualization techniques. Topics include data mining to identify the structure inherent in daily behavior; introduction to fractals, random walks and methods to analyze trajectories. Algorithms to model and characterize complex networks, and their applications to daily commuting, air travels, and roads. Includes weekly open laptop exercises based on the data sets and methods from the research papers covered in class. Exposes students to the current challenges and opportunities in networks applied to human mobility.
M. C. Gonzalez
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

1.207 Computer Algorithms in Systems Engineering
Prereq: 1.001 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit


Staff

1.208 Resilient Infrastructure Networks
Prereq: 1.151 or 6.041/6.431; 15.058 or 15.093
G (Fall)
3-0-9 H-LEVEL Grad Credit

Control algorithms and game-theoretic tools to enable resilient operation of large-scale infrastructure networks. Dynamical network flow models, stability analysis, robust predictive control, fault and attack diagnostic tools. Strategic network design, routing games, congestion pricing, demand response, and incentive regulation. Design of operations management strategies for different reliability and security scenarios.

Applications to transportation, logistics, electric-power, and water distribution networks.

S. Amin

1.231J Planning and Design of Airport Systems
(Same subject as 16.781J, ESD.224J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.


1.233J Air Transportation Operations Research
(Same subject as 16.763J)
Prereq: 16.71J, 6.431, 15.093, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 16.763J.

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

1.234J Airline Management
(Same subject as 16.75J)
Prereq: 16.71J
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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

Studies the history, policy, practice and politics of urban transportation. Covers the role of the federal, state, and local government and the MPO, public transit in the auto era, analysis of current trends and pattern breaks; analytical tools for transportation planning, traffic engineering and policy analysis; the contribution of transportation to air pollution, social costs and climate change; land use and transportation interactions; traffic and place making; bicycles, pedestrians, and traffic calming. Examples from the Boston area and from Bilbao.

Staff

1.253J Transportation Policy, the Environment, and Livable Communities
(Same subject as 11.543J, ESD.222J)
(Same subject as 11.540J, ESD.225J)
Prereq: Permission of Instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Examines the economic and political conflict between transportation and the environment. Investigates the role of government regulation, green business and transportation policy as a facilitator of economic development and environmental sustainability. Analyzes a variety of international policy problems, including government-business relations, the role of interest groups, non-governmental organizations, and the public and media in the regulation of the automobile; sustainable development; global warming; politics of risk and siting of transport facilities; environmental justice; equity; as well as transportation and public health in the urban metropolis. Provides students with an opportunity to apply transportation and planning methods to develop policy alternatives in the context of environmental politics. Students taking graduate version complete additional assignments.

J. Coughlin
1.254 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, 4-step planning, and traffic models. Study conducted in Greater Boston. Students develop road and street, pedestrian, and public transportation networks. Uses the latest Census Transportation Planning Products (CTPP) data, and Boston home travel survey 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.  
Staff

1.255 Transportation MEng Project  
Prereq: None. Coreq: 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. Students must register for 1.255 for the Fall term, IAP, and the Spring term. Preference to Course 1 MEng students.  
Staff

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 and 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.  
Staff

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  
See description under subject ESD.262J.  
B. Arntzen, 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.  
C. Cassa

1.265J Global Supply Chain Management  
(Same subject as 2.965J, 15.765J, ESD.265J)  
Prereq: 1.260, 1.261, 15.761, 15.778, or permission of instructor  
G (Spring)  
2-0-4 H-LEVEL Grad Credit  
Focuses on the planning, processes, and activities of supply chain management for companies involved in international commerce. Students examine the end-to-end processes and operational challenges in managing global supply chains, such as the basics of global trade, international transportation, duty, taxes, trade finance and hedging, currency issues, outsourcing, cultural differences, risks and security, and green supply chains issues. Highly interactive format features student-led discussions, staged debates, and a mock trial. Includes assignments on case studies and sourcing analysis, as well as projects and a final exam.  
B. Arntzen

1.271J The Theory of Operations Management  
(Same subject as 15.764J, ESD.274J)  
Prereq: 15.081J or 6.251J, 6.436J; or permission of instructor  
G (Spring)  
3-0-9 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

1.273J 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.  
Staff

1.274J Manufacturing System and Supply Chain Design  
(Same subject as 15.763J, ESD.268J)  
Prereq: 1.260, 15.761, or 15.778  
G (Spring)  
2-0-4 H-LEVEL Grad Credit  
See description under subject 15.763J.  
S. C. Graves, D. Simchi-Levi

1.283J Urban and Regional Economics  
(Same subject as 11.410J, 14.573J, ESD.191J)  
(Subject meets with 14.51)  
Prereq: 14.04, 14.32  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 14.573J.  
Consult W. Wheaton
1.284| Analyzing and Accounting for Regional Economic Change
(Same subject as 11.481), (ESD.192)
Prereq: 14.03, 14.04
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.481).

K. R. Polenske

1.285| Regional Socioeconomic Impact Analyses and Modeling
(Same subject as 11.482), (ESD.193)
Prereq: 11.481 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
2-1-9 H-LEVEL Grad Credit
See description under subject 11.482).

K. R. Polenske

1.286| Energy and Infrastructure Technologies
(Same subject as 11.477)
(Subject meets with 11.165)
Prereq: 14.01 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 11.477).

K. R. Polenske

GEOENVIRONMENTAL AND GEOTECHNICAL ENGINEERING

1.322| Soil Behavior
Prereq: 1.361
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
4-0-8 H-LEVEL Grad Credit
Detailed study of soil properties with emphasis on interpretation of field and laboratory test data and their use in soft-ground construction engineering. Includes: consolidation and secondary compression; basic strength principles; stress-strain strength behavior of clays, emphasizing effects of sample disturbance, anisotropy, and strain rate; strength and compression of granular soils; and engineering properties of compacted soils. Some knowledge of field and laboratory testing assumed; 1.37 desirable.

A. J. Whittle

1.331| Advanced Soil Dynamics
Prereq: Permission of Instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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, risk assessment, and monitoring for soils, groundwater, and sediments. Design, construction, operation, and hydrology of waste disposal facilities.

Staff

1.351| Theoretical Soil Mechanics
Prereq: 1.361
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

A. J. Whittle

1.361| Advanced Soil Mechanics
(Subject meets with 1.032, 1.366)
Prereq: 1.036
G (Fall)
3-0-9 H-LEVEL Grad Credit
Consideration of the following fundamentals of soil mechanics: the nature of soil; the effective stress principle; hydraulic conductivity and seepage; stress-strain-strength behavior of cohesionless and cohesive soil; lateral earth stresses; bearing capacity and slope stability; consolidation theory; and settlement analyses. Core requirement for Geoenvironmental MEng program.

J. Germaine

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. 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
Identification, presentation, and illustration of principles of soil mechanics. Considers the following topics: the nature of soil; the effective stress principle; hydraulic conductivity and seepage; stress-strain-strength behavior of soil; and lateral earth stresses. Applies principles to stability and deformation problems. Restricted to graduate students not specializing in Geotechnical Engineering. Same lectures as 1.361.

J. Germaine

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 bound-
ary 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.

H. H. Einstein

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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-6 H-LEVEL Grad Credit
Provides familiarization with the most important aspects of planning, analysis, design, and construction of underground structures in soil and rock. Covers detailed engineering analysis and design, and major aspects of construction techniques and construction planning. Discusses general planning and economic problems. Includes a major design project.

H. H. Einstein

1.39 Independent Study 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 topics in geotechnical engineering.
Information: A. J. Whittle

CONSTRUCTION ENGINEERING AND MANAGEMENT

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 market in project financing, with a primary focus on infrastructure. Includes discussion of innovative approaches to marketing, partnering, risk management, finance, specialized delivery systems, and privatization.

F. Moavenzadeh, D. Wolff

1.472J Innovative Project Delivery in the Public and Private Sectors
(Same subject as 11.344J)
Prereq: Permission of instructor
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 11.344J.

C. M. Gordon

MATERIALS AND STRUCTURES

1.541 Mechanics and Design of Concrete Structures
(Subject meets with 1.054)
Prereq: 1.035
G (Fall)
3-0-9 H-LEVEL Grad Credit
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

1.545 Atomistic Modeling and Simulation of Materials and Structures
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers multiscale atomistic modeling and simulation methods, with focus on mechanical properties (elasticity, plasticity, creep, fracture, fatigue) of a range of materials (metals, ceramics, proteins, biological materials, biomaterials). Topics include mechanics of materials (energy principles, nano-/micromechanics, deformation mechanisms, size effects, hierarchical biological structures) and atomistic modeling (chemistry, interatomic potentials, visualization, data analysis, numerical methods, supercomputing, algorithms). Includes an interactive computational project.

M. J. Buehler

1.56J Structural Mechanics in Nuclear Power Technology
(Same subject as 2.084J, 22.314J)
Prereq: 2.001 or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 22.314J.

M. S. Kazimi
1.561 Motion-Based Design
Prereq: Permission of instructor
G (Fall)
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.

1.562 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.
P. Ghisbain

1.57 Mechanics of Materials: An Energy Approach
Prereq: 1.050 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-2-7 H-LEVEL Grad Credit
An opportunity to update knowledge in continuum mechanics and constitutive behavior, and modeling of engineering materials based on thermodynamics of irreversible processes. Introduction to continuum mechanics and material modeling of engineering materials based on first energy principles: deformation and strain; momentum balance, stress, and stress states; elasticity and elasticity bounds; plasticity and yield design. Overarching theme is a unified mechanistic language using thermodynamics, which allows for understanding, modeling, and design of a broad range of engineering materials.
F. J. Ulm

1.570 Micromechanics and Durability of Solids
Prereq: 1.050, 1.57; or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to fracture mechanics, poromechanics and micromechanics using a unified mechanistic approach based on energy principles for modeling a large range of man-made and natural engineering material behavior. Energy release and fracture energy, stress intensity factors and toughness, saturated and partially saturated poromechanics of deformable porous materials, Darcy’s law, linear micromechanics and application to porous materials, homogenization methods, chemomechanics of dissolution processes. In addition to assignments, emphasizes development of a consistent engineering science approach, culminating in a term paper.
F. J. Ulm

1.571 Modeling and Analysis of Structures
Prereq: Permission of Instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers analytical and computer-based methods for the analysis of structural systems. Introduces strategies for the quantitative study of indeterminate and nonlinear structures. Provides insight into structural analysis software and the implementation of the finite element method. Emphasizes modeling complex structural behavior, such as elastic instability, local and global buckling, physical nonlinearity, geometric stiffness, and thermal expansion. Application examples cover a range of structural components and systems, with models and methods specific to the study of building frames, arches, shells, and cable-supported and tensile structures. Assignments provide experience with the construction of mathematical and finite element models, the derivation of closed-form solutions, and the effective use of structural analysis programs.
P. Ghisbain

1.572 Structural Systems
Prereq: Permission of instructor
G (Fall)
3-0-6 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. Develops skills necessary for conceptual design work, such as how to visualize options and judge 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.
Staff

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

1.581J Structural Dynamics and Vibrations
(Same subject as 2.060, 16.221J)
(Subject meets with 1.058)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
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.
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.
Staff
HYDRODYNAMICS AND COASTAL ENGINEERING

1.61 Transport Processes in the Environment
Prereq: 1.060B
G (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. Meets with 1.061A first half of term and 1.061B second half of term.

H. Nepf

1.63J Advanced Fluid Dynamics
(Same subject as 2.26J)
Prereq: 18.085; 2.25 or permission of instructor.
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: 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
(Subject meets with 1.064)
Prereq: 1.061B
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit
Provides an introduction to physical processes occurring in lakes and shallow surface water systems with emphasis on mechanisms affecting fate and transport. Topics include internal waves, differential heating and cooling, boundary mixing, turbulent mixing, and influence of vegetation. Begins with a review of Navier-Stokes equation. Students taking graduate version complete additional assignments.
H. 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
4-0-8 H-LEVEL Grad Credit
Staff

1.685J Nonlinear Dynamics and Waves
(Same subject as 2.034J, 18.377J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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
J. Trowbridge

1.692J Ocean Wave Interaction with Ships and Offshore Energy Systems
(Same subject as 2.24J)
Prereq: 2.20, 18.085
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
4-0-8 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.
J. Preisig, WHOI Staff

HYDROLOGY AND WATER RESOURCE SYSTEMS

1.714 Surface Hydrology
Prereq: 1.070 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

1.72 Groundwater Hydrology
(Subject meets with 1.072)
Prereq: 1.061B
G (Fall)
3-1-8 H-LEVEL Grad Credit
Presents the fundamentals of subsurface flow and transport, emphasizing the role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater. Topics include Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, storage properties, regional circulation, unsaturated flow, recharge, stream-aquifer interaction, well hydraulics,
flow through fractured rock, numerical models, groundwater quality, contaminant transport processes, dispersion, decay, and adsorption. Includes laboratory and computer demonstrations. Students taking graduate version complete additional assignments. C. Harvey

1.721 Advanced Subsurface Hydrology
Prereq: 1.72, 18.075, permission of instructor Acad Year 2014–2015: Not offered Acad Year 2015–2016: G (Spring) 3-0-9 H-LEVEL Grad Credit
Advanced treatment of solute transport in natural porous media with a focus on coupled chemical reaction and transport. Numerical modeling. Stochastic treatment of temporal and spatial variability. Mobile/immobile domain mass transfer, macrodispersion, tracer tests, salt water intrusion, heat transport. C. Harvey

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

1.725J Chemicals in the Environment: Fate and Transport
(Same subject as ESD.151J)
Prereq: Permission of instructor G (Fall) 3-0-9
For Institute students in all departments interested in the behavior of 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. E. E. Adams

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

1.74 Land, Water, Food, and Climate (New)
Prereq: None G (Spring) 3-0-3
Seminar examines food production in a changing world, with an emphasis on key scientific questions about the connections between natural resources, climate, and agriculture. Students read and discuss papers on a range of topics, including water and land resources, climate change, demography, agro-ecology, biotechnology, trade, and food security. Provides a broad and balanced perspective on one of the defining global issues of this century. Considers scientific controversies as well as areas of general agreement and examines practical solutions for addressing critical problems. Participants present reviews of selected papers and lead follow-up discussions. They also have a role in shaping subject content. D. McLaughlin

AQUATIC SCIENCES, WATER QUALITY CONTROL, AND ENVIRONMENTAL MANAGEMENT

1.75 Limnology and Wetland Ecology
Prereq: Permission of instructor Acad Year 2014–2015: G (Fall) Acad Year 2015–2016: 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 2014–2015: Not offered Acad Year 2015–2016: G (Spring) 3-0-9 H-LEVEL Grad Credit
Quantitative treatment of chemical processes in aquatic systems such as lakes, oceans, rivers, estuaries, groundwaters, and wastewaters. A brief review of chemical thermodynamics is followed by discussion of acid-base, precipitation-dissolution, coordination, and reduction-oxidation reactions. Emphasis is on equilibrium calculations as a tool for understanding the variables that govern the chemical composition of aquatic systems and the fate of inorganic pollutants. B. Kocar

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 Develop-
ment 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

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

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, the production and use of toxic chemicals, 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. Caldart

1.802J Regulation of Chemicals, Radiation, and Biotechnology (Same subject as 11.022J) (Subject meets with 1.812J, 10.805J, 11.631J, ESD.134J, ESD.136J) Prereq: 1.801 or permission of instructor U (Spring) Not offered regularly; consult department 3-0-9

Focuses on policy design and evaluation in the regulation of hazardous substances and processes. Includes risk assessment, industrial chemicals, pesticides, food contaminants, pharmaceuticals, radiation and radioactive wastes, product safety, workplace hazards, indoor air pollution, biotechnology, victims’ compensation, and administrative law. Health and economic consequences of regulation, as well as its potential to spur technological change, are discussed for each regulatory regime. Students taking the graduate version are expected to explore the subject in greater depth.

N. Ashford, C. Caldart

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: Permission of instructor for undergraduates G (Fall) 3-0-9 H-LEVEL Grad Credit

Reviews and analyzes federal and state regulation of air and water pollution, hazardous wastes, and the production and use of toxic chemicals. 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. Ashford, 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: 1.811 or permission of instructor G (Spring) Not offered regularly; consult department 3-0-9 H-LEVEL Grad Credit

Focuses on policy design and evaluation in the regulation of hazardous substances and processes. Includes risk assessment, industrial chemicals, pesticides, food contaminants, pharmaceuticals, radiation and radioactive wastes, product safety, workplace hazards, indoor air pollution, biotechnology, victims’ compensation, and administrative law. Health and economic consequences of regulation, as well as its potential to spur technological change, are discussed for each regulator regime. Students taking the graduate version are expected to explore the subject in greater depth.

N. Ashford, C. Caldart

1.813J Technology, Globalization, and Sustainable Development (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. Ashford

1.818J Sustainable Energy (Same subject as 2.65J, 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

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

Presents thought processes and quantitative tools, including life-cycle assessment (LCA) and the LEED and ENVISION rating systems, applicable to integrated design of buildings and horizontal infrastructure with the goal of minimizing the waste of materials, energy, and water. Readings, lectures, site visits, and assignments 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

1.83 Environmental Organic Chemistry (Subject meets with 1.831) 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 structure-reactivity relationships to estimate chemical, photochemical, and biochemical transformation rates. Resulting process models are combined to predict environmental concentrations (and related biological exposures) of anthropogenic and natural organic compounds. 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
Focuses on the processes affecting organic compounds in the environment. Uses physical chemical properties to predict chemical transfers between environmental compartments (air, water, sediments, and biota). Uses molecular properties to estimate chemical, photochemical, and biochemical transformation rates. Resulting process models are combined to predict environmental concentrations (and related biological exposures) of anthropogenic and natural organic compounds.

P. M. Gschwend

1.84J Atmospheric Chemistry
(Subject same as 10.817j, 12.807j)
Prereq: 5.60
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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; photochemical smog; aerosol chemistry; and sources and sinks of greenhouse gases and other climate forcers.

J. H. Kroll

1.84J1 Atmospheric Composition in the Changing Earth System
(Subject same as 12.817j)
Prereq: 1.84
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Explores how atmospheric chemical composition both drives and responds to climate, with a particular focus on feedbacks via the biosphere. Topics include atmospheric nitrogen; DMS, sulfates, and CLAW; biogenic volatile organic compounds and secondary organic aerosol; wildfires and land use change; atmospheric methane and the oxidative capacity of the troposphere; and air quality and climate and geoengineering.

C. Heald

1.85 Water and Wastewater Treatment Engineering
Prereq: 1.061, 1.61, or 1.725
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9

Staff

1.851J Water, Sanitation, Hygiene and Environmental Sanitation (WASH-ENV) in Low- and Middle-Income Countries
(Same subject as 11.479j)
Prereq: None
G (Spring)
Units arranged
Addresses principles and practice of water, sanitation, hygiene and environmental sanitation (WASH-ENV) systems, infrastructure, engineering, and planning in low- and middle-income countries. Incorporates interdisciplinary technical, socio-cultural, public health, human rights, behavioral, and economic aspects into the design and implementation of interventions. Students develop skills to plan simple, yet reliable, WASH-ENV systems together with urban or rural communities that are compatible with local customs and available human and material resources.

Staff

1.86J Methods and Problems in Microbiology
(Same subject as 7.492j, 20.445j)
Prereq: Permission of instructor or Coreq: 7.493
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 7.492j.

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, E. Alm

1.88 Physical Ecology at the Microscale
Prereq: Permission of instructor
G (Fall)
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
(Subject meets with 1.089)
Prereq: Biology (GIR)
G (Fall)
3-0-9 H-LEVEL Grad Credit
Provides 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. 7.014 recommended as prerequisite; students taking graduate version complete additional assignments.

J. R. Thompson

1.899 Career Reengineering Program and Professional Development Workshops
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
(Subject same as 5.95j, 6.982, 7.59j, 8.395j, 18.09j)
(Same subject with 2.978)
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)
0-2-0
Provides classroom teaching experience under the supervision of faculty member(s). Students prepare instructional material, deliver lectures, grade assignments, and prepare a teaching portfolio to be submitted at the end of term. Concurrent enrollment in 1.95J strongly recommended. Enrollment limited by availability of suitable teaching assignments.
Information: Academic Program Office

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.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject
(Offered 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)
0-0-1 [P/D/F]
See description under subject 2.EPE.
Staff

1.EPW UPOP Engineering Practice Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (fall, IAP)
1-0-0 [P/D/F]
See description under subject 2.EPW.
Staff

1.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, MEng, CE, PhD, or ScD thesis; to be arranged by the student and an appropriate MIT faculty member.
Consult Department Academic Programs Office

1.THU Undergraduate Thesis
Prereq: Permission of instructor
U (fall, IAP, spring, summer)
Units arranged
Can be repeated for credit
Program of research leading to the writing of 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
1.URG Research in Civil and Environmental Engineering
Prereq: None
U (fall, IAP, spring, summer)
Units arranged
Can be repeated for credit
Individual research or laboratory study under faculty supervision. Also opportunities in ongoing research program.
Consult Department Academic Programs Office

1.S82 Special Problems in Environmental Microbiology and Chemistry
Prereq: Permission of instructor
G (fall, spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced study of topics not covered in the regular subject listings, particularly seminar, laboratory, and experimental subjects offered by permanent or visiting faculty. Addresses topics in environmental microbiology, ecological genomics, microbial evolution and population genetics, oceanography, biogeochemical processes, environmental organic chemistry and aquatic chemistry.
1.5991 Special Undergraduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

1.5992 Special Undergraduate Subject in Civil and Environmental Engineering
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

Subjects taught experimentally; subjects offered by visiting faculty; and seminars on topics of current interest not included in the regular curriculum. 1.991 is taught P/D/F.

Consult Department Academic Programs Office
Bachelor of Science in Environmental Engineering Science/Course 1-E

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement (2)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement (one subject can be satisfied by 1.805, 1.102, or 14.01 in the Departmental Program)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (can be satisfied by 1.050)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (can be satisfied by 1.101 and 1.102 in the Departmental Program)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
<td></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>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.018AJ</td>
<td>Fundamentals of Ecology I</td>
<td>6</td>
</tr>
<tr>
<td>1.018BJ</td>
<td>Fundamentals of Ecology II</td>
<td>6</td>
</tr>
<tr>
<td>1.020</td>
<td>Principles of Energy and Water Sustainability</td>
<td>12</td>
</tr>
<tr>
<td>1.050</td>
<td>Solid Mechanics</td>
<td>12</td>
</tr>
<tr>
<td>1.060A</td>
<td>Fluid Mechanics I</td>
<td>6</td>
</tr>
<tr>
<td>1.060B</td>
<td>Fluid Mechanics II</td>
<td>6</td>
</tr>
<tr>
<td>18.03</td>
<td>Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>1.093</td>
<td>Senior Civil and Environmental Engineering Design</td>
<td>12</td>
</tr>
<tr>
<td>One of the following two subjects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.000</td>
<td>Introduction to Computers and Engineering Problem Solving</td>
<td>12</td>
</tr>
<tr>
<td>or</td>
<td>1.000</td>
<td>Computer Programming for Scientific and Engineering Applications</td>
</tr>
<tr>
<td>1.010</td>
<td>Uncertainty in Engineering</td>
<td>12</td>
</tr>
</tbody>
</table>

**Environmental Engineering Science**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.061A</td>
<td>Transport Processes in the Environment I</td>
<td>6</td>
</tr>
<tr>
<td>1.061B</td>
<td>Transport Processes in the Environment II</td>
<td>6</td>
</tr>
<tr>
<td>1.070A</td>
<td>Introduction to Hydrology and Water Resources</td>
<td>6</td>
</tr>
<tr>
<td>1.070B</td>
<td>Introduction to Hydrology Modeling</td>
<td>6</td>
</tr>
<tr>
<td>1.080A</td>
<td>Environmental Chemistry I</td>
<td>6</td>
</tr>
<tr>
<td>1.080B</td>
<td>Environmental Chemistry II</td>
<td>6</td>
</tr>
<tr>
<td>1.083A</td>
<td>Environmental Health Engineering and Biology I</td>
<td>6</td>
</tr>
<tr>
<td>1.083B</td>
<td>Environmental Health Engineering and Biology II</td>
<td>6</td>
</tr>
<tr>
<td>1.106</td>
<td>Environmental Fluid Transport Processes and Hydrology Laboratory</td>
<td>6</td>
</tr>
<tr>
<td>1.107</td>
<td>Environmental Chemistry and Biology Laboratory</td>
<td>6</td>
</tr>
</tbody>
</table>

**Economics and Public Policy**

One of the following three subjects:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.801J</td>
<td>Environmental Law, Policy, and Economics: Pollution Prevention &amp; Control</td>
<td>12</td>
</tr>
<tr>
<td>11.002J</td>
<td>Making Public Policy</td>
<td>12</td>
</tr>
<tr>
<td>14.01</td>
<td>Principles of Microeconomics</td>
<td>12</td>
</tr>
</tbody>
</table>

**Laboratory**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.101</td>
<td>Introduction to Civil and Environmental Engineering Design I</td>
<td>6</td>
</tr>
<tr>
<td>1.102</td>
<td>Introduction to Civil and Environmental Engineering Design II</td>
<td>6</td>
</tr>
</tbody>
</table>

**Restricted Elective**

One advanced subject from the following list (students may petition the department to substitute an upper-level subject in science or engineering):

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.064</td>
<td>Physical Limnology</td>
<td>12</td>
</tr>
<tr>
<td>1.071J</td>
<td>Global Change Science</td>
<td>12</td>
</tr>
<tr>
<td>1.072</td>
<td>Groundwater Hydrology</td>
<td>12</td>
</tr>
<tr>
<td>1.085</td>
<td>Air Pollution</td>
<td>12</td>
</tr>
<tr>
<td>1.089</td>
<td>Environmental Microbiology</td>
<td>12</td>
</tr>
<tr>
<td>5.56</td>
<td>Thermodynamics and Kinetics</td>
<td>12</td>
</tr>
</tbody>
</table>

**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.
(1) Any of the subjects that fulfill the Institute Chemistry Requirement is satisfactory, though 5.111 or 5.112 is recommended.
(2) The combination of 1.018AJ and 1.018BJ counts as a REST subject.
(3) Students are encouraged to take both 1.00 and 1.010, in which case one may be counted as a restricted elective.

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 as Recommended by the Department of Civil and Environmental Engineering/Course 1-ENG

<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 (can be satisfied by)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00, 1.000, and 18.03 in the Departmental Program</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (can be satisfied from among 1.101, 1.102, 1.106, and 1.107 in the Departmental Program)</td>
<td>1</td>
<td></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

<table>
<thead>
<tr>
<th>Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Department Requirements (GDRs)</td>
<td>54</td>
</tr>
<tr>
<td>1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR) or</td>
<td></td>
</tr>
<tr>
<td>1.000 Computer Programming for Scientific and Engineering Applications, 12, REST; 18.03*</td>
<td></td>
</tr>
<tr>
<td>1.010 Uncertainty in Engineering, 12; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>1.013 Senior Civil and Environmental Engineering Design, 12; CI-M; permission of instructor</td>
<td></td>
</tr>
<tr>
<td>1.070A Introduction to Environmental Data Analysis, 6; 1.010</td>
<td></td>
</tr>
<tr>
<td>or 1.074 Multivariate Data Analysis, 6; 1.010</td>
<td></td>
</tr>
<tr>
<td>18.03 Differential Equations, 12; REST; Calculus II (GIR)</td>
<td></td>
</tr>
</tbody>
</table>

Core Subjects

Students are required to formulate or select one area of core coursework. They can select from the following areas or create their own core from a combination of them with the approval of the CEE Program Officer.

Environment

| 1.018A Fundamentals of Ecology I, 6 |          |
| 1.060A Fluid Mechanics I, 6; 18.03* |          |
| 1.061A Transport Processes in the Environment I, 6; 1.060A, 1.070A, 1.106 |          |
| 1.070A Introduction to Hydrology I, 6; 1.060A, 1.061A, 1.106 |          |
| 1.080A Environmental Chemistry I, 6; Chemistry (GIR) |          |
| 1.083A Environmental Health Engineering and Biology, 6; Chemistry (GIR), Biology (GIR), 1.061A |          |
| 1.092 Traveling Research Environmental Experience (TREX), 12, CI-M; permission of instructor |          |
| 1.106 Environmental Fluid Transport Processes and Hydrology Laboratory, 6, LAB; 1.061A, 1.070A |          |
| 1.107 Environmental Chemistry and Biology Laboratory, 6, LAB; 1.080A |          |

Mechanics/Materials

| 1.035 Mechanics of Structures and Soils, 18; 1.050, 18.03 |          |
| 1.050 Solid Mechanics, 12; Physics I (GIR), Calculus II (GIR) |          |
| 1.060A Fluid Mechanics II, 6; 1.106A |          |
| 1.101 Introduction to Civil and Environmental Engineering Design I, 6, LAB |          |
| 1.102 Introduction to Civil and Environmental Engineering Design II, 6, LAB; Physics II (GIR)* |          |

Systems

| 1.011 Project Evaluation and Management, 12, CI-M |          |
| 1.020 Principles of Energy and Water Sustainability, 12; Physics I (GIR), 18.03 |          |
| 1.022 Urban Networks, 6; 1.09*, 1.010 |          |
| 1.041 Transportation Systems Modeling, 12; 1.00*, 1.010 |          |
| 1.101 Introduction to Civil and Environmental Engineering Design I, 6, LAB |          |
| 1.102 Introduction to Civil and Environmental Engineering Design II, 6, LAB; Physics II (GIR)* |          |

Elective Subjects with Engineering Content

Students are required to take four Restricted Electives selected from subjects offered within or outside CEE to form a coherent program of study under supervision by CEE faculty.

| Departmental Program Units That Also Satisfy the GIRs | (36) |
| Unrestricted Electives | 48–54 |

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.

To satisfy the CI-M component of the Communication Requirement, students must take two of the department's CI-M subjects (1.011, 1.013, 1.092) 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.
FRESHMAN YEAR
INTRODUCTORY SUBJECTS

2.00AJ Fundamentals of Engineering Design: Explore Space, Sea and Earth
(Same subject as 16.00AJ)
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
3-3-3

Student teams formulate and complete space/environmental 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 specialists 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 design 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

2.00 Introduction to Design
Prereq: None
U (Fall; second half of term)
2-3-1

Project-based introduction to product development and engineering design. Emphasizes key elements of the design process, including defining design problems, generating ideas, and building solutions. Presents a range of design techniques to help students think about, evaluate, and communicate designs, from sketching to physical prototyping, as well as other types of modeling. Student work both individually and in teams. Enrollment limited; preference to Course 2-A sophomores.

M. Yang

2.001 Mechanics and Materials I
Prereq: Physics I (GIR); Coreq: 18.03 or 2.087
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.

G. Barbastathis, A. E. Hosoi, K. Kamrin

2.002 Mechanics and Materials II
Prereq: 2.001, or 2.01 and 2.02B; Chemistry (GIR)
U (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 their selection. Major topics: elasticity, plasticity, limit analysis, fatigue, fracture, and creep. Materials selection. Laboratory experiments involving projects related to materials in mechanical design. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.

L. Anand, K. Kamrin, P. Reis

2.003J Dynamics and Control I
(Same subject as 1.053J)
Prereq: Physics I (GIR), 18.03, or permission of instructor; Coreq: 2.086 or 1.020
U (Fall, Spring)
4-1-7 REST


J. K. Vandiver, N. C. Makris, N. M. Patrikalakis, T. Peacock, D. Gossard, K. Turitsyn

2.004 Dynamics and Control II
Prereq: 2.003 or 2.03; 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. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.

Visual thinking, computer-aided design (CAD), idea generation, estimation, concept selection, subject relies on active learning via major projects on schedule and within budget. Robustness of physical laws. Instruction on how to complete creative design process bolstered by application of physical models of performance 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. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.


2.006 Thermal-Fluids Engineering II
Prereq: 2.005; or 2.051, 2.06
U (Fall, Spring)
5-0-7


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

2.007 Design and Manufacturing I
Prereq: 2.001 or 2.01; 2.670; Coreq: 2.086
U (Spring)
3-4-5

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.

Limited enrollment. Pre-registration required for lab assignment; special sections by lottery only.

D. Frey, S. Kim, A. Winter

2.008 Design and Manufacturing II
Prereq: 2.007 or Coreq: 2.017; 2.005 or 2.051
U (Fall, Spring)
3-3-6 1/2 Institute LAB

Integration of design, engineering, and management disciplines and practices for analysis and design of manufacturing enterprises. Emphasis is on the physics and stochastic nature of manufacturing processes and systems, and their effects on quality, rate, cost, and flexibility. Topics include process physics and control, design for manufacturing, and manufacturing systems. Group project requires design and fabrication of parts using mass-production and assembly methods to produce a product in quantity. Six units may be applied to the General Institute Lab Requirement. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.


2.009 The Product Engineering Process
Prereq: 2.001 or 2.01; 2.003 or 2.03; 2.005 or 2.051; 2.670, 2.678 or 2.00B; senior standing or permission of instructor also required.
U (Fall)
3-3-6

Students develop an understanding of product development phases and experience working in teams to design and construct high-quality product prototypes. Design process learned is placed into a broader development context. Primary goals are to improve ability to reason about design alternatives and apply modeling techniques appropriate for different development phases; understand how to gather and process customer information and transform it into engineering specifications; and use teamwork to resolve the challenges in designing and building a substantive product prototype. Instruction and practice in oral communication provided. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.

D. R. Wallace

2.014 Engineering Systems Development
Prereq: 2.001 or 2.01; 2.003 or 2.03; 2.005 or 2.051; 2.670, 2.678 or 2.00B
U (Spring)
0-6-6

Can be repeated for credit

Focuses on implementation and operation of engineering systems. Emphasizes system integration and performance verification using methods of experimental inquiry. Students refine their subsystem designs and the fabrication of working prototypes. Includes experimental analysis of system 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. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.

D. Hart

2.016 Hydrodynamics
Prereq: Physics II (GIR), 18.03
U (Fall)
4-2-6

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, P. D. Sclavounos

2.017J Design of Electromechanical Robotic Systems
(Same subject as 1.015J)
Prereq: 2.003 or 2.03; Coreq: 2.005, 2.05 and 2.051, or 2.016; 2.671
U (Spring)
3-3-6 1/2 Institute LAB
Design, construction, and testing of field robotic systems, through team projects with each student responsible for a specific subsystem. Projects focus on electronics, instrumentation, and machine elements. Design for operation in uncertain conditions is a focus point, with ocean waves and marine structures as a central theme. Basic statistics, linear systems, Fourier transforms, random processes, spectra and extreme events with applications in design. Lectures on ethics in engineering practice included. Enrollment may be limited due to laboratory capacity.
F. S. Hover, J. J. Leonard

2.019 Design of Ocean Systems
Prereq: 2.001; 2.003; 2.005 or 2.016. Senior standing or permission of instructor also required.
U (Spring)
3-3-6
Complete cycle of designing an ocean system using computational design tools for the conceptual and preliminary design stages. Team projects assigned, with each student responsible for a specific subsystem. Lectures cover hydrodynamics; structures; power and thermal aspects of ocean vehicles, environment, materials, and construction for ocean use; generation and evaluation of design alternatives. Focus on innovative design concepts chosen from high-speed ships, submersibles, autonomous vehicles, and floating and submerged deep-water offshore platforms. Lectures on ethics in engineering practice included. Instruction and practice in oral and written communication provided. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.
C. Chryssostomidis, M. S. Triantafyllou

2.02A Engineering Materials: Properties and Applications
Prereq: 2.01
U (Fall; second half of term) 2-0-4
Introduction to the physical mechanisms that give rise to mechanical properties of engineering materials: stiffness, creep, stress-relaxation, strength, fracture-toughness, and fatigue. Also covers materials selection for mechanical design. Includes case studies on materials-limited problems in engineering design.
A. Kolpak

2.02B Mechanics of Structures
Prereq: 2.01
U (Fall; second half of term) 2-0-4
Introduction to continuum mechanics of deformable solids, emphasizing strain-displacement and stress-equilibrium relations while specializing material constitutive response to linear elasticity and its limits. Teaches students to solve example boundary value problems and consider the engineering implications of the solutions. Corresponding numerical solutions based on finite element methods are introduced and explored.
D. M. Parks

2.03 Dynamics I
Prereq: None. Coreq: 2.086
U (Fall; Spring; first half of term) 2-0-4
Credit cannot also be received for 2.503
D. Gossard, K. Turitsyn, T. Peacock

2.031 Dynamics II
Prereq: 2.03
U (Fall; Spring; second half of term) 2-0-4
Continuation of topics introduced in 2.03, including work-energy concepts, Lagrange’s equations for systems of particles and rigid bodies in planar motion, and matrix eigenvalue problems. Meets with 2.003 second half of term.
D. Gossard, K. Turitsyn, T. Peacock

2.04A Systems and Controls
Prereq: None. Coreq: 2.03
U (Spring; first half of term) 2-1-3
Introduction to linear systems, transfer functions, and Laplace transforms. Covers stability and feedback, and provides basic design tools for specifications of transient response. Briefly covers frequency-domain techniques. Enrollment may be limited due to laboratory capacity.
G. Barbastathis

2.04B Introduction to Mechanical Vibration
Prereq: 2.03, 2.086
U (Fall; first half of term) 2-1-3
Analyzes the time domain response of single- and multiple-degree-of-freedom (DOF) systems to initial conditions and force inputs. Uses matrix formulation of multiple-DOF problems, including finding natural frequencies and mode shapes. Provides an introduction to the method of normal mode superposition. Includes transfer function analysis of the response of linear systems to steady state harmonic inputs, with application to vibration isolation and dynamic absorbers. Also includes application to the analysis of machines with rotating imbalances. Enrollment may be limited due to lab capacity; preference to Course 2 majors and minors.
J. K. Vandiver

2.05 Thermodynamics
Prereq: 2.01
U (Fall; first half of term) 3-0-3
Provides an introduction to thermodynamics, including first law (coupled and uncoupled systems, incompressible liquid, ideal gas) and second law (equilibrium, reversibility and irreversibility). Explores systems in communication with heat reservoirs; quasi-static processes; and heat engines and refrigeration. Properties of open systems, including mass, energy and entropy transfer.
C. Buie

2.051 Introduction to Heat Transfer
Prereq: 2.05
U (Fall; second half of term) 2-0-4
Introduces fundamental processes of heat transfer. Fourier’s law. Heat conduction processes including thermal resistance, lumped capacitance, fins, and the heat equation. Elementary convection, including laminar and turbulent boundary layers, internal flow, and natural convection. Thermal radiation, including Stefan-Boltzmann
law, small object in large enclosure, and parallel plates. Basic concepts of heat exchangers.
J. H. Lienhard, E. N. Wang, A. Hosoi

2.06 Fluid Dynamics
Prereq: 2.01
U (Fall, Spring; second half of term)
2-0-4
G. H. McKinley, A. Hosoi, K. Varanasi

2.086 Numerical Computation for Mechanical Engineers
Prereq: Physics I (GIR), Calculus II (GIR); Coreq: 18.03 or 2.087
U (Fall, Spring)
0-3-9 REST
Covers elementary programming concepts, including variable types, data structures, and flow control. Provides an introduction to linear algebra and probability. Numerical methods relevant to MechE, including approximation (interpolation, least squares, and statistical regression), integration, solution of linear and nonlinear equations, and ordinary differential equations. Presents deterministic and probabilistic approaches. Uses examples from MechE, particularly from robotics, dynamics, and structural analysis. Assignments require MATLAB programming. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.
N. Hadjiconstantinou, A. Patera, D. Frey, A. Hosoi

2.078 Engineering Mathematics: Linear Algebra and ODEs
Prereq: Calculus II (GIR), Physics I (GIR)
U (Fall, Spring; first half of term)
2-0-4
Introduction to linear algebra and ordinary differential equations (ODEs), including general numerical approaches to solving systems of equations. Linear systems of equations, existence and uniqueness of solutions, Gaussian elimination. Initial value problems, 1st and 2nd order systems, forward and backward Euler, RK4. Eigenproblems, eigenvalues and eigenvectors, including complex numbers, functions, vectors and matrices.
A. Hosoi, T. Peacock

DYNAMICS AND ACOUSTICS

2.032 Dynamics
Prereq: 2.003
G (Fall)
3-0-9 H-LEVEL Grad Credit
T. R. Akylas, T. Peacock, N. Hadjiconstantinou

2.034J Nonlinear Dynamics and Waves
(Same subject as 1.685J, 18.377J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 18.385J.
R. R. Rosales

2.050J Nonlinear Dynamics: 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.
R. Lagrange

2.060J Structural Dynamics and Vibrations
(Same subject as 1.581J, 16.221J)
Prereq: 1.058
3-1-8 H-LEVEL Grad Credit
See description under subject 1.581J.
E. Kausel, 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
T. R. Akylas, R. R. Rosales

2.065 Acoustics and Sensing
(Subject meets with 2.066)
Prereq: 2.003, 2.048, 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, 2.048, 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 or 2.02A
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 anisotropic linear thermal elasticity. Variational and energy methods. Linear viscoelasticity. Small-strain elastic-plastic deformation. Mechanics of large deformation; nonlinear hyperelastic material behavior. Foundations and methods of deformable-solid mechanics, including relevant applications. Provides base for further study and specialization within solid mechanics, including continuum mechanics, computational mechanics (e.g., finite-element methods), plasticity, fracture mechanics, structural mechanics, and nonlinear behavior of materials.

L. Anand, D. M. Parks

2.072 Mechanics of Continuous Media
Prereq: 2.071
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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-(visco) plastic solids. Analytical and numerical solution of selected boundary value problems. Applications to deformation processing of metals.

L. Anand, D. M. Parks

2.074 Solid Mechanics: Elasticity
Prereq: 2.002, Coreq: 18.03
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit


D. M. Parks

2.076J Mechanics of Heterogeneous Materials (New)
(Same subject as 16.223J)
Prereq: 2.002, 3.032, 16.20, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 16.223J.

B. L. Wardle, S-G. Kim

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

Presents fundamental concepts of structural mechanics with applications to marine, civil, and mechanical structures. Covers 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; and approximate methods, energy methods, principle of virtual work, and introduction to computational structural mechanics.

T. Wierzbicki, J. J. Connor, Jr., H. Schmidt

2.081J Plates and Shells: Static and Dynamic Analysis
(Same subject as 16.230)
Prereq: 2.071, 2.080J, or permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit


T. Sapsis

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 2.081. 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

See description under subject 22.314J.

M. S. Kazimi, O. Buyukozturk
COMPUTATIONAL ENGINEERING

2.089J Computational Geometry
(Same subject as 1.128I)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 or 2.01; 2.003 or 2.03
U (Fall)
3-0-9

2.093 Finite Element Analysis of Solids and Fluids I
(Subject meets with 2.092)
Prereq: 2.001 or 2.01; 2.003 or 2.03
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: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 16.920J.
Q. Wang, J. K. White

2.099J Computational Mechanics of Materials
(Same subject as 16.225J)
Prereq: Permission of instructor, programming in either C++, C, or Fortran
G (Fall)
3-0-9 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 8.370J, 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
(Subject meets with 2.12)
Prereq: 2.004, or 2.031 and 2.04A
U (Fall)
3-2-7

2.120 Introduction to Robotics
(Subject meets with 2.12)
Prereq: 2.004, or 2.031 and 2.04A, or permission of instructor
G (Fall)
3-2-7 H-LEVEL Grad Credit

Presents the fundamentals of robot mechanisms, dynamics, and controls. Planar and spatial kinematics, differential motion, energy method for robot mechanics; mechanism design for manipulation and locomotion; multi-rigid-body dynamics; force and compliance control, balancing control, visual feedback, human-machine interface; actuators, sensors, wireless networking, and embedded software. Weekly laboratories include real-time control, vehicle navigation, arm and end-effector design, and balancing robot control. Group term project requires design and fabrication of robotic systems. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity.
H. Asada, J. J. Leonard

2.131 Advanced Instrumentation and Measurement
Prereq: Permission of Instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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, 2.04A, or 2.04B
3-3-6

2.140 Analysis and Design of Feedback Control Systems
(Subject meets with 2.14)
Prereq: 2.004, 2.04A, 2.04B, 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. Enrollment may be limited due to laboratory capacity.

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

2.141 Modeling and Simulation of Dynamic Systems
Prereq: 2.151
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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; multport 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**

2.151 Advanced System Dynamics and Control
Prereq: 2.004, 18.06; or 2.087, 2.04A
G (Fall)
4-0-8 H-LEVEL Grad Credit

Analytical and graphical descriptions of state-determined dynamic physical systems; time and frequency domain representations; system characteristics—controllability, observability, stability; linear and nonlinear system responses. Modification of system characteristics using feedback. State observers, Kalman filters. Modeling/performance trade-offs in control system design. Emphasis on application of techniques to physical systems.

**K. Youcef-Toumi, N. Hogan, D. Rowell**

2.152J Nonlinear Control System Design
(Subject meets with 2.14)
Prereq: 2.151, 6.241, 16.31, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit


**J.-J. E. Slotine**

2.153 Adaptive Control
Prereq: 2.151
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

Introduces the foundation of adaptive control in continuous-time and discrete-time systems. Adaptive control is the ability to self-correct a controller in the presence of parametric uncertainties using online information is its main and most compelling feature. Examples drawn from aerospace, propulsion, automotive, and energy systems will be used to elucidate the underlying concepts.

**A. Annaswamy**

2.154 Maneuvering and Control of Surface and Underwater Vehicles
Prereq: 2.22
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit


**M. S. Triantafyllou**

2.160 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. E. Slotine**

2.161 Signal Processing: Continuous and Discrete
Prereq: Knowledge of system dynamics
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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**
2.167 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
Prereq: 2.14, 2.151, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: 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
Prereq: 18.03, Biology (GIR), or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

2.180 Biomolecular Feedback Systems
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

2.20 Marine Hydrodynamics
Prereq: 1.060, 2.006, 2.06, or 2.016
G (Fall)
4-1-7 H-LEVEL Grad Credit
laws. Application of potential theory to surface waves, energy transport, wave/body forces. Linearized theory of lifting surfaces. Experimental project in the towing tank or propeller tunnel.

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
Acad Year 2014–2015: G (Fall; first half of term)
Acad Year 2015–2016: Not offered
2-0-4 H-LEVEL Grad Credit

Reviews the theory and design of hydrofoil sections; lifting and thickness problems for subcavitating sections and unsteady flow problems. Covers lifting line and lifting surface theory with applications to hydrofoil craft, rudder, control surface, propeller and wind turbine rotor design. Topics include propeller lifting line and lifting surface theory; wake adapted propellers, steady and unsteady propeller thrust and torque; waterjets; performance analysis and design of wind turbine rotors. Presents numerical principles of vortex lattice and lifting surface panel methods. Projects illustrate the development of theoretical and computational methods for lifting, propulsion and wind turbine applications.

P. D. Sclavounos

2.24j Ocean Wave Interaction with Ships and Offshore Energy Systems
(Next subject as 1.63J)
Prereq: 2.20, 18.085
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 or 2.06; 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

2.26j Advanced Fluid Dynamics
(Next subject as 1.63J)
Prereq: 18.085; 2.25 or permission of instructor.
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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, or 2.051 and 2.06
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit


A. F. Ghoniem

2.29 Numerical Fluid Mechanics
Prereq: 2.006, 2.06, 2.016, 2.20, or 2.25; 18.075
G (Spring)
4-0-8 H-LEVEL Grad Credit


P. F. J. Lermusiaux
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

2.52J Modeling and Approximation of Thermal Processes
(Same subject as 4.424J)
Prereq: 2.51
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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)
4-0-8 H-LEVEL Grad Credit
Advanced treatment of fundamental aspects of heat and mass transport. Covers topics such as diffusion kinetics, conservation laws, laminar and turbulent convection, mass transfer including phase change or heterogeneous reactions, and basic thermal radiation. Problems and examples include theory and applications drawn from a spectrum of engineering design and manufacturing problems.
J. H. Lienhard

2.56 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
(Subject meets with 2.570)
Prereq: 2.005, 2.051, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

2.570 Nano-to-Macro Transport Processes
(Subject meets with 2.57)
Prereq: 2.005, 2.051, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
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 descriptions. 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-2-7 H-LEVEL Grad Credit

See description under subject 22.313J.
E. Baglietto

E N E R G Y A N D P O W E R S Y S T E M S

2.60J Fundamentals of Advanced Energy Conversion
(Same subject as 10.390J)
Prereq: 2.006, or 2.051 and 2.06, or permission of instructor
U (Spring)
4-0-8
Credit cannot also be received for 2.62, 10.392, 22.40

Fundamentals of thermodynamics, chemistry, and transport applied to energy systems. Analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance, and environmental impact. Applications to fuel reforming and alternative fuels, hydrogen, fuel cells and batteries, combustion, catalysis, combined and hybrid power cycles using fossil, nuclear and renewable resources. CO2 separation and capture. Biomass energy. Meets with 2.62 when offered concurrently; students taking the graduate version complete additional assignments.
A. F. Ghoniem, W. Green, M. Kazimi

2.601J Re-Energizing MIT: Innovating Energy Management at the Institute
(Same subject as 11.160J)
Prereq: None
U (Spring)
4-0-8

See description under subject 11.160J.
Staff

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. Engine Laboratory project. For graduate and senior undergraduate students.
W. K. Cheng

2.611 Marine Power and Propulsion
(Subject meets with 2.612)
Prereq: 2.005
G (Fall)
4-0-8 H-LEVEL Grad Credit

2.612 Marine Power and Propulsion
(Subject meets with 2.611)
Prereq: 2.005
U (Fall)
4-0-8

Selection and evaluation of commercial and naval ship power and propulsion systems. Analysis of propulsors, prime mover thermodynamic cycles, propeller-engine matching. Propeller selection, waterjet analysis, review of alternative propulsors; thermodynamic analyses of Rankine, Brayton, Diesel, and Combined cycles, reduction gears and integrated electric drive. Battery operated vehicles, fuel cells. Term project requires analysis of alternatives in propulsion plant design for given physical, performance, and economic constraints. Graduate students complete different assignments and exams.
M. Thomas, M. S. Triantafyllou, R. S. McCord

2.62J Fundamentals of Advanced Energy Conversion
(Same subject as 10.392J, 22.40J)
Prereq: 2.006, or 2.051 and 2.06, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit

Credit cannot also be received for 2.60, 10.390

Fundamentals of thermodynamics, chemistry, and transport applied to energy systems. Analysis of energy conversion and storage in thermal, mechanical, chemical, and electrochemical processes in power and transportation systems, with emphasis on efficiency, performance, and environmental impact. Applications to fuel reforming and alternative fuels, hydrogen, fuel cells and batteries, combustion, catalysis, combined and hybrid power cycles using fossil, nuclear and renewable resources. CO2 separation and capture. Biomass energy. Meets with 2.62 when offered concurrently; students taking the graduate version complete additional assignments.
A. F. Ghoniem, W. Green, M. Kazimi

2.621 Marine Power and Propulsion
(Subject meets with 2.612)
Prereq: 2.005
U (Fall)
4-0-8
2.625J Electrochemical Energy Conversion and Storage: Fundamentals, Materials and Applications  
(Same subject as 10.625J)  
Prereq: 2.005, 3.046, 3.53, 10.40, or 2.051 and 2.06, or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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  
T. Buonassisi

2.64 Superconducting Magnets  
Prereq: 2.51, permission of instructor  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
3-0-9 H-LEVEL Grad Credit  
Covers design, manufacture, and operation issues of superconducting magnets for major engineering applications in biomedical science (MRI and NMR magnets), high-energy physics (dipole/quadrupole/detector magnets), and electric power (motor/generator/transmission cable) as well as laboratory use. Topics include electromagnetic field analyses, mechanical stress analyses, thermal stability analyses, protection circuit design, cryogenics, and experimental techniques.  
Y. Iwasa, S. Hahn

2.65 J Sustainable Energy  
(Subject meets with 2.650J, 2.651J, 2.652J)  
Prereq: Permission of instructor  
G (Fall)  
3-1-8 H-LEVEL Grad Credit  
See description under subject 22.811J.  
M. W. Golay

2.651J Introduction to Sustainable Energy  
(Subject meets with 2.650J, 2.651J, 2.652J)  
Prereq: Permission of instructor  
U (Fall)  
3-1-8  
See description under subject 22.811J.  
M. W. Golay

2.66J Fundamentals of Energy in Buildings  
(Subject meets with 2.044J, 4.42J)  
Prereq: Physics I (GIR), Calculus II (GIR)  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-2-7 REST  
See description under subject 4.42J.  
L. R. Glicksman

2.671 Measurement and Instrumentation  
Prereq: 2.001 or 2.01; 2.003 or 2.03; Physics II (GIR)  
U (Fall, Spring)  
3-3-6 Institute LAB  
Experimental techniques for observation and measurement of physical variables such as force, strain, temperature, flow rate, and acceleration. Emphasizes principles of transduction, measurement circuitry, MEMS sensors, Fourier transforms, linear and nonlinear function fitting, uncertainty analysis, probability density functions and statistics, system identification, electrical impedance analysis and transfer functions, computer-aided experimentation, and technical reporting. Typical laboratory experiments involve oscilloscopes, electronic circuits including operational amplifiers, thermocouples, strain gauges, digital recorders, lasers, etc. Basic material and lab objectives are developed in lectures. Instruction and practice in oral and written communication provided. Enrollment limited.  
I. W. Hunter, J. J. Leonard

2.672 Project Laboratory  
Prereq: 2.001, 2.003, 2.006, 2.671  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
0-3-3 1/2 Institute LAB  
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, E. Wang

2.673J Instrumentation and Measurement for Biological Systems  
(Subject meets with 20.409)  
Prereq: Biology (GIR), Physics II (GIR), 6.0002, 18.03, 20.330; 2.001, 20.310, or 6.02; or permission of instructor  
U (Fall, Spring)  
3-6-3  
See description under subject 20.309J.  
Fall: P. Blainey, A. Jasanoff, S. Manalis, S. Nagle, S. Wasserman  
Spring: E. Boyden, M. Jonas, S. Nagle, P. So, S. Wasserman, M. Yanik
2.674 Micro/Nano Engineering Laboratory
Prereq: 2.001 or 2.01; 2.003 or 2.03; 2.005, or 2.051 and 2.06; 2.671 or permission of instructor
U (Fall, Spring)
1-3-2

Concepts, ideas, and enabling tools of nanoelectromechanical systems (NEMS) taught through lab modules and imaging tools, which include microfluidics, micro-thermal systems, MEMS, nanomaterials, SEM, TEM, and AFM. Provides practical knowledge and experience via building, observing and manipulating micro- and nanoscale structures. Teaches students how to apply engineering knowledge to practical fluid, thermal, and dynamic systems at small scales. Meets with 2.675 in the fall term. Enrollment limited; preference to Course 2 majors and minors.
S. G. Kim, G. Chen, E. Wang, R. Karnik

2.675 Micro/Nano Engineering Laboratory
Prereq: 2.25; 2.372 or permission of instructor
G (Fall)
1-3-8 H-LEVEL Grad Credit

Concepts, ideas, and enabling tools of nanoelectromechanical systems (NEMS) taught through lab modules and imaging tools, which include microfluidics, micro-thermal systems, MEMS, nanomaterials, SEM, TEM, and AFM. Provides practical knowledge and experience via building, observing and manipulating micro- and nanoscale structures. Teaches students how to apply engineering knowledge to practical fluid, thermal, and dynamic systems at small scales. Meets with 2.674 in the fall term. Enrollment limited.
S. G. Kim, G. Chen, E. Wang, R. Karnik

2.678 Electronics for Mechanical Systems
Prereq: Physics II (GIR)
U (Fall, Spring)
2-2-2

Practical introduction to the fundamentals of electronics in the context of electro-mechanical systems, with emphasis on experimentation and project work in basic electronics. Laboratory exercises include the design and construction of simple electronic devices, such as power supplies, amplifiers, op-amp circuits, switched mode dc-dc converters, and dc motor drivers. Surveys embedded microcontrollers as system elements. Laboratory sessions stress the understanding of electronic circuits at the component level, but also point out the modern approach of system integration using commercial modules and specialized integrated circuits. Enrollment may be limited due to laboratory capacity; preference to Course 2 majors and minors.
D. Rowell

2.680 Unmanned Marine Vehicle Autonomy, Sensing, and Communication
Prereq: Permission of instructor
G (Spring)
2-6-4 H-LEVEL Grad Credit

Focuses on software and algorithms for autonomous decision making (autonomy) by unmanned underwater vehicles operating in ocean environments. Discusses how autonomous marine vehicles (UMVs) adapt to the environment for improved sensing performance. Covers sensors for acoustic, biological and chemical sensing and their integration with the autonomy system for environmentally adaptive underwater mapping and observation. Introduces students to the underwater acoustic communication environment and various options for underwater navigation, highlighting their relevance to the operation of collaborative undersea networks for environmental sensing. Labs involve the use of the MOOP-kp automation software for the development of integrated sensing, modeling and control solutions. Solutions modeled in simulation environments and include field tests with small autonomous surface and underwater vehicles operated on the Charles River. Limited enrollment.
H. Schmidt, J. J. Leonard, M. Benjamin

2.681 Environmental Ocean Acoustics
Prereq: 2.066, 18.075 or Permission of instructor
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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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, WHOI Staff

2.683 Marine Bioacoustics and Geoaoustics
Prereq: 2.681
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 acoustical 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, WHOI Staff

2.684 Wave Scattering by Rough Surfaces and Inhomogeneous Media
Prereq: 2.066 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 electromag-
2.687 Time Series Analysis and System Identification

Prereq: 6.011, 18.06
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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, WHOI 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.

H. Singh, G. Terray, WHOI Staff

2.689| Projects in Oceanographic Engineering

(Same subject as 1.699)
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.

J. C. Preisig, WHOI Staff

2.690 Corrosion in Marine Engineering (New)

Prereq: 3.012, permission of instructor
G (Summer)
3-0-3 H-LEVEL Grad Credit

Introduction to forms of corrosion encountered in marine systems material selection, coatings and protection systems. Case studies and causal analysis developed through student presentations.

J. W. Ketcham, T. W. Eager

NAVAL ARCHITECTURE

2.700 Principles of Naval Architecture

(Same subject with 2.701)
Prereq: 2.002 or 2.02B
G (Fall)
4-2-6

2.701 Principles of Naval Architecture

(Same subject with 2.700)
Prereq: 2.002 or 2.02B
G (Fall)
4-2-6

Introduces principles of naval architecture, ship geometry, hydrostatics, calculation and drawing of curves of form, intact and damage stability, hull structure strength calculations and ship resistance. Introduces computer-aided naval ship design and analysis tools. Projects include analysis of ship lines drawings, calculation of ship hydrostatic characteristics, analysis of intact and damaged stability, ship model testing, and hull structure strength calculations. Students taking graduate version complete additional assignments.

F. S. Hover, A. H. Techet, J. Ketcham, P. D. Sclavounos, M. Thomas

2.702 Systems Engineering and Naval Ship Design

Prereq: 2.701
G (Spring)
3-3-3 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.

J. Ketcham, 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.

J. Ketcham, M. Thomas, F. S. Hover

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, J. Ketcham

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, J. Ketcham

2.707 Submarine Structural Acoustics

Prereq: 2.066
Acad Year 2014–2015: G (Spring; first half of term)
Acad Year 2015–2016: 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, 2.04A, 2.04B, 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, 2.04A, 2.04B, 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

2.715) Optical Microscopy and Spectroscopy for Biology and Medicine
(Subject meets with 20.487J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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

2.717 Optical Engineering
Prereq: 2.710 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

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

2.718 Photonic Materials
(Subject meets with 2.719)
Prereq: 2.003, 8.03, 6.161, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9

2.719 Photonic Materials
(Subject meets with 2.718)
Prereq: 2.003, 8.03, 6.161, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit


G. Barbastathis, N. Fang

DESIGN

2.72 Elements of Mechanical Design
(Subject meets with 2.720)
Prereq: 2.005 or 2.051; 2.008; Coreq: 2.671
U (Spring)
3-3-6

Advanced study of modeling, design, integration, and best practices for use of machine elements, such as bearings, bolts, belts, flexures, and gears. Modeling and analysis is based upon rigorous application of physics, mathematics, and core mechanical engineering principles, which are reinforced via laboratory experiences and a design project in which students model, design, fabricate, and characterize a mechanical system that is relevant to a real-world application. Activities and quizzes are directly related to, and coordinated with, the project deliverables. Develops the ability to synthesize, model and fabricate a design subject to engineering constraints (e.g., cost, time, schedule). Students taking graduate version complete additional assignments. Enrollment limited.

M. L. Culpepper

2.722) D-Lab: Design
(Subject meets with EC.720J)
Prereq: None
U (Fall, Spring)
4-0-5

See description under subject EC.720J.

A. B. Smith, V. Grau-Serrat

2.723) Engineering Innovation and Design
(Subject meets with 6.902J, ESD.051J)
Prereq: None
U (Fall, Spring)
4-0-5

See description under subject ESD.051J.

B. Kotelly

2.737 Mechatronics
Prereq: 6.071 or 6.002; 2.14, 6.302, or 16.30
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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, 15.761, 15.778, 15.810, or permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.735, ESD.40
See description under subject 15.783J.
S. Eppinger, W. P. Seering

2.740 Bio-inspired Robotics (New)
(Same subject as 2.740)
Prereq: 2.004 or permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit
Interdisciplinary approach to bio-inspired design, with emphasis on principle extraction applicable to various robotics research fields, such as robotics, prosthetics, and human assistive technologies. Focuses on three main components: biomechanics, numerical techniques that allow multi-body dynamics simulation with environmental interaction and optimization, and basic robotics techniques and implementation skills. Students integrate the components into a final robotic system project of their choosing through which they must demonstrate their understanding of dynamics and control and test hypothesized design principles. Students taking graduate version complete additional assignments. Enrollment may be limited due to laboratory capacity.
S. Kim

2.744J Product Design
(Same subject as ESD.64J)
Prereq: 2.009
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 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 process, industrial design, visual communication, form-giving, mass production, marketing, and environmentally conscious design.
D. R. Wallace

2.750J Medical Device Design
(Same subject as 6.525J)
(Same subject as 2.750J, 6.025J)
Prereq: 2.72, 6.071, 6.115, or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
2.750J Medical Device Design
(Same subject as 6.525J)
(Same subject as 2.750J, 6.525J)
Prereq: 2.72, 6.071, 6.115, or permission of instructor
U (Fall)
4-0-8
Application of mechanical and electrical engineering fundamentals to the design of medical devices that address clinical needs. Throughout the term, students work in small teams on a major project to translate a clinical challenge into a proof-of-concept prototype device. Students conduct user analysis, develop design specifications, and follow a structured process to cultivate creative designs and apply analytical techniques to optimize them. They deepen their understanding of art and intellectual property by researching prior representations. Develops practical skills in prototyping and testing as well as project management. Includes lectures, problem sets and exams that focus on design fundamentals. Instruction and practice in written and oral communication provided. Students taking graduate version complete additional assignments. Limited enrollment.
A. H. Slocum, C. G. Sodini

2.752 Development of Mechanical Products
(Same subject as 2.752)
Prereq: 2.750, 2.009, or permission of instructor
U (Spring)
3-0-9
2.753 Development of Mechanical Products
(Same subject as 2.753)
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 2.7ThU, 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. Enrollment limited.
A. Slocum

2.76 Global Engineering (New)
Prereq: 2.008 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Combines rigorous engineering theory and user-centered product design to create technologies for developing and emerging markets. Covers machine design theory to parametrically analyze technologies; bottom-up/top-down design processes; engaging stakeholders in the design process; understanding socioeconomic factors that affect adoption of products; and developing/emerging market dynamics and their effect on business and technology. Includes guest speakers who are subject matter experts in relevant fields and case studies on successful and failed technologies. Student teams apply course material to term-long projects to create new technologies, developed in collaboration with industrial partners and other stakeholders in developing/emerging markets.
A. Winter

**BIOENGINEERING**

2.772J Thermodynamics of Biomolecular Systems
(Same subject as 20.110J)
Prereq: Calculus II (GIR), Chemistry (GIR)
U (Fall)
5-0-7 REST
Credit cannot also be received for 7.10, 20.111
See description under subject 20.110J.
L. Griffith, C. Voigt

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, or 2.01 and 2.02A; Chemistry (GIR), Biology (GIR); or permission of instructor  
G (Fall)  
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 and Neurophysiology**  
(Same subject as 6.021J, 20.370J)  
(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.  
J. Han, T. Heldt, J. Voldman

**2.792J Quantitative Systems Physiology**  
(Same subject as 6.022J, 20.371J, 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.  
T. Heldt, R. G. Mark, C. M. Stultz

**2.793J Fields, Forces and Flows in Biological Systems**  
(Same subject as 6.023J, 20.330J)  
Prereq: Physics II (GIR); 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

**2.794J Cellular Biophysics**  
(Same subject as 6.521J, 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 6.521J.  
D. M. Freeman, J. Han, T. Heldt, J. Voldman, M. F. Yanik

**2.795J Fields, Forces and Flows in Biological Systems**  
(Same subject as 6.561J, 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, R. D. Kamm

**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.  
T. Heldt, R. G. Mark, C. M. Stultz

**2.797J 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  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 20.410J.  
R. D. Kamm, K. Van Vliet

**2.799 The Cell as a Machine**  
Prereq: 5.07, 18.03, 7.011, or 7.05  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-3-6 H-LEVEL Grad Credit  
Examines a variety of essential cellular functions from the perspective of the cell as a machine. Includes phenomena such as nuclear organization, protein synthesis, cell and membrane mechanics, cell migration, cell cycle control, cell transformation. Lectures are provided by video twice per week; live 3-hour recitation one evening per week. Course is taken simultaneously by students at multiple universities; homework and take-home exams common to all students. Preference to students in Courses 2 and 20.  
R. Kamm, M. Sheetz, H. Yu

**MANUFACTURING**

**2.810 Manufacturing Processes and Systems**  
Prereq: 2.001, 2.006, 2.008  
G (Fall)  
3-3-6 H-LEVEL Grad Credit  
Introduction to manufacturing processes and manufacturing systems including assembly, machining, injection molding, casting, thermoforming, and more. Emphasis on the physics and randomness and how they influence quality, rate, cost, and flexibility. Attention to the relationship between the process and the system, and the process and part design. Project (in small groups) requires fabrication (and some design) of a product using several different processes (as listed above). Enrollment may be limited due to laboratory constraints.  
T. G. Gutowski
2.813 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. Combines lectures and group discussions of journal articles and selected literature, often with opposing views. Graduate students complete term-long project with report required for graduate credit.
T. G. Gutowski

2.83 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
Introduction to the major dilemma that faces manufacturing and society for the 21st century: how to support economic development while protecting the environment. Subject addresses industrial ecology, materials flows, life-cycle analysis, thermodynamic analysis and exergy accounting, manufacturing process performance, product design analysis, design for the environment, recycling and ecological economics. Combines lectures and group discussions of journal articles and selected literature, often with opposing views. Graduate students complete term-long project with report required for graduate credit.
T. G. Gutowski

2.851 System Optimization and Analysis for Operations
(Prereq: subject meets with 15.066, ESD.750)
Prereq: Calculus II (GIR)
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.066).
V. Farias

2.852 Manufacturing Systems Analysis
Prereq: 6.041 or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: 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
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

2.888 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. Explores opportunities for new ventures in manufacturing. Intended primarily for Master of Engineering in Manufacturing students.
D. E. Hardt, S. B. Gershwin

2.900 Ethics for Engineers
Engineering School-Wide Elective Subject
Prereq: None
U (Fall)
2-0-4
See description under subject 10.01.
D. Doneson, B. L. Trout

2.96 Management in Engineering
Engineering School-Wide Elective Subject
Prereq: None
U (Fall)
3-1-8
See description under subject 10.01.
D. Doneson, B. L. Trout

2.961 Management in Engineering
Engineering School-Wide Elective Subject
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, H. S. Marcus
2.965J Global Supply Chain Management
(Same subject as 1.265J, 15.765J, ESD.265J)
Prereq: 1.260, 1.261, 15.761, 15.778, or permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit
Focuses on the planning, processes, and activities of supply chain management for companies involved in international commerce. Students examine the end-to-end processes and operational challenges in managing global supply chains, such as the basics of global trade, international transportation, duty, taxes, trade finance and hedging, currency issues, outsourcing, cultural differences, risks and security, and green supply chains issues. Highly interactive format features student-led discussions, staged debates, and a mock trial. Includes assignments on case studies and sourcing analysis, as well as projects and a final exam.
B. Arntzen

ADVANCED TOPICS AND SPECIAL SUBJECTS

Check with our Department graduate office prior to the beginning of each term for other proposed listings.

2.980 Head of the Zesiger Cardboard Boat Regatta
Prereq: None
U (IAP)
1-0-2 [P/D/F]
Students work in teams to design and construct a boat from cardboard and paper tape that is able travel 50–100 yards. Topics covered include historical boat design concepts, hydrodynamic and hydrostatic principles, propulsion systems, and maneuverability. Also covers variables that affect boat design, including volume, weight distribution, stability, static trim and heeling angle, and hull shape. Concludes with a final competition in the Zesiger Center Pool. Entry fee. Limited to 40.
F. S. Hover

2.990 Practical Work Experience
Prereq: None
U (Fall, IAP, Spring)
0-1-0 [P/D/F]
Can be repeated for credit
For Mechanical Engineering undergraduates participating in curriculum-related off-campus work experiences in mechanical engineering. Before enrolling, students must have an employment offer from a company or organization and must find a Mech E supervisor. Upon completion of the work the student must submit a detailed design notebook, approved by the MIT supervisor. Subject to departmental approval. Consult Department Undergraduate Office for details on procedures and restrictions.
A. Slocum

2.993, 2.994 Independent Study
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Designed for undergraduates wanting to continue substantial projects of their 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 A. E. Hosoi

2.995 Advanced Topics in Mechanical Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit only for completely different subject matter
Assigned reading and problems or research in distinct areas, either theoretical or experimental, or design. Arranged on individual basis with instructor in the following areas: mechanics and materials, thermal and fluid sciences, systems and design, biomedical engineering, and ocean engineering.
Consult D. Hardt

2.996-2.998 Advanced Topics in Mechanical Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit only for completely different subject matter
Assigned reading and problems or research in distinct areas, either theoretical or experimental, or design. Arranged on individual basis with instructor in the following areas: mechanics and materials, thermal and fluid sciences, systems and design, biomedical engineering, and ocean engineering.
Consult D. Hardt

2.5790–2.5792 Graduate Special Subject in Bioengineering
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit only for completely different subject matter
Advanced lecture, seminar or laboratory course consisting of material in the broadly defined field of bioengineering not offered in regularly scheduled subjects.
Consult R. Kamm

2.597–2.5995 Undergraduate Special Subject in Mechanical Engineering
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit only for completely different subject matter
Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. 2.5972–2.5974 and 2.5992 are graded P/D/F.
Consult A. E. Hosoi

2.5981–2.5999 Graduate Special Subject in Mechanical Engineering
Prereq: Permission of instructor
G (Fall, IAP, Spring; second half of term)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit only for completely different subject matter
Advanced lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects. 2.5980 and 2.5996 are graded P/D/F.
Consult D. Hardt

THESIS, RESEARCH, AND PRACTICE

2.978 Instruction in Teaching Engineering
(Subject meets with 1.95J, 5.95J, 6.982J, 7.59J, 8.395J, 18.094J)
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
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

For students participating in departmentally approved undergraduate teaching programs. Students assist faculty in the design and execution of the curriculum and actively participate in the instruction and monitoring of the class participants. Students prepare subject materials, lead discussion groups, and review progress. Credit is arranged on a subject-by-subject basis and is reviewed by the department.

A. E. Hosoi

2.999 Engineer’s Degree Thesis Proposal Preparation
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged 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 Engineering Practice Experience
Engineering School-Wide Elective Subject
(Offered 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)
0-0-1 [P/D/F]

Provides sophomores with guided practice in finding opportunities and excelling in the world of practice. Building on the skills and relationships acquired in the Engineering Practice Workshop, students receive coaching to articulate goals, involve the UPOP network of mentors and employers, identify and pursue opportunities, and negotiate terms of their summer assignment. Students complete a 10-12 week internship, which includes filing three progress reports, conducting one informational interview, and possibly hosting a site visit by MIT staff. Returning to campus as juniors, UPOP students take part in reflective exercises that aid assimilation of learning objectives and reinforce the cognitive link between all aspects of the UPOP experience and disciplinary fields of study. Sequence begins in the spring of sophomore year and ends in the fall of junior year.

Staff

2.999 Engineer’s Degree Thesis Proposal Preparation
Prereq: None
U (Fall, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

2.UR Undergraduate Research in Mechanical Engineering
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Individual study, research, or laboratory investigations under faculty supervision, including individual participation in an ongoing research project. See projects listing in Undergraduate Office, 1-110, for guidance.

Consult D. Rowell
Bachelor of Science in Mechanical Engineering/Course 2

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 2.001 and 18.03 in the Departmental Program] 2
Laboratory Requirement [can be satisfied by 2.671 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) [satisfied by 2.009 and 2.671 in the Departmental Program].

PLUS Departmental Program

Required Departmental Core Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.001</td>
<td>Mechanics and Materials I, 12, REST; Physics I (GIR), Calculus II (GIR), 18.03*</td>
<td>12</td>
<td>2.001, Chemistry (GIR)</td>
</tr>
<tr>
<td>2.002</td>
<td>Mechanics and Materials II, 12, 2.001*, Chemistry (GIR)</td>
<td>12</td>
<td>2.001, Physics I (GIR)*</td>
</tr>
<tr>
<td>2.003J</td>
<td>Dynamics and Control I, 12, REST; Physics I (GIR)<em>, 2.086</em></td>
<td>12</td>
<td>2.003, Physics II (GIR)</td>
</tr>
<tr>
<td>2.004</td>
<td>Dynamics and Control II, 12, 2.003*, Physics II (GIR)</td>
<td>12</td>
<td>2.086, Physics II (GIR)<em>, 2.005</em></td>
</tr>
<tr>
<td>2.005</td>
<td>Thermal-Fluids Engineering I, 12, 2.086*, Physics II (GIR), Calculus II (GIR)*, 2.006</td>
<td>12</td>
<td>2.005, Thermal-Fluids Engineering II, 2.005*</td>
</tr>
<tr>
<td>2.008</td>
<td>Design and Manufacturing II, 12, 1/2 LAB; 2.007 or 2.017*, 2.005*</td>
<td>12</td>
<td>2.008, The Product Engineering Process, 12, CI-M; 2.001*, 2.003J*, 2.005*, 2.008</td>
</tr>
<tr>
<td>2.009</td>
<td>The Product Engineering Process, 12, CI-M; 2.001*, 2.003J*, 2.005*, 2.008*</td>
<td>12</td>
<td>2.009, Measurement and Instrumentation, 12, LAB, CI-M; 2.001*, 2.003J*, Physics II (GIR)</td>
</tr>
<tr>
<td>2.016</td>
<td>Fluid Mechanics, 12</td>
<td>12</td>
<td>2.001, Physics II (GIR)</td>
</tr>
<tr>
<td>2.019</td>
<td>Design of Ocean Systems, 12, CI-M; 2.001, 2.003J, 2.005*; senior standing or permission of instructor</td>
<td>12</td>
<td>2.019, Hydrodynamics, 12; Physics II (GIR), 18.03</td>
</tr>
<tr>
<td>2.020</td>
<td>Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J*, 2.005*, 2.671</td>
<td>12</td>
<td>2.020, Analysis and Design of Feedback Control Systems, 12, 2.004*</td>
</tr>
<tr>
<td>2.021J</td>
<td>Project Laboratory, 6, 1/2 LAB; 2.001, 2.003J, 2.006, 2.671</td>
<td>6</td>
<td>2.021, Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J*, 2.005*, 2.671</td>
</tr>
<tr>
<td>2.027</td>
<td>Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J*, 2.005*, 2.671</td>
<td>12</td>
<td>2.027, Design of Ocean Systems, 12, CI-M; 2.001, 2.003J, 2.005*; senior standing or permission of instructor</td>
</tr>
<tr>
<td>2.050</td>
<td>Nonlinear Dynamics I: Chaos, 12; 18.03*, Physics II (GIR)</td>
<td>12</td>
<td>2.050, Nonlinear Dynamics II: Chaos, 12; 2.003J*, 2.005*, 2.671</td>
</tr>
<tr>
<td>2.052</td>
<td>Computer Methods in Dynamics, 12; 2.001, 2.003J</td>
<td>12</td>
<td>2.052, Analysis and Design of Feedback Control Systems, 12, 2.004*</td>
</tr>
<tr>
<td>2.053</td>
<td>Introduction to Robotics, 12, 2.004*</td>
<td>12</td>
<td>2.053, Analysis and Design of Feedback Control Systems, 12, 2.004*</td>
</tr>
<tr>
<td>2.061</td>
<td>Introduction to Robotic Systems, 12, 2.004*</td>
<td>12</td>
<td>2.061, Introduction to Robotic Systems, 12, 2.004*</td>
</tr>
<tr>
<td>2.062</td>
<td>Analysis and Design of Feedback Control Systems, 12, 2.004*</td>
<td>12</td>
<td>2.062, Analysis and Design of Feedback Control Systems, 12, 2.004*</td>
</tr>
<tr>
<td>2.184</td>
<td>Biomechanics and Neural Control of Movement, 12, 2.004*</td>
<td>12</td>
<td>2.184, Biomechanics and Neural Control of Movement, 12, 2.004*</td>
</tr>
<tr>
<td>2.190</td>
<td>Molecular Mechanics, 12, 2.001*, Chemistry (GIR)</td>
<td>12</td>
<td>2.190, Molecular Mechanics, 12, 2.001*, Chemistry (GIR)</td>
</tr>
<tr>
<td>2.250</td>
<td>Intermediate Heat and Mass Transfer, 12, 2.006*</td>
<td>12</td>
<td>2.250, Intermediate Heat and Mass Transfer, 12, 2.006*</td>
</tr>
<tr>
<td>2.370</td>
<td>Introduction to Sustainable Energy, 12; permission of instructor</td>
<td>12</td>
<td>2.370, Introduction to Sustainable Energy, 12; permission of instructor</td>
</tr>
<tr>
<td>2.371</td>
<td>Optics, 12; Physics II (GIR), 18.03, 2.004*</td>
<td>12</td>
<td>2.371, Optics, 12; Physics II (GIR), 18.03, 2.004*</td>
</tr>
<tr>
<td>2.372</td>
<td>Elements of Mechanical Design, 12; 2.007*, 2.008, 2.671</td>
<td>12</td>
<td>2.372, Elements of Mechanical Design, 12; 2.007*, 2.008, 2.671</td>
</tr>
<tr>
<td>2.373</td>
<td>Molecular, Cellular, and Tissue Biomechanics, 12; 2.370*, 18.03*, Biology (GIR)</td>
<td>12</td>
<td>2.373, Elements of Mechanical Design, 12; 2.007*, 2.008, 2.671</td>
</tr>
<tr>
<td>2.375</td>
<td>Energy, Materials, and Manufacturing, 12; 2.008*</td>
<td>12</td>
<td>2.375, Energy, Materials, and Manufacturing, 12; 2.008*</td>
</tr>
<tr>
<td>2.396</td>
<td>Management in Engineering, 12</td>
<td>12</td>
<td>2.396, Management in Engineering, 12</td>
</tr>
</tbody>
</table>

Departmental Program Units That Also Satisfy the GIRs (36)

Restricted Electives 24

Unrestricted Electives 48

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 may fulfill this requirement by completing an alternative Course 2 CI-M subject (e.g., 2.013 or 2.750). No substitutions are allowed for 2.671.

(2) Consult the MechE Undergraduate Office, Room 1-110, regarding substitutions.

(3) To encourage more substantial research, design, or independent study, the department permits up to 15 units of 2.711 credit, subject to approval of the student’s thesis advisor.

(4) The department suggests that students elect a basic electronics subject (e.g., 2.678, 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)

<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 2.086 in the Departmental Core Subjects and one subject in the Elective Subjects with Engineering Content]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [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 2.009 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>2.00 Introduction to Design, 6*</td>
<td></td>
</tr>
<tr>
<td>2.01 Elements of Structures, 6; Physics I (GIR), 2.087</td>
<td></td>
</tr>
<tr>
<td>2.086 Numerical Computation for Mechanical Engineers, 12, REST; Physics I (GIR), Calculus II (GIR), 2.087*</td>
<td></td>
</tr>
<tr>
<td>2.087 Engineering Mathematics: Linear Algebra and ODEs, 6; Physics I (GIR), Calculus I (GIR)</td>
<td></td>
</tr>
<tr>
<td>2.09 Dynamics, 6; 2.086</td>
<td></td>
</tr>
<tr>
<td>2.05 Thermodynamics, 6; 2.01</td>
<td></td>
</tr>
<tr>
<td>2.051 Introduction to Heat Transfer, 6; 2.05</td>
<td></td>
</tr>
<tr>
<td>2.06 Fluid Dynamics, 6; 2.01</td>
<td></td>
</tr>
<tr>
<td>2.678 Electronics for Mechanical Systems, 6; Physics II (GIR)</td>
<td></td>
</tr>
</tbody>
</table>

#### Second-Level Subjects (36 units)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.009 The Product Engineering Process, 12, CI-M; 2.01*, 2.03*, 2.05*, 2.678*; senior standing or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>2.671 Measurement and Instrumentation, 12, LAB, CI-M; 2.01*, 2.03*, Physics II (GIR)</td>
<td></td>
</tr>
<tr>
<td>2.02A Mechanics of Materials: Properties and Applications, 6; 2.01 or 2.02B Mechanics of Structures, 6; 2.01</td>
<td></td>
</tr>
<tr>
<td>2.04A Systems and Controls, 6; 2.03 or 2.04B Introduction to Mechanical Vibration, 6; 2.03</td>
<td></td>
</tr>
</tbody>
</table>

#### Elective Subjects with Engineering Content

(Must include one REST subject outside Course 2.)

#### Departmental Program Units That Also Satisfy the GIRs

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.
* Students may also fulfill this requirement by completing an alternative 2.00X subject, i.e., 2.00B.
* These electives define a concentrated area of study and must be chosen with the written approval of the MechE Undergraduate Office. The 72 units of concentration electives must be engineering topics. Concentration electives must include one subject that meets the REST GIR, but not subjects that fulfill a HASS GIR. 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 obvious.

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 Mechanical and Ocean Engineering/Course 2-OE

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>[can be satisfied by 2.001 and 18.03 in the Departmental Program]</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>[can be satisfied by 2.671 in the Departmental Program]</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) [satisfied by 2.019 and 2.671 in the Departmental Program].

PLUS Departmental Program  

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Departmental Subjects</strong></td>
<td>159</td>
</tr>
<tr>
<td>2.001 Mechanics and Materials I, 12, REST; Physics I (GIR), 18.03*</td>
<td></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)<em>, 2.086</em></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; 2.086*, Physics II (GIR), Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>2.016 Hydrodynamics, 12; Physics II (GIR), 18.03</td>
<td></td>
</tr>
<tr>
<td>2.017 Design of Electromechanical Robotic Systems, 12, 1/2 LAB; 2.003J*, 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*; senior standing or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>2.065 Acoustics and Sensing, 12; 2.003J*</td>
<td></td>
</tr>
<tr>
<td>2.086 Numerical Computation for Mechanical Engineers, 12; Physics I (GIR), Calculus II (GIR), 18.03*</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*, 2.003*, Physics II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Elective</strong></td>
<td>12</td>
</tr>
<tr>
<td>Students are required to take one of the following elective subjects (substitutions by petition to the MechE Undergraduate Office):</td>
<td></td>
</tr>
<tr>
<td>2.006 Thermal Fluids Engineering II, 12; 2.001*</td>
<td></td>
</tr>
<tr>
<td>2.007 Design and Manufacturing I, 12; 2.001*, 2.086</td>
<td></td>
</tr>
<tr>
<td>2.008 Design and Manufacturing II, 12, 1/2 LAB; 2.007 or 2.017; 2.005*</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; 2.004*</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>2.60J Fundamentals of Advanced Energy Conversion, 12; 2.006*</td>
<td></td>
</tr>
<tr>
<td>2.700 Principles of Naval Architecture, 12; 2.002*</td>
<td></td>
</tr>
<tr>
<td>2.72 Elements of Mechanical Design, 12; 2.005*, 2.008, 2.671</td>
<td></td>
</tr>
<tr>
<td>2.76 Management in Engineering, 12</td>
<td></td>
</tr>
<tr>
<td>2ThU Undergraduate Thesis, 12</td>
<td></td>
</tr>
<tr>
<td><strong>Departmental Program Units That Also Satisfy the GIRs</strong></td>
<td>(36)</td>
</tr>
<tr>
<td><strong>Unrestricted Electives</strong></td>
<td>48</td>
</tr>
<tr>
<td><strong>Total Units Beyond the GIRs Required for SB Degree</strong></td>
<td>183</td>
</tr>
</tbody>
</table>

Notes  
* Alternate prerequisites and corequisites are listed in the subject description.  
(1) Consult the MechE Undergraduate Office, Room 1-110, regarding substitutions.  
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule,  
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

3.004 Principles of Engineering Practice
(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.
C. Schuh, 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. Kimerling, D. Sadoway

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 problemsolving 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, 3.021, 10.333, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Fall)
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, M. J. Demkowicz

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.
Y. Chiang, G. Beach, J. Hu
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. Beicher, L. Gibson, M. F. Rubner  
P. Anikeeva, G. Beach, J. Hu  

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.  
L. Gibson  

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. Topics include 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 narroreactors; chemical degradation of soft materials through readdition, hydrolysis, and thermolysis; electroactive organic materials. Firsthand application of lecture topics through design-oriented experiments.  
M. Tarkanian  

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  
W. C. Carter  

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  

3.038, 3.039, 3.04 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  

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.  
M. Tarkanian  

3.044 Materials Processing  
Prereq: 3.012, 3.022  
U (Spring)  
4-0-8  
Credit cannot also be received for 3.044  
Introduction to materials processing science, with emphasis on heat transfer, chemical diffusion, and fluid flow. Uses an engineering approach to analyze industrial-scale processes, with the goal of identifying and understanding physical limitations on scale and speed. Covers materials of all classes, including metals, polymers, electronic materials, and ceramics. Considers specific processes, such as melt-processing of metals and polymers, deposition technologies (liquid, vapor, and vacuum), colloid and slurry processing, viscous shape forming, and powder consolidation.  
E. Olivetti  

3.046 Thermodynamics of Materials  
Prereq: 18.03, 18.034, or 3.016  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Spring)  
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 multi-phase 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 2014–2015: Not offered  
Acad Year 2015–2016: 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
3.052 Nanomechanics of Materials and Biomaterials
Prereq: 3.032 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

Staff

3.053J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 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 20.310).
R. D. Kamm, A. J. Grodzinsky, K. Van Vliet

3.054 Cellular Solids: Structure, Properties, Applications
(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
(Same subject as 20.363J)
(Subject meets with 3.963J, 20.463J)
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
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.

N. Holten-Andersen

3.07 Introduction to Ceramics
Prereq: 3.012
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

E. Fitzgerald

3.074 Imaging of Materials
(Subject meets with 3.34)
Prereq: 3.024, 3.073, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9

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.

S. Gradeck
3.080 Economic and Environmental Materials Selection
Prereq: 3.012, 3.014, or permission of instructor
U (Spring)
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.
R. Kirchain

3.081 Industrial Ecology of Materials (New)
Prereq: 3.012, 3.014, 3.022, 3.024, or permission of instructor
U (Fall)
3-0-9
Covers quantitative techniques to address principles of substitution, dematerialization and waste mining implementation in materials systems. Includes life-cycle and materials flow analysis of the impacts of materials extraction; processing; use; and recycling for materials, products, and services. Student teams undertake a case study regarding materials and technology selection using the latest methods of analysis and computer-based models of materials process.
E. Olivetti

3.086 Innovation and Commercialization of Materials Technology
(Subject meets with 3.207)
Prereq: None
U (Spring)
4-0-8
Credit cannot also be received for 3.5086
Covers the fundamental process of innovation through its implications on organizations and innovation ecosystems. Emphasizes historical and modern examples of innovation in materials and devices. Discusses the final implications for innovation ecosystems.
E. Fitzgerald

3.091 Introduction to Solid-State Chemistry
(Subject meets with ES.3091)
Prereq: None
U (Fall, Spring)
5-0-7 CHEMISTRY
Credit cannot also be received for 5.111, 5.112, CC.5111, ES.5111, ES.5112
Basic principles of chemistry and their application to engineering systems. The relationship between electronic structure, chemical bonding, and atomic order. Characterization of atomic arrangements in crystalline and amorphous solids: metals, ceramics, semiconductors, and polymers (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: N. Holten-Andersen, D. Paul

3.094 Materials in Human Experience
Prereq: None
U (Spring)
2-3-4 HASS-S
Examines the ways in which people in ancient and contemporary societies have selected, evaluated, and used materials of nature, transforming them to objects of material culture. Some examples: 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.
H. Lechtman, D. Hosler

3.14 Physical Metallurgy
(Subject meets with 3.40, 22.71j)
Prereq: 3.022, 3.032
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.
J. Li

3.15 Electrical, Optical, and Magnetic Materials and Devices
Prereq: 3.024
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
4-0-8
Credit cannot also be received for 3.515
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

3.152 Magnetic Materials
(Subject meets with 3.45)
Prereq: 3.024
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9
Topics include origin of magnetism in materials, magnetic domains and domain walls, magnetostatics, magnetic anisotropy, antiferro- and ferrimagnetism, magnetism in thin films and nanoparticles, magnetotransport phenomena, and magnetic characterization. Discusses a range of applications, including magnetic recording, spin-valves, and tunnel-junction sensors. Assignments include problem sets and a term paper on a magnetic device or technology. Students taking graduate version complete additional assignments.
C. Ross

3.153 Nanoscale Materials
Prereq: 3.024
U (Spring)
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
3.154 J Materials Performance in Extreme Environments
(Same subject as 22.054J)
Prereq: 3.032, 3.044
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-2-7
Studies the behavior of materials in extreme environments typical of those in which advanced energy systems (including fossil, nuclear, solar, fuel cells, and battery) operate. Takes both a science and engineering approach to understanding how current materials interact with their environment under extreme conditions. Explores the role of modeling and simulation in understanding material behavior and the design of new materials. Focuses on energy and transportation-related systems.

R. Ballinger

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

3.156 Photonic Materials and Devices
(Subsect meets with 3.46)
Prereq: 3.016 or 18.03; 3.024
U (Fall)
3-0-9

P. Anikeeva

3.5171 Special Subject: Processing and Properties of Structural Materials (New)
(Subject meets with 2.821J, 3.371J)
Prereq: 3.012, 3.014
U (Fall, Spring; partial term)
2-0-10
Can be repeated for credit
Experimental subject that combines online and in-person lectures to discuss materials selection and design using structural materials, casting, deformation processes, welding and joining, non-destructive testing, codes, standards, and life assessment. Presented in modules; repeatable for credit one time with permission of instructor. To be proposed for permanent status as an undergraduate version of 3.371 in 2015–2016.

T. Eagar, A. Slocum

3.19 Sustainable Chemical Metallurgy
Prereq: 3.012, 3.022
U (Spring)
3-0-9
Covers principles of extractive metallurgy processes design. Provides a direct application of the fundamentals of thermodynamics and kinetics to the industrial production of metals from their ores, e.g. iron, aluminum, or reactive metals and silicon. Discusses the corresponding economics and global challenges. Addresses advanced techniques for sustainable metal extraction, particularly with respect to greenhouse gas emissions.

A. Allanore

3.20 Materials at Equilibrium
Prereq: 3.012, 3.014, 3.022, 3.024, 3.034, and 3.042; or permission of instructor
G (Fall)
5-0-10 H-LEVEL Grad Credit

A. Allanore

3.207 Innovation and Commercialization
(Subject meets with 3.086)
Prereq: None
G (Spring)
4-0-8
Credit cannot also be received for 3.5086
Explores in depth projects on a particular materials-based technology. Investigates the science and technology of materials advances and their strategic value, explore potential applications for fundamental advances, and determine intellectual property related to the materials technology and applications. Students map progress with presentations, and are expected to create an end-of-term document enveloping technology, intellectual property, applications, and potential commercialization. Lectures cover aspects of technology, innovation, entrepreneurship, intellectual property, and commercialization of fundamental technologies.

E. 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 atomic 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.

C. Thompson

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
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 variation 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

3.30 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


J. Grossman

3.32 Fracture and Fatigue
Prereq: 3.032, 3.22
Acad Year 2014-2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit


M. Dao

3.33 Cellular Solids: Structure, Properties, Applications
(Subject meets with 3.054)
Prereq: 3.032 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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.

J. Li

3.34 Imaging of Materials
(Subject meets with 3.074)
Prereq: 3.23 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

Focuses on atomic defects in solids and magnetic permeability in metals, semiconductors, and insulators. Survey of common devices such as transistors, magnetic storage media, optical fibers.

L. Gibson

3.35 Imaging of Materials
(Subject meets with 3.074)
Prereq: 3.23 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit


L. Gibson

3.36 Fracture and Fatigue
Prereq: 3.032, 3.03
G (Fall)
3-0-9 H-LEVEL Grad Credit


M. Dao

3.37 Fracture and Fatigue
Prereq: 3.032, 3.03
G (Fall)
3-0-9 H-LEVEL Grad Credit


L. Gibson

3.38 Imaging of Materials
(Subject meets with 3.074)
Prereq: 3.23 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit


L. Gibson

3.39 Imaging of Materials
(Subject meets with 3.074)
Prereq: 3.23 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit


L. Gibson

3.40 Modern Physical Metallurgy
(Subject meets with 22.71J)
Prereq: 3.371J Materials Manufacturing
G (Summer, Fall, Spring)
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.

J. Li
3.41 Colloids, Surfaces, Absorption, Capillarity, and Wetting Phenomena
Prereq: 3.20, 3.21
G (Spring)
3-0-9
Integrates elements of physics and chemistry toward the study of material surfaces. Begins with classical colloid phenomena and the interaction between surfaces in different media. Discusses the mechanisms of surface charge generation as well as how dispersion forces are created and controlled. Continues with exploration of chemical absorption processes and surface design of inorganic and organic materials. Includes examples in which such surface design can be used to control critical properties of materials in applications. Addresses last how liquids interact with solids as viewed by capillarity and wetting phenomena. Studies how materials are used in processes and applications that are intended to control liquids, and how the surface chemistry and structure of those materials makes such applications possible.
M. Cima

3.42 Electronic Materials Design
Prereq: 3.23
G (Fall)
3-0-9 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

3.43 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.
D. A. Antoniadis, 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. Ross

3.45 Magnetic Materials
(Same subject as 3.152)
Prereq: 3.23
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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
(Same subject as 3.156)
Prereq: 3.23
G (Fall)
3-0-9 H-LEVEL Grad Credit
P. Anikeeva

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

3.54 Corrosion: The Environmental Degradation of Materials
(Same subject as 22.72J)
Prereq: 3.012
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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

3.57 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
(Same subject as 3.072)
Prereq: 3.016 or 18.03
G (Fall)
4-0-8 H-LEVEL Grad Credit
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.

E. Fitzgerald

3.65 Experimental Mechanics of Soft Condensed Matter
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-4-5
Focuses on the design and execution of advanced experiments to quantify the mechanical behavior of extremely compliant, soft, and/or adhesive materials. These include engineered and natural polymers, cells and tissues, biological composites, and nanocomposites that may exist in bulk, thin-film, or individual fibers. First half of the term includes interactive lectures, demonstrations, and lab practicum sessions in which students gain experience in key experimental aspects of mechanical analysis via instrumented indentation, atomic force microscopy, and other advanced tools. Second half is project-based, where students work in small teams to put class topics in the context of thesis-related research. Includes group lab work, experimental design, and reporting online. Limited to 12.

K. J. Van Vliet

3.69 Teaching Fellows Seminar
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
2-0-1
Can be repeated for credit
Provides instruction to help prepare students for teaching at an advanced level and for industry or academic career paths. Topics include preparing a syllabus, selecting a textbook, scheduling assignments and examinations, lecture preparation, “chalk and talk” vs. electronic presentations, academic honesty and discipline, preparation of examinations, grading practices, working with teaching assistants, working with colleagues, mentoring outside the classroom, pursuing academic positions, teaching through technical talks, and successful grant writing strategies.

Staff

3.691 Teaching Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, Spring)
0-1-0 [P/D/F]
Can be repeated for credit
Provides classroom or laboratory teaching experience under the supervision of faculty member(s). Students assist faculty by preparing instructional materials, leading discussion groups, and monitoring students’ progress. Limited to Course 3 undergraduates selected by Teaching Assignments Committee.

G. Beach

3.692 Teaching Materials Science and Engineering
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Provides classroom or laboratory teaching experience under the supervision of faculty member(s). Students assist faculty by preparing instructional materials, leading discussion groups, and monitoring students’ progress. Credit arranged on a case-by-case basis and reviewed by the department. Limited to Course 3 undergraduates selected by Teaching Assignments Committee.

G. Beach

3.693–3.699 Teaching Materials Science and Engineering
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
Units arranged
Can be repeated for credit
Laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview. Enrollment limited by availability of suitable teaching assignments.

D. Sadoway

3.70 Materials Science and Engineering of Clean Energy
Prereq: 3.20, 3.23, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Develops the materials principles, limitations and challenges in clean energy technologies, including solar, energy storage, thermoelectrics, fuel cells, and novel fuels. Correlations drawn between the limitations and challenges related to key figures of merit and the basic underlying thermodynamic, structural, transport, and physical principles, in addition to the means for fabricating devices exhibiting optimum operating efficiencies and extended life at reasonable cost.

J. Grossman, H. Tuller

3.903J 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.

A. Alexander-Katz, B. Olsen, D. Irvine

3.91 Mechanical Behavior of Polymers
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 Internship Program
Prereq: None
U (Summer)
0-6-0 [P/D/F]
Provides academic credit for first approved materials science and engineering internship. For reporting requirements, consult the faculty internship program coordinator. Limited to Course 3 internship track majors.

T. Eagar

3.931 Internship Program
Prereq: 3.930
U (Summer)
0-6-0
Provides academic credit for second approved materials science and engineering internship in the year following completion of 3.930. For reporting requirements consult the faculty internship program coordinator. Limited to Course 3 internship track majors.

T. Eagar
3.932 Industrial Practice
Prereq: Permission of instructor
G (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.
D. Sadoway

3.94 Morphology of Polymers
Prereq: 3.063
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 10.668J.
G. C. Rutledge, A. Alexander-Katz

3.963J Biomaterials Science and Engineering
(Same subject as 20.463J)
(Subject meets with 3.055J, 20.363J)
Prereq: 3.03A, 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

3.961J 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

3.96J 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 20.441J.
I. V. Yannas, M. Spector

3.97J Cell-Matrix Mechanics
(Same subject as 2.785J, 20.411J, HST.523J)
Prereq: 2.001, or 2.01 and 2.02A; Chemistry (GIR), Biology (GIR); or permission of instructor
G (Fall)
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
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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

3.982 The Ancient Andean World
Prereq: None
U (Fall)
3-0-6 HASS-S
Examines development of Andean civilization which culminated in the extraordinary empire established by the Inka. Archaeological, ethnographic, and ethnohistorical approaches. Particular attention to the unusual topography of the Andean area, its influence upon local ecology, and the characteristic social, political, and technological responses of Andean people to life in a topographically "vertical" world. Characteristic cultural styles of prehistoric Andean life.
H. Lechtman

3.983 Ancient Mesoamerican Civilization
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-6 HASS-S
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
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.
H. Lechtman, J. Meanwell

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
Pressing issues in archaeology as an anthropological science. Stresses the natural science and engineering methods archaeologists use to address these issues. Reconstructing time, space, and human ecologies provides one focus;
materials technologies that transform natural materials to material culture provide another. Topics include 14C dating, ice core and palynological analysis, GIS and other remote sensing techniques for site location, soil micromorphology and site formation, sourcing of metal artifacts, and microstructural and mechanical analyses of cementitious materials used in ancient monumental buildings. 
H. Lechtman

3.986 The Human Past: Introduction to Archaeology
Prereq: None
U (Fall)
3-0-9 HASS-S; 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 Andes and Mesoamerica. Exposes students to various classes of archaeological data, such as stone, bone, and ceramics, that help reconstruct the past.
K. Grossman

3.987 Human Evolution: Data from Palaeontology, Archaeology, and Materials Science
Prereq: None
U (Spring)
3-6-3 HASS-S
Examines human physical and cultural evolution over the past five million years via lectures and labs that incorporate data from human palaeontology, archaeology, and materials science. Topics include the evolution of hominin morphology and adaptations; the nature and structure of bone and its importance in human evolution; and the fossil and archaeological evidence for human behavioral and cultural evolution, from earliest times through the Pleistocene. Laboratory sessions include study of stone technology, artifacts, and fossil specimens.
H. V. Merrick

3.989 Materials in Ancient Societies: Ceramics Laboratory
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-6-3
Laboratory analysis of archaeological artifacts of ceramics. Follows on 3.984.
H. Lechtman, D. Hosler

3.990 Seminar in Archaeological Method and Theory
Prereq: 3.985, 3.986, 21A.00
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 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-6 HASS-S
Focus on the rise of settled communities, cities, and empires and the 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.
H. Lechtman

3.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 22.EPE)
Prereq: 2.EPE or permission of instructor
U (Fall, Spring)
0-0-1 [P/D/F]
See description under subject 2.EPE.
Staff

3.S02–3.S05 Special Subject in Materials Science and Engineering (New)
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit only for completely different subject matter

3.S06–3.S09 Special Subject in Materials Science and Engineering (New)
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit only for completely different subject matter

3.S70–3.S75 Special Subject in Materials Science and Engineering (New)
Prereq: Permission of instructor
Lecture, seminar, or laboratory consisting of material not offered in regularly scheduled subjects.
Staff

3.S70–3.S75 Special Subject in Materials Science and Engineering
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
Bachelor of Science in Materials Science and Engineering/Course 3

General Institute Requirements (GIRs)  
<table>
<thead>
<tr>
<th>Subjects</th>
<th>(Units)</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><a href="#">can be satisfied by 3.012 and 3.021</a> in the Departmental Program</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td><a href="#">can be satisfied by 3.014 in the Departmental Program</a></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).  

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.012 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*(2)</td>
<td>128–138</td>
</tr>
<tr>
<td>3.014 Materials Laboratory, 12, LAB, CI-M</td>
<td></td>
</tr>
<tr>
<td>One of the following three subjects:</td>
<td></td>
</tr>
<tr>
<td>3.016 Mathematical Methods for Materials Scientists and Engineers, 12; Calculus II (GIR)(3)</td>
<td></td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>One of the following four subjects:</td>
<td></td>
</tr>
<tr>
<td>3.022 Introduction to Modeling and Simulation, 12, REST; 18.03*(2)</td>
<td></td>
</tr>
<tr>
<td>3.046 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
<td></td>
</tr>
<tr>
<td>6.01 Introduction to EECS I, 12, 1/2 LAB; Physics II (GIR)</td>
<td></td>
</tr>
<tr>
<td>3.016 Mathematical Methods for Materials Scientists and Engineers, 12; Calculus II (GIR)(3)</td>
<td></td>
</tr>
<tr>
<td>3.022 Microstructural Evolution in Materials, 12; 3.012</td>
<td></td>
</tr>
<tr>
<td>3.024 Electronic, Optical, and Magnetic Properties of Materials, 12; 3.012</td>
<td></td>
</tr>
<tr>
<td>3.032 Mechanical Behavior of Materials, 12; Physics I (GIR), 3.016*</td>
<td></td>
</tr>
<tr>
<td>3.034 Organic and Biomaterials Chemistry, 12; 3.012</td>
<td></td>
</tr>
<tr>
<td>3.042 Materials Project Laboratory, 12, CI-M; 3.014*</td>
<td></td>
</tr>
<tr>
<td>3.044 Materials Processing, 12; 3.012, 3.022</td>
<td></td>
</tr>
<tr>
<td>3.THU Thesis, 9**(4) or</td>
<td></td>
</tr>
<tr>
<td>3.930 Internship Program, 6 plus</td>
<td></td>
</tr>
<tr>
<td>3.931 Internship Program, 6</td>
<td></td>
</tr>
</tbody>
</table>

**Restricted Electives**(5)  
<table>
<thead>
<tr>
<th>Subjects</th>
<th>(Units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.004 Principles of Engineering Practice, 12; Physics I (GIR), Calculus I (GIR)</td>
<td>48</td>
</tr>
<tr>
<td>3.016 Mathematical Methods for Materials Scientists and Engineers, 12; Calculus II (GIR)(3)</td>
<td></td>
</tr>
<tr>
<td>3.023 Introduction to Modeling and Simulation, 12, REST; 18.03*(2)</td>
<td></td>
</tr>
<tr>
<td>3.046 Thermodynamics of Materials, 12, REST; 18.03*</td>
<td></td>
</tr>
<tr>
<td>3.048 Advanced Materials Processing, 12; 3.022, 3.044</td>
<td></td>
</tr>
<tr>
<td>3.052 Nanomechanics of Materials and Biomaterials, 12; 3.012*</td>
<td></td>
</tr>
<tr>
<td>3.053 Molecular, Cellular, and Tissue Biomechanics, 12; 18.03*, Biology I (GIR), 2.370*</td>
<td></td>
</tr>
<tr>
<td>3.054 Cellular Solids: Structure, Properties, Applications, 12; 3.032</td>
<td></td>
</tr>
<tr>
<td>3.055 Biomaterials Science and Engineering, 12; 3.014*</td>
<td></td>
</tr>
<tr>
<td>3.063 Polymer Physics, 12; 3.012</td>
<td></td>
</tr>
<tr>
<td>3.064 Polymer Engineering, 12; 3.032, 3.044</td>
<td></td>
</tr>
<tr>
<td>3.07 Introduction to Ceramics, 12; 3.012</td>
<td></td>
</tr>
<tr>
<td>3.072 Symmetry, Structure, and Tensor Properties of Materials, 12; 3.016*</td>
<td></td>
</tr>
<tr>
<td>3.074 Imaging of Materials, 12; 3.024*</td>
<td></td>
</tr>
<tr>
<td>3.08 Economic and Environmental Materials Selection, 12; 3.012*</td>
<td></td>
</tr>
<tr>
<td>3.14 Physical Metallurgy, 12; 3.012, 3.022, 3.032</td>
<td></td>
</tr>
<tr>
<td>3.25 Electrical, Optical, and Magnetic Materials and Devices, 12; 3.024</td>
<td></td>
</tr>
<tr>
<td>3.255 Nanoscale Materials, 12; 3.024</td>
<td></td>
</tr>
<tr>
<td>3.354 Materials Performance in Extreme Environments, 12; 3.032, 3.044</td>
<td></td>
</tr>
<tr>
<td>3.355 Micro/Nano Processing Technology, 12, CI-M; permission of instructor</td>
<td></td>
</tr>
</tbody>
</table>

**Departmental Program Units That Also Satisfy the GIRs**  
<table>
<thead>
<tr>
<th>Unrestricted Electives</th>
<th>(99)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.046 Introduction to Ceramics, 12; 3.012</td>
<td></td>
</tr>
<tr>
<td>3.072 Symmetry, Structure, and Tensor Properties of Materials, 12; 3.016*</td>
<td></td>
</tr>
<tr>
<td>3.074 Imaging of Materials, 12; 3.024*</td>
<td></td>
</tr>
<tr>
<td>3.08 Economic and Environmental Materials Selection, 12; 3.012*</td>
<td></td>
</tr>
<tr>
<td>3.14 Physical Metallurgy, 12; 3.012, 3.022, 3.032</td>
<td></td>
</tr>
<tr>
<td>3.355 Micro/Nano Processing Technology, 12, CI-M; permission of instructor</td>
<td></td>
</tr>
</tbody>
</table>

**Total Units Beyond the GIRs Required for SB Degree**  
185–195

**Notes**  
* Alternate prerequisites are listed in the subject description.  
** These subjects can count as part of the required subjects or as restricted electives, but not both.  
(1) Students may elect 9–12 units.  
(2) 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,  
# 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, 3.021] or 12.001 in the Departmental Program</td>
<td>2</td>
</tr>
<tr>
<td>Science Requirement</td>
<td></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 or 3.983 in the Departmental Program]</td>
<td>6</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>Units</td>
</tr>
<tr>
<td>Required Subjects</td>
</tr>
<tr>
<td>3.012 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*</td>
</tr>
<tr>
<td>3.014 Materials Laboratory, 12, LAB, CI-M</td>
</tr>
<tr>
<td>One of the following three subjects:</td>
</tr>
<tr>
<td>3.016 Mathematical Methods for Materials Scientists and Engineers, 12; Calculus II (GIR)</td>
</tr>
<tr>
<td>18.03Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>18.03jDifferential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>One of the following three subjects:</td>
</tr>
<tr>
<td>3.02d Introduction to Modeling and Simulation, 12, REST; 18.03*</td>
</tr>
<tr>
<td>1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
</tr>
<tr>
<td>6.01 Introduction to EECS I, 12, 1/2 LAB; Physics II (GIR)</td>
</tr>
<tr>
<td>3.02 Microstructural Evolution in Materials, 12; 3.012</td>
</tr>
<tr>
<td>3.032 Mechanical Behavior of Materials, 12; Physics I (GIR), 3.016*</td>
</tr>
<tr>
<td>or 3.044 Materials Processing, 12; 3.012, 3.022</td>
</tr>
<tr>
<td>3.ThU Thesis, 9(1)</td>
</tr>
<tr>
<td>3.985jArchaeological Science, 9, HASS-S; Chemistry (GIR)*</td>
</tr>
<tr>
<td>3.986 The Human Past: Introduction to Archaeology, 12, HASS-S, CI-H</td>
</tr>
<tr>
<td>3.987 Human Origins and Evolution, 12, HASS-S</td>
</tr>
<tr>
<td>3.990 Seminar in Archaeological Method and Theory, 9, CI-M; 3.986, 3.985j, 21A.100</td>
</tr>
<tr>
<td>12.001 Introduction to Geology, 12, REST</td>
</tr>
<tr>
<td>12.119 Analytical Techniques for Studying Environmental and Geologic Samples, 12, LAB</td>
</tr>
<tr>
<td>21A.100 Introduction to Anthropology, 12, HASS-S</td>
</tr>
</tbody>
</table>

Restricted Electives (2)

One subject from the following list:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.07 Introduction to Ceramics, 12; 3.012</td>
<td>21–24</td>
</tr>
<tr>
<td>3.14 Physical Metallurgy, 12; 3.012, 3.022, 3.032</td>
<td></td>
</tr>
<tr>
<td>3.052 Nanomechanics of Materials and Biomaterials, 12; 3.032*</td>
<td></td>
</tr>
</tbody>
</table>

One subject from the following list:

<table>
<thead>
<tr>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.982 The Ancient Andean World, 9, HASS-S</td>
</tr>
<tr>
<td>3.983 Ancient Mesoamerican Civilization, 9, HASS-S</td>
</tr>
<tr>
<td>3.984 Materials in Ancient Societies: Ceramics, 12; permission of instructor</td>
</tr>
</tbody>
</table>

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.

(1) Students may elect up to 9–12 units.

(2) 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.
Preparatory subjects for thesis are listed within each of the disciplinary headings of the subject listing. For specific requirements in a degree program, consult the department’s website.

ARCHITECTURE DESIGN

4.021 Introduction to Architecture Design (4.111)
Prereq: None
U (Fall)
3-3-6 HASS-A
Credit cannot also be received for 4.02A
Provides an introduction to the architecture design process. Develops skills that enable design creativity, thinking, representation, and development. Beginning with abstract exercises, introduces techniques for designing and developing 2-dimensional and 3-dimensional form and space in architecture.
Architecture Design Staff

4.022 Architecture Design Foundations (4.112)
Prereq: None
U (Spring)
3-3-6
Provides the foundations for architectural design. Focuses on design methodologies, formal and spatial analysis and the translation of creative conceptual strategies into architectural design propositions. Instruction in design skills, including digital and analogue representational techniques. Preference to Course 4 majors and minors.
Architecture Design Staff

4.023 Architecture Design Studio I (4.114)
Prereq: 4.021, 4.022
U (Fall)
0-12-12
Provides instruction in architectural design and project development within design constraints including architectural program and site. Students engage the design process through various 2-dimensional and 3-dimensional media. Working directly with representational and model making techniques, students gain experience in the conceptual, formal, spatial and material aspects of architecture. Instruction and practice in oral and written communication provided. Preference to Course 4 majors and minors.
Architecture Design Staff

4.024 Architecture Design Studio II (4.115)
Prereq: 4.023, 4.401, 4.500
U (Spring)
0-12-12
Provides instruction in architectural design and project development with an emphasis on social, cultural, or civic programs. Builds on foundational design skills with more complex constraints and contexts. Integrates aspects of architectural theory, building technology, and computation into the design process. Preference to Course 4 majors.
Architecture Design Staff

4.025 Architecture Design Studio III (4.116)
Prereq: 4.024, 4.440
U (Fall)
0-12-12
Provides instruction in more advanced architectural design projects. Students develop integrated design skills as they negotiate the complex issues of program, site, and form in a specific cultural context. Focuses on how architectural concepts and ideas translate into built environments that transform the public sphere. Studio designed to prepare students for graduate studies in the field. Preference to Course 4 majors.
Architecture Design Staff

4.02A Introduction to Architecture Design Intensive (4.11A)
Prereq: None
U (IAP)
2-2-5
Provides an introduction to the architecture design process. Develops skills that enable design creativity, thinking, representation, and development. Beginning with abstract exercises, introduces techniques for designing and developing 2-dimensional and 3-dimensional form and space in architecture.
Architecture Design Staff

4.100 Architecture Workshop: Form and Material
Prereq: None
U (IAP)
0-3-0 [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 built structures and environments. Lab fee. Limited to 15; preference to freshmen.
Architecture Design Staff

4.105 Geometric Disciplines and Architecture Skills I
Prereq: Permission of instructor
G (Fall)
2-2-5
Intensive introduction to architectural design tools and process, taught through a series of short exercises. Together with 4.107, covers a broad range of topics relating to the discourse of geometry as the basis of architectural design process. Focuses on projective drawings, explicit 3-D modeling, and the reciprocity between representation and materialization. Lectures, workshops, and pin-ups address the architectural arguments intrinsic to geometry and its representation. Restricted to level one MArch students.
J. Lamere

4.107 Geometric Disciplines and Architecture Skills II
Prereq: 4.105
G (Spring)
2-2-5
Intensive investigation of advanced architectural design tools and process, taught through a series of progressive exercises. Together with 4.105, covers a broad range of topics relating to the discourse of geometry as the basis of architectural design process. Focuses on contemporary digital modeling tools, including parametric and solver-based modeling and their relationship to digital fabrication. Lectures, workshops, and pin-ups address the architectural implications of simulations and innovative
4.109 Shop for Architects
Prereq: 4.151 or permission of instructor
G (IAP)
0-3-6
Provides students with the tools for developing complex geometries from flat components. Students learn precision handwork to multi-axis computer numerically controlled (CNC) machining on a variety of materials used in architecture modeling. They will develop and build an installation to be displayed on campus as a way of examining a variety of architectural issues, such as the interaction between occupant and space. Preference to first-year MArch students.
J. Lavallee

4.110j Design Across Scales, Disciplines and Problem Contexts
(Same subject as MAS.330j)
(Subject meets with MAS.650)
Prereq: None
U (Spring)
2-2-8 HASS-A
Explores the reciprocal relationships among design, science, and technology across scales. Covers a wide range of topics, from visualization, fabrication, computation, material ecology, interaction, and architecture to games and performance. Examines how transformations in science and technology have influenced design thinking and vice versa. Students collaborate on interdisciplinary design projects and creative opportunities. Additional work is required of students taking the graduate version of the subject.
N. Oxman, J. M. Yoon

4.111 Architecture Design Fundamentals II
Prereq: 4.111 or 4.11A; 4.112
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

4.119 Preparation for Undergraduate Architecture Design Thesis
Prereq: 4.024
U (Fall)
1-0-2
Selection of thesis topic, defining method of approach, and preparation of thesis proposal for BSA degree in architecture. Weekly class meeting as well as individual conference with faculty.
Architecture Design Staff

4.120 Furniture Making Workshop
Prereq: Permission of instructor
G (Spring)
2-2-5
Provides instruction in designing and building a functional piece of furniture from an original design. Develops woodworking techniques from use of traditional hand tools to digital fabrication. Gives students the opportunity to practice design without using a building program or code. Surveys the history of furniture making and includes site visits to local collections and artists/craftsmen. Limited to 12 students.
C. Dewart, J. Lavallee

4.130 Architectural Design Theory and Methodologies
Prereq: Permission of instructor
G (Fall)
3-3-6
Can be repeated for credit with permission of instructor
Studies design as an interrogative technique to examine material sciences, media arts and technology, cultural studies, computation and emerging fabrication protocols. Provides in-depth, theoretical grounding to the notion of ‘design’ in architecture, and to the consideration of contemporary design methodologies, while encouraging speculation on emerging design thinking. Topical focus varies with instructor.
A. Miljacki

4.140j How to Make (Almost) Anything
(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, S. Tibbits

4.151 Architecture Design Core Studio I
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
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.
Architecture Design Staff

4.153 Architecture Design Core Studio III
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.
Architecture Design Staff

4.154 Architecture Design Option Studio
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.

Architecture 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.

Architecture Design Staff

4.163J Urban Design Studio
(Same subject as 11.332)
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.

Architecture Design Staff

4.166 Beijing Urban Design Studio
(Subject meets with 11.307)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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.

D. Frenchman, J. Wampler

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

4.183–4.185 Architectural Design Workshop
Prereq: 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.

Architecture 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.

Architecture Design Staff

4.190 Practical Experience in Architecture
Prereq: Permission of instructor
G (Fall)
0-0-3 [P/D/F]
Practical experience through summer internships secured by the student in the field of architecture, urbanism, digital design, art, or building technology.

Staff

4.191 Independent Study in Architecture Design
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

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

4.193 Independent Study in Architecture Design
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

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

Architecture Design Staff

4.196 Independent Study in Architecture Design
Prereq: Permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Preparatory research 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.

Architecture Design Staff

4.197 Independent Study in Architecture Design
Prereq: Permission of instructor
G (Fall)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual or group basis. Registration subject to prior arrangement for subject matter and supervision by staff.

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

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

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

4.213] Ecological Urbanism Seminar  
(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

4.214] Water, Landscape and Urban Design  
(Same subject as 11.314J)  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-3-6 H-LEVEL Grad Credit  
Can be repeated for credit  
Workshop surveys how water affects the design of buildings, landscapes and cities in aesthetic, functional and symbolic ways. Combines the systematic study of water issues with urban design projects in South Asia and the US. Covers topics such as rainwater harvesting, water use efficiency, wastewater reuse, stormwater management, floodplain design, constructed wetlands, and waterfront development. Students work together to integrate these design concepts at the site, urban, and international scales. Limited to 15.  
J. Wescoat

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

4.216] Landscape and Urban Heritage Conservation  
(Same subject as 11.316J)  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
3-3-6 H-LEVEL Grad Credit  
Can be repeated for credit  
Focuses on cultural landscape history, theory, and heritage issues and projects in the Indo-Islamic realm. Landscape and urban heritage inquiry go beyond monuments to encompass sites, cities, and regions. Combines the study of conservation theory and practice with an exploration of active urban landscape planning and design projects. Limited to 15.  
J. Wescoat

4.217] Disaster Resilient Design  
(Same subject as 11.315J)  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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

4.221 Architecture Studies Colloquium  
Prereq: Permission of instructor  
G (Fall)  
2-1-3  
Series of open lectures, presented as an introduction to the diverse academic and creative community of MIT and the region, at which discipline groups of the SMArchS program converge and exchange ideas. Organized thematically, guest speakers from cultural and scientific fields present viewpoints in areas of emerging interest within design, building technology, architectural computation, history, and art. Encourages discourse with speakers and among students from different disciplines. Students initiate online debates among their peers and respond to an evolving series of discussions resulting in publication.  
Architecture 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
4.225 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

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

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

4.236j Structuring Low-Income Housing Projects in Developing Countries
(Same subject as 11.463j)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Examines dynamic relationship among key actors: beneficiaries, government, and funder. Emphasis on cost recovery, affordability, replicability, user selection, and project administration. Extensive case examples provide basis for comparisons.
R. Goethert

4.240j 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.
S. Gray, M. A. Ocampo

4.241j 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
Covers 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.
Architecture Staff

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 (Spring)
3-0-9 HASS-H
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.
Staff

4.253j Urban Design Politics
(Same subject as 11.302j)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 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)
6-0-12 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 H-LEVEL Grad Credit
See description under subject 11.304j.
S. Gray, M. A. Ocampo

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

2014 – 2015
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 (Fall)
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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-6 H-LEVEL Grad Credit
Explores design opportunities and technical challenges in the vertical integration of energy sector materials in designs for the built environment. Interdisciplinary design approach enables students to work directly with the selected energy harvesting materials to understand the performance attributes and their application value. Students investigate the spatial, social and environmental 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: 4.022
U (IAP)
Units arranged [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. During IAP, a full-time, 4-week internship is required; maximum IAP credit, 6 units.
M. J. Yoon

4.287 Graduate Architecture Internship
Prereq: 4.151
G (IAP)
Units arranged [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. During IAP, a full-time, 4-week internship is required; maximum IAP credit, 6 units.
M. J. Yoon

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

4.299 Summer Research Topics
Prereq: Permission of instructor
G (Summer)
Units arranged [P/D/F] 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
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

4.S21 Special Subject: Architecture Studies
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

4.S22, 4.S23 Special Subject: Architecture Studies
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

4.S24 Special Subject: Architecture Studies
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

4.S25 Special Subject: Urban Housing
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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 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
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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
4.307 Art, Architecture, and Urbanism in Dialogue
(Subject meets with 4.308)
Prereq: 4.301 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-3-6
4.308 Art, Architecture, and Urbanism in Dialogue
(Subject meets with 4.307)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-3-6 H-LEVEL Grad Credit
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. Includes 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. Additional work required of students taking the graduate version. Lab fee.
G. Urbonas

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 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-3-3 HASS-A
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 2014–2015: 6 (Fall)
Acad Year 2015–2016: Not offered
3-3-6 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.
G. Urbonas

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
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
Examine 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 varying fields. Additional work required of students taking the graduate version. Lab fee. Enrollment limited.
R. Green

4.320 Introduction to Sound Creations
(Subject meets with 4.321)
Prereq: 4.301 or permission of instructor
U (Spring)
3-3-6 HASS-A
4.321 Introduction to Sound Creations
(Subject meets with 4.320)
Prereq: Permission of instructor
G (Spring)
3-3-6
Develops appreciation and critical awareness of how sound as an artistic practice is performed, produced, and distributed. Explores contemporary and historical practices that emerge outside a purely musical environment. Investigates specific compositional developments of post-war modernity and electro-acoustic music as well as non-musical disciplines related to the psychophonics of hearing and listening. Additional work required of students taking the graduate version. Lab fee.
Art, Culture and Technology Staff
4.322 Introduction to Three-Dimensional Art Work
Prereq: None
U (Fall)
2-4-6 HASS-A

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, screenings, and field trips, readings and debates supplement studio practice. Lab fee. Enrollment limited. A. Aksamija

4.330 Introduction to Networked Cultures and Participatory Media
(Subject meets with 4.331)
Prereq: None
G (Fall)
3-3-6

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. Examines how online communications have altered the way in which collaboration occurs, changes notions of authorship, and gives rise to the collective. Students implement, critique, and discuss design exercises and experiments and develop skills in media literacy and communication. Additional work required of students taking the graduate version. Lab fee. G. Urbonas

4.332 Advanced Seminar in Networked Cultures and Participatory Media
(Subject meets with 4.333)
Prereq: 4.330 or permission of instructor
U (Spring)
3-3-6 HASS-A

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)
3-3-6 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 communication. Students implement, critique, and discuss design exercises and experiments. Additional work required of students taking the graduate version. Lab fee. G. Urbonas

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

4.342 Introduction to Photography and Related Media
(Subject meets with 4.341)
Prereq: Permission of instructor
G (Fall, Spring)
3-3-6

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. J. Kapadia

4.344 Advanced Photography and Related Media
(Subject meets with 4.345)
Prereq: 4.341
U (Fall, Spring)
3-2-4

4.345 Advanced Photography and Related Media
(Subject meets with 4.344)
Prereq: 4.342 or permission of instructor
G (Fall, Spring)
3-2-4 H-LEVEL Grad Credit
Can be repeated for credit

Fosters critical awareness of how images in our culture are produced and constructed. Covers a range of experimental techniques and camera formats, advanced traditional and experimental black-and-white darkroom printing, and all aspects of digital imaging and output. Includes individual and group reviews, field trips, and visits from outside professionals. Topical focus changes each term; coursework centers on student-initiated project with emphasis on conceptual, theoretical, and technical development. Additional work required of students taking the graduate version. Equipment available for checkout. Lab fee. Enrollment limited. J. Kapadia

4.352 Advanced Video and Related Media
(Subject meets with 4.353)
Prereq: 4.354 or permission of instructor
U (Spring)
3-3-6 HASS-A

4.353 Advanced Video and Related Media
(Subject meets with 4.352)
Prereq: Permission of instructor
G (Spring)
3-3-6 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 as well as audio and sonic components. Context provided by regular viewings of contemporary video artworks and other audio-visual formats. Students work individually and in groups to develop skills in media literacy and communication. Additional work required of those taking the graduate version. Lab fee. A. Nevarez
**4.354 Introduction to Video and Related Media**  
(Subject meets with 4.355)  
Prereq: None  
U (Fall)  
3-3-6 HASS-A  

**4.355 Introduction to Video and Related Media**  
(Subject meets with 4.354)  
Prereq: Permission of instructor  
G (Fall)  
Units arranged  

Covers the technical and conceptual variables and strategies inherent in contemporary video art practice. Analyzes structural concepts of time, space, perspective and sound within the art form. Building upon the historical legacy of moving image and video, students consider self-exploration, performance, social critique, and manipulation of raw experience into aesthetic form. Emphasizes practical knowledge of lighting, video capturing and editing, and montage. Presentation and critique of student work, technical workshops, screenings, and reading discussions assist students with final project. Students taking graduate version complete additional assignments. Lab fee. Enrollment limited.  
A. Nevarez

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

**4.357 Cinematic Migrations**  
(Subject meets with 4.356)  
Prereq: 4.355 or permission of instructor  
G (Fall, Spring)  
3-3-6  
Can be repeated for credit  

Explores ideas and contexts behind moving images through a multifaceted look at cinemas transmutations, emergence on local and national levels, and global migrations. Looks at the transformation caused by online video, television, spatial installations, performances, dance and many formats and portable devices. Studies the theory and context of films categorization, dissemination and analysis. Presentations, screenings, field trips, readings, guest visitors, and experimental transdisciplinary projects broaden the perception of present cinema. Additional work required of students taking the graduate version. Limited to 12.  
R. Green

**4.361 Performance Art Workshop**  
(Subject meets with 4.362)  
Prereq: Permission of instructor  
U (Fall)  
3-3-6 HASS-A  

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

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.  
Art, Culture and Technology Staff

**4.368 Studio Seminar in Public Art/Public Sphere**  
(Subject meets with 4.369)  
Prereq: Permission of instructor  
U (Spring)  
3-3-6 HASS-A  

**4.369 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  

Focuses on the production of artistic intervention in public space beyond the gallery/museum context. Addresses and negotiates the complexity of ideas, situations, objects, and materials that are inherent to any public space. 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. Assigned readings and discussions help students develop an initial concept for a publicly diffused project. Additional work required of students taking the graduate version. Lab fee.  
A. Muntadas

**4.373 Advanced Projects in Visual Arts**  
(Subject meets with 4.374)  
Prereq: Permission of instructor  
U (Spring)  
3-3-6 HASS-A  
Can be repeated for credit

**4.374 Advanced Projects in Visual Arts**  
(Subject meets with 4.373)  
Prereq: Permission of instructor  
G (Spring)  
3-3-6 H-LEVEL Grad Credit  
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. Additional work required of students taking the graduate version.  
Art, Culture and 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 1st year SMACT students.  
A. Aksamija

**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 2nd year SMACT students.  
A. Aksamija
Art, Culture and Technology Staff

4.390 Art, Culture and Technology Studio
Prereq: Permission of instructor
G (Fall, IAP, 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 investigation, documentation 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 SMACT students.
A. Muntadas

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
Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Art, Culture and Technology Staff

4.530 Special Subject: Art, Culture and Technology
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

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

4.532. 4.533 Special Subject: Art, Culture and Technology
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

4.534 Special Subject: Art, Culture and Technology
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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 Environmental Technologies in Buildings
Prereq: None
U (Fall)
3-2-7
Credit cannot also be received for 4.461
Introduction to the thermal behavior of buildings, modern architectural systems, and the materials and construction of their components and assemblies. Examines the basic scientific principles underlying these topics, covering building enclosure, structure, interior space, circulation and conveyance systems, as well as power and water distribution systems. Introduces a range of technologies and analysis techniques for designing comfortable and resource-efficient indoor environments. Students apply these techniques to explore the role that energy and materials have in shaping architecture.
C. Reinhart

4.411J D-Lab Schools: Building Technology Laboratory
(Same subject as EC.713J)
Prereq: Physics I (GIR), Calculus II (GIR)
U (Fall)
2-3-7 Institute LAB
Focuses on the design, analysis, and application of technologies that support the construction of less expensive and better performing schools in developing countries. Prepares students to design or retrofit school buildings in partnership with local communities and NGOs. Strategies covered include daylighting, passive heating and cooling, improved indoor air quality via natural ventilation, appropriate material selection, and structural design. Investigations are based on application of engineering fundamentals, experiments and simulations. Case studies illustrate the role of technologies in reducing barriers to improved education.
L. K. Norford

4.42J Fundamentals of Energy in Buildings
(Same subject as 1.044J, 2.66J)
Prereq: Physics I (GIR), Calculus II (GIR)
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-2-7 REST
Design-based introduction to energy and thermo-sciences, with applications to sustainable, energy-efficient architecture and building technology. Covers introductory thermodynamics, air/water/vapor mixtures, and heat transfer. Studies leading order factors in building energy use. Includes several building design projects in which students creatively employ energy fundamentals and building energy use.
L. R. Glicksman

4.424J Modeling and Approximation of Thermal Processes
(Same subject as 2.52J)
Prereq: 2.51
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 2.52J.
L. R. Glicksman

4.430 Daylighting and Solar Gain Control
Prereq: 4.401 or permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Studies natural and electric lighting in an architectural context. Promotes the integration of occupant comfort, energy efficiency and daylight availability throughout the design process, with an emphasis on the role light can play in shap-
ing architecture. Through group and individual projects, students practice design techniques, from rule of thumb simulations to high dynamic range photography and physical model building. Offered for 9 or 12 units.

C. Reinhart

4.431 Architectural Acoustics
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.

Building Technology Staff

4.432 Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods
(Subject meets with 4.433)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-2-7

4.433 Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods
(Subject meets with 4.432)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-2-4 H-LEVEL Grad Credit

Studies energy flows in and around groups of buildings from individual structures to complete, large-scale neighborhoods. Students use digital techniques to analyze and influence building energy use, neighborhood walkability, and outdoor comfort. Group work focuses on the design of a sustainable, mixed-use urban neighborhood that successfully engages microclimatic effects, such as shading of neighboring buildings, urban heat island effects, and localized wind patterns. Additional work is required of students taking the graduate version.

C. Reinhart

4.440) Building Structural Systems I
(Subject meets with 4.462)
Prereq: Calculus II (GIR)
U (Spring)
3-3-6 REST

Introduces the design and behavior of large-scale structures and structural materials.

4.441 Analysis of Historic Structures
(Subject meets with 4.445)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9

4.442 Analysis of Historic Structures
(Subject meets with 4.444)
Prereq: None
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-6

4.443 Design for Sustainability
(Subject meets with 1.819)
Prereq: Permission of instructor
G (Fall)
2-0-4 H-LEVEL Grad Credit

See description under subject 1.819.

J. Connor, J. Ochsendorf

4.461 Architectural Building Systems
Prereq: None
G (Fall)
3-1-5
Credit cannot also be received for 4.401

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.

Building Technology Staff

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

Introduces the design and behavior of large-scale structures and structural materials. Emphasizes the development of structural form and the principles of structural design. Introduces design methods for timber, masonry, concrete, and steel applied to long-span roof systems, bridges, and high-rise buildings. Includes environmental assessment of structural systems and materials. In laboratory sessions, students solve structural problems by building and testing simple models. Graduate and undergraduate students have separate lab sections.

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 envelopes, and contemporary production technologies. Continues the exploration of structural elements and systems, expanding to include more complex determinate, indeterminate, long-span, and high-rise systems. Topics include reinforced concrete, steel and engineered-wood design, and an introduction to tensile systems. The contemporary exterior envelope is discussed with an emphasis on the classification of systems, performance attributes, and analysis techniques, material specifications and novel construction technologies.

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-efficient 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. Norford
4.473 Design Workshop for a Sustainable Future
Prereq: 4.151; 4.461 or permission of instructor
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 building performance goals, such as energy-efficiency, efficient material use, structural stability and occupant comfort into the design process. Limited to 16.
J. Ochsendorf

4.475 Design for Sustainable Urban Futures
Prereq: 4.151; 4.461 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 consumption. 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.
Building Technology and Architecture Design Staff

4.477 Emergent Materials
Prereq: None
G (Spring)
 Units arranged
Workshop reinterprets the function and application of various emerging building materials used in contemporary architectural constructs. Lectures address themes of resource efficiency and material selection within the context of emerging areas of research. Readings establish what is considered state-of-the-art and support the making of material prototypes. Offered for 9 or 12 units.
J. Fernandez

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

4.488 Preparation for S.M.B.T. Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
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
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
U (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
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Building Technology Staff

4.495 Independent Study in Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Building Technology Staff

4.497 Independent Study in Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Supplementary work on individual basis. Registration subject to prior arrangement for subject matter and supervision by staff.
Building Technology Staff
4.S40 Special Subject: Building Technology
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

4.S41 Special Subject: Building Technology
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

4.S42 Special Subject: Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

4.S43 Special Subject: Building Technology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

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

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

4.S46 Special Subject: Energy in Buildings
Prereq: Permission of instructor
G (IAP, Spring)
Units arranged H-LEVEL Grad Credit
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.S47 Special Subject: Architectural Lighting
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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.S48 Special Subject: Structural Design
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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

COMPUTATION

4.500 Introduction to Geometric Modeling
Prereq: None
U (Fall)
2-2-8

Introduces 3-D CAD modeling to students with little or no experience. Uses basic theories in generative modeling combined with a variety of modeling applications to explore surface, solid, and mesh modeling techniques. Presents a variety of input tools, from entry-level keyboard commands to 3-D scanning and CAD scripting. Design models created throughout the term aid in exploration of a variety of output devices, such as paper-printed media, 3-D rendering, 3-D printing, and some CNC manufacturing. Includes weekly modeling assignments and a final project. Preference to Course 4 majors and minors.

L. Sass

4.501 Creative Design Prototyping
Prereq: 4.500
U (Spring)
3-3-6

Introduction to digital fabrication and online presentation as a single design process. Project-based class that integrates iterative design on paper with physical prototyping across many scales. Hands on learning of fabrication lab equipment integrated with design studio. It starts with machine learning through exercises quickly moving to a stepped design to production process: 3-D printings, CNC machining and robotic finishing. The final product is an individually designed and fabricated functional piece of furniture. Preference to Course 4 majors and minors.

L. Sass

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

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. Preference to Course 4 majors and minors.

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

4.510 Design in the Making
Prereq: Permission of instructor
G (Fall)
3-3-6 H-LEVEL Grad Credit

Research-based class that explores novel architectural systems. Students develop propos-
4.517 Parametric and Building Information Modeling
Prereq: 4.500 or permission of instructor
G (Fall)
3-2-7 H-LEVEL Grad Credit
Addresses professional applications of digital modeling in the development of contemporary construction systems 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.
L. Sass

4.520 Visual Computing I
(Subject meets with 4.521)
Prereq: None
U (Fall)
3-0-9
4.521 Visual Computing I
(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.
T. Knight

4.522 Visual Computing II
(Subject meets with 4.523)
Prereq: 4.520 or permission of instructor
U (Spring)
3-0-9
4.523 Visual Computing II
(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 graduate students.
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 $U_i$ and $W_j$ 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 Computational Design Lab
(Subject meets with 4.570)
Prereq: Permission of instructor
U (Spring)
Units arranged
Can be repeated for credit
4.552 Workshop in Architectural Computation
Prereq: Permission of instructor
G (IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
4.553 Workshop in Architectural Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for exploration of a topic in computation through research-focused design projects or exercises. Registration subject to prior arrangement of topic and supervision by staff.
Computational Staff

4.557J City Science
(Subject meets with 4.552)
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.
K. Larson, R. Chin

4.561 Introduction to Building Information Modeling in Architecture
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-2-7 H-LEVEL Grad Credit
Addresses fundamental methods, theories, and practices that engage contemporary modeling tools in the context of architectural design. Introduces selected academic and professional topics through lectures, demonstrations, and assignments. Topics include parametric modeling, component types and assembly, prototyping, scripting, and simulations. Initiates intellectual explorations in the use of building information modeling in research projects and design practices.
T. Nagakura

4.562 Advanced Visualization: Architecture in Motion Graphics
(Subject meets with 4.503)
Prereq: Permission of instructor
G (Fall)
3-2-7 H-LEVEL Grad Credit
Advanced projects in architectural visualization with an emphasis on the use of computer
graphics animation and video production media. 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

4.564 Design Scripting
(Subject meets with 4.504)
Prereq: Permission of instructor
G (Spring)
2-2-8 H-LEVEL Grad Credit
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

4.566 Advanced Projects in Digital Media
Prereq: 4.562, 4.564, or permission of instructor
G (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

4.569 Designing Interactions: Media and Mobile Technologies (New)
(Same subject as CMS.834J)
(Subject meets with CMS.674)
Prereq: None
G (Fall)
3-3-6
Can be repeated for credit
See description under subject CMS.834J.
F. Casalegno, T. Nagakura

4.570 Computational Design Lab
(Subject meets with 4.550)
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Provides students with an opportunity to explore projects that engage real world problems concerning spatial design, technology, media, and society. In collaboration with industry partners and public institutions, students identify topical issues and problems, and also explore and propose solutions through the development of new ideas, theories, tools, and prototypes. Industry and academic collaborators act as a source of expertise, and as clients and critics of projects developed during the term. General theme of workshop varies by term or year. Open to students from diverse backgrounds in architecture and other design-related areas. Additional work required of students taking graduate version.

Computation Staff

4.580 Inquiry into Computation and Design
Prereq: None
G (Fall)
3-0-9
Explores the varied nature, history and practice of computation in design through lectures, readings, small projects, discussions, and guest visits by Computation group faculty and others. Topics may vary from year to year. Aims to help students develop a critical awareness of different approaches to and assumptions about computation in design beyond the specifics of techniques and tools, and to open avenues for further research.

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.

G. Stiny

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.

T. Knight

4.584 Reading Seminar in Design and Computation
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Reading and discussion of particular topics in design and computation. Students lead discussions, make oral presentations, and prepare reviews of weekly readings.

T. Knight

4.587 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

4.589 Preparation for Design and Computation PhD Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Computation Staff
4.591 Independent Study in Architectural Computation
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

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

4.593 Independent Study in Architectural Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

4.594 Independent Study 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

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
Prereq: None
U (IAP, Spring)
Units arranged
Can be repeated for credit

4.551 Special Subject: Architectural Computation
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

4.552 Special Subject: Architectural Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

4.553 Special Subject: Architectural Computation
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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

4.554 Special Subject: Architectural Computation
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
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
U (Fall)
3-2-7 HASS-A

Introduction to the history and interpretation of western art that explores painting, graphic arts and sculpture from the Renaissance to the present. Engages diverse methodological perspectives to examine changing conceptions of art and the artist, and to investigate the plural meaning of artworks within the larger contexts of culture and history. Subject includes trips to local museums.

K. Smentek

4.602 Modern Art and Mass Culture
Prereq: None
U (Spring)
4-0-8 HASS-A; CI-H

Introduction to theories of modernism and postmodernism and their related art forms (roughly 18th century to present). Focuses on how artists use the tension between fine art and mass culture to critique both. Examines visual art in a range of genres, from painting to video and “relational aesthetics.” These art works are viewed in their interaction with advertising, caricature, comics, graffiti, television, fashion, “primitive” art, propaganda, and networks on the internet.

C. Jones
4.603 Formal Analysis in Architecture, Art, and Design
(Subject meets with 4.604)
Prereq: None
U (Fall)
3-0-9 HASS-A

4.604 Formal Analysis in Architecture, Art, and Design
(Subject meets with 4.603)
Prereq: Permission of instructor
G (Fall)
Units arranged
Explores buildings, works of art, and artifacts of the twentieth century that have shaped today’s understanding and approach to architecture. Emphasizes exemplary works, as understood from the practitioner’s perspective. Students analyze buildings through drawing, modeling, reading, and writing. Provides a framework for understanding contemporary architectural design and to building a visual vocabulary to communicate effectively about design. Additional work required of students taking the graduate version. Preference to Course 4 majors.

HTC Staff

4.605 A Global History of Architecture
Prereq: None
U (Spring)
4-0-8 HASS-A

Provides an outline of the history of architecture and urbanism from ancient times to the early modern period. Analyzes buildings as the products of culture and in relation to the special problems of architectural design. Stresses the geopolitical context of buildings and in the process familiarizes students with buildings, sites and cities from around the world.

M. Jarzombek

4.606 Visual Perception and Art
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-2-7 HASS-A; CI-H

Introduces visual perception from neurological, cultural, and artistic vantage points. Examines aspects of visual culture ranging from body adornment to public spaces, and from logotypes to moving images. Topics range from ritual space to forensics to machine-aided vision (cameras, radar devices, robotic scanners). Designed to develop skills in visual analysis and interpretation through lectures, oral presentations, field trips, and written essays. 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

4.608 Seminar in the History of Art and Architecture (New)
(Subject meets with 4.609)
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit

Examination of historical method in art and/or architecture, focusing on periods and problems determined by the research interest of the faculty member leading the seminar. Emphasizes critical reading and viewing and direct tutorial guidance. Additional work required of students taking the graduate version.

HTC Staff

4.609 Seminar in the History of Art and Architecture
(Subject meets with 4.608)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-A

Examination of historical method in art and/or architecture, focusing on periods and problems determined by the research interest of the faculty member leading the seminar. Emphasizes critical reading and viewing and direct tutorial guidance. Additional work required of students taking the graduate version.

HTC Staff

4.610 Civic Architecture in Islamic History
(Subject meets with 4.611)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-A

4.611 Civic Architecture in Islamic History
(Subject meets with 4.610)
Prereq: None
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
Units arranged
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 Architecture in the Islamic World
Prereq: None
U (Fall)
3-0-9 HASS-A

Introduces the history of Islamic cultures that spans fourteen centuries and three continents—Asia, Africa, Europe—and recent developments in the United States. Studies a number of representative examples, from the House of the Prophet to the present, in conjunction with their urban, 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 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-A

Explores the history of Cairo from initial settlement (640s) to the present. Reviews its urban and architectural developments, and connects them to their Islamic and Mediterranean architectural and cultural contexts. Presents the city as a major cultural, political, and economic center that has for over a millennium influenced its Arab, Islamic, African, and Mediterranean milieus. 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
Units arranged H-LEVEL Grad Credit

Seminar on how culture interacts with architecture. 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. Focuses on examples from Islamic history and establishes historical and theoretical frameworks for investigation.

N. Rabbat

4.617 Issues in Islamic Urbanism
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
Units arranged H-LEVEL Grad Credit

Seminar on selected topics from the history of Islamic urbanism. Examines patterns of settlement, urbanization, development, and architectural production in various places and periods, ranging from the formative period in the 7th century to the new cities emerging today. Discusses the leading factors in shaping and transforming urban forms, design imperatives, cultural and economic structures, and social and civic attitudes. Critically analyzes the body of literature on Islamic urbanism. Research paper required.

N. Rabbat

4.618 The Architecture of Cairo
(Subject meets with 4.615)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
Units arranged H-LEVEL Grad Credit

Explores the history of Cairo from initial settlement (640s) to the present. Reviews its urban and architectural developments, and connects them to their Islamic and Mediterranean architectural and cultural contexts. Presents the city as a major cultural, political, and economic center that has for over a millennium influenced its Arab, Islamic, African, and Mediterranean milieus. Additional work required of students taking the graduate version.

N. Rabbat

4.619 Historiography of Islamic Architecture
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

Critical review of literature on Islamic art and architecture in the last two centuries. Analyzes the cultural, disciplinary, and theoretical contours of the field and highlights the major figures that have influenced its evolution. Challenges the tacit assumptions and biases of standard studies of Islamic art and architecture and addresses historiographic and critical questions concerning how knowledge of a field is defined, produced, and reproduced.

N. Rabbat

4.621 Orientalism and Representation
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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 the West 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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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 with their contemporary significance for cultural heritage conservation and design. Limited to 15.

J. Wescoat

4.625J Water Planning, Policy, and Design
(Subject as 11.378)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Focuses on water in environmental planning, policy, and design. Draws together faculty and students who are working on water-related research projects to develop and maintain a current perspective on the field from the site to metropolitan and international scales. Limited to 15.

J. Wescoat

4.633 Locating Capitalism: Producing Early Modern Cities and Objects (New)
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit

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

L. Jacobi

4.634 Early Modern Architecture and Art
(Subject meets with 4.635)
Prereq: None
G (Fall)
Units arranged

4.635 Early Modern Architecture and Art
(Subject meets with 4.634)
Prereq: None
U (Fall)
3-0-9 HASS-A

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

L. Jacobi
4.640 Advanced Study in Critical Theory of Architecture
Prereq: Permission of instructor
G (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
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 to 1900 with an emphasis on Western Europe and its global points of contact. Topics include art and revolution, empire and its image, mythologies of the artist, gender and representation, public exhibitions, 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. 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
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, which sees 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
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

4.648J Resonance: Sonic Experience, Science, and Art (New)
(Same subject as 21A.519J)
(Subject meets with 4.648J, 21A.507J)
Prereq: None
U (Fall)
3-0-9 HASS-A
Examines the sonic phenomena and experiences that motivate scientific, humanistic, and artistic practices. Explores the aesthetic and technical aspects of how we hear; measure or describe vibrations; record, compress, and distribute resonating materials; and how we ascertain what we know about the world through sound. Although the focus is on sound as an aesthetic, social, and scientific object, the subject also investigates how resonance is used in the analysis of acoustics, architecture, and music theory. Students make a sonic artifact or research project as a final requirement. Students taking graduate version complete additional assignments.
S. Helmreich, C. Jones

4.651 Art Since 1940
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-A
Critical examination of major developments in European, Asian, and American art from 1940 to the present. Surveys the mainstream of art production but also examines marginal art movements (feminism, identity politics, AIDS activism) that come to change the terms of arts engagements with civic culture. Visits to area art museums and writing assignments develop skills for visual analysis and critical writing.
C. Jones

4.661 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.
M. Jarzombek
4.670 Nationalism, Internationalism, and Globalism in Modern Art
(Subject meets with 4.671)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
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 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-1-8

Students study how international modernism interacted with the concept of “nation” and how contemporary discourses concerning globalization change 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
Units arranged

4.673 Installation Art
(Subject meets with 4.672)
Prereq: 4.601 or permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
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. Its corollary in site-specific art is explored in relation to previous exhibition models such as natural history displays or merchandising conventions. Students taking the graduate version must produce a final research paper.

C. Jones

4.674 Collect, Classify, Consume
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor

Historical study of collecting from the Renaissance to the present. Addresses the practices of collecting and display at both the individual and institutional level, and analyzes their social, aesthetic, scientific, political and economic dimensions. Specific themes vary from year to year. Offered for 9 or 12 units.

K. Smentek

4.675 Collect, Classify, Consume
Prereq: Permission of instructor
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit with permission of instructor


HTC Staff

4.676 SMArchS AKPIA Pre-Thesis Preparation
(Not)
Prereq: 4.221; 4.619 or 4.621
G (Fall, Spring)
0-1-2 [P/D/F] H-LEVEL Grad Credit

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

HTC Staff

4.677 Advanced Study in the History of Art
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

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

K. Smentek

4.678 SMArchS HTC Pre-Thesis Preparation
Prereq: 4.221, 4.661
G (Fall, Spring)
0-1-2 [P/D/F] H-LEVEL Grad Credit

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

HTC Staff
4.S60 Special Subject: History, Theory and Criticism of Architecture and Art
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
4.S61 Special Subject: History, Theory and Criticism of Architecture and Art
Prereq: None
U (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
4.S63 Special Subject: History, Theory and Criticism of Architecture and Art
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
4.S64 Special Subject: History, Theory and Criticism of Architecture and Art
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
4.S65 Special Subject: Islamic and Non-Western Architecture
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
4.S66 Special Subject: History, Theory and Criticism of Art
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
4.S67 Special Subject: Study in Modern Art
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
4.S68 Special Subject: Study in Modern Architecture
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
4.S69 Special Subject: Advanced Study in the History of Urban Form
Prereq: Permission of instructor
G (IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

THESES AND UROP

Graduate Subjects

4.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Program of research and writing of thesis; to be arranged by the student with supervising committee.

Staff

Undergraduate Subjects

4.THTJ Thesis Research Design Seminar
(Same subject as 11.THTJ)
Prereq: None
U (Fall)
3-0-9
Can be repeated for credit
See description under subject 11.THTJ.
K. Smentek, 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.UR Undergraduate Research in Architecture
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

4.URG Undergraduate Research in Architecture
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Research and project activities, which cover the range represented by the various research interests and projects in the department. Students who wish a letter grade option for their work must register for 4.URG.
L. Sass
# 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

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>4.021 Introduction to Architecture Design, 12, HASS-A</td>
<td>153–156</td>
</tr>
<tr>
<td>or 4.02A Introduction to Architecture Design Intensive, 9, HASS-A</td>
<td></td>
</tr>
<tr>
<td>4.022 Architecture Design Foundations, 12</td>
<td></td>
</tr>
<tr>
<td>4.023 Architecture Design Studio 1, 24, CI-M; 4.021*, 4.022</td>
<td></td>
</tr>
<tr>
<td>4.024 Architecture Design Studio 2, 24; 4.023, 4.040, 4.500, 4.603</td>
<td></td>
</tr>
<tr>
<td>4.025 Foundations in Art, Design, and Spatial Practices, 12, 4.021*; CI-M</td>
<td></td>
</tr>
<tr>
<td>4.401 Environmental Technologies in Buildings, 12</td>
<td></td>
</tr>
<tr>
<td>4.440J Building Structural Systems I, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>4.500 Introduction to Geometric Modeling, 12</td>
<td></td>
</tr>
<tr>
<td>4.501 Creative Design Prototyping, 12; 4.500†</td>
<td></td>
</tr>
<tr>
<td>or 4.503 Advanced Visualization: Architecture in Motion Graphics, 12; 4.500†</td>
<td></td>
</tr>
<tr>
<td>4.505 A Global History of Architecture, 12, HASS-A</td>
<td></td>
</tr>
<tr>
<td>or 4.614 Architecture in the Islamic World, 12, HASS-A†</td>
<td></td>
</tr>
<tr>
<td>or 4.635 Early Modern Architecture and Art, 12, HASS-A†</td>
<td></td>
</tr>
</tbody>
</table>

### Restricted Electives

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.025 Architecture Design Studio 3, 24; 4.024, 4.440</td>
<td></td>
</tr>
<tr>
<td>or Two subjects from the following list of subjects</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Art, Culture and Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.301 Art, Architecture, and Urbanism in Dialogue, 12; 4.301 or 4.302</td>
</tr>
<tr>
<td>4.322 Introduction to Three-Dimensional Art Work, 12, HASS-A</td>
</tr>
<tr>
<td>4.341 Introduction to Photography and Related Media, 12, HASS-A</td>
</tr>
<tr>
<td>4.354 Introduction to Video and Related Media, 12, HASS-A</td>
</tr>
<tr>
<td>4.368 Studio Seminar in Public Art/Public Sphere, 12, HASS-A; permission of instructor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.411D Lab Schools: Building Technology Laboratory, 12; LAB; Physics I (GIR), Calculus I (GIR)</td>
</tr>
<tr>
<td>4.421 Fundamentals of Energy in Buildings, 12, REST; Physics I (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>4.432 Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods, 12; permission of instructor</td>
</tr>
<tr>
<td>4.44 Analytic of Historic Structures, 12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Computation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.501 Digital Design and Fabrication, 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>4.520 Visual Computing 1, 12</td>
</tr>
<tr>
<td>4.522 Visual Computing 2, 12; 4.520*</td>
</tr>
<tr>
<td>Course Code</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>4.601</td>
</tr>
<tr>
<td>4.602</td>
</tr>
<tr>
<td>4.605</td>
</tr>
<tr>
<td>4.614</td>
</tr>
<tr>
<td>4.635</td>
</tr>
<tr>
<td>4.651</td>
</tr>
</tbody>
</table>

**Departmental Program Units That Also Satisfy the GIRs** (36)

<table>
<thead>
<tr>
<th>Credit Type</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>48–51</td>
</tr>
</tbody>
</table>

**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 are listed in the subject description.

† Restricted electives are subjects that are also listed under required subjects. However students only choose one from the designated groups to satisfy the required subjects. It is acceptable for them to use the subjects not chosen toward the restricted elective options.

‡ Only three subjects required by the department may 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).
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, S. Lippard

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.
Y. Surendranath

5.05 Principles of Inorganic Chemistry III
Prereq: 5.03, 5.04
G (Spring; partial term)
3-0-6 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, C. Landis

5.061 Principles of Organmetallic Chemistry
Prereq: 5.03
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall; partial 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)
3-0-9 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. Introduces additional topics to expose students to exciting new advances in the field, such as medicinal application of inorganic chemistry; multi-component enzyme systems (e.g., nitrogenase, hydrogenase, and photosystem II); and metalloprotein engineering and design (e.g., the conversion by mutagenesis of existing metalloprotein scaffolds to achieve novel functions).
S. Lippard, E. Nolan

5.063 Organometallic Compounds in Catalytic Reactions
Prereq: 5.061
Acad Year 2016–2015: Not offered
Acad Year 2015–2016: 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)
2-3-1 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)
3-0-3 H-LEVEL Grad Credit
Discusses the physical methods used to probe the electronic and geometric structures of inorganic compounds, with additional techniques employed in the characterization of inorganic solids and surfaces. Includes vibrational spectroscopy, solid state and solution magnetochemical methods, Mossbauer spectroscopy, electron paramagnetic resonance spectroscopy, electrochemical methods, and a brief survey of surface techniques. Applications to current research problems in inorganic and solid-state chemistry.
M. Dinca

5.069 Crystal Structure Analysis
Prereq: 5.03, 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

5.07 Biological Chemistry I
(Subject meets with 7.07J)
Prereq: 5.12; 5.07 or 7.05
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.
A. Ting, A. Klubanov

5.08 Biological Chemistry II
(Subject meets with 7.08J)
Prereq: 5.12; 5.07 or 7.05
U (Spring)
4-0-8
More advanced treatment of biochemical mechanisms that underlie biological processes. Topics include macromolecular machines such as the ribosome, the proteosome, fatty acid synthases as a paradigm for polyketide syntheses and non-ribosomal polypeptide syntheses, and polymerases. Emphasis is on experimental methods used to unravel these processes and
how these processes fit into the cellular context and coordinate regulation.
J. Stubbe, E. Nolan

5.111 Principles of Chemical Science
Prereq: None
U (Fall, Spring)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.112, CC.5111, ES.3091, ES.5111, ES.5112

Introduction to chemistry, with emphasis on basic principles of atomic and molecular electronic structure, thermodynamics, acid-base and redox equilibria, chemical kinetics, and catalysis. Introduction to the chemistry of biological, inorganic, and organic molecules.
Fall: C. Drennan
Spring: M. Shoulders, T. Van Voorhis

5.112 Principles of Chemical Science
Prereq: None
U (Fall)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.111, CC.5111, ES.3091, ES.5111, ES.5112

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.
R. Schrock, 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: E. Vogel Taylor, M. Movassaghi
Spring: R. L. Danheiser, T. Swager

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.
T. Jamison, S. L. Buchwald

5.24 Archaeological Science
(Same subject as 3.985J, 12.011J)
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 HASS-S
See description under subject 3.985J.
H. N. Lechtman

5.301 Chemistry Laboratory Techniques
Prereq: Chemistry (GIR), permission of instructor
U (IAP)
1-4-1 [P/D/F]

Practical training in basic chemistry laboratory techniques. Intended to provide freshmen with the skills necessary to undertake original research projects in chemistry. Freshmen only.
Enrollment limited.
J. Dolhun

5.310 Laboratory Chemistry
Prereq: None. Coreq: 5.12
U (Fall, Spring)
2-8-2 Institute LAB

Introduces experimental chemistry for students who are not majoring in Course V. Principles and applications of chemical laboratory techniques, including preparation and analysis of chemical materials, measurement of pH, gas and liquid chromatography, visible-ultraviolet spectrophotometry, infrared spectroscopy, kinetics, data analysis, and elementary synthesis. Enrollment limited.
J. Dolhun

5.35 Introduction to Experimental Chemistry
(Subject meets with 5.35U)
Prereq: See module descriptions
U (Fall, Spring)
Units arranged Institute LAB
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 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. Jamison (Module 3)
Spring: K. Nelson (Module 1), M. Twardowski (Module 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 (May be taken for 8 or 4 units)
Can be repeated for credit up to a total of 12 units

For students who might not take all modules of 5.35. Consult department when choosing a version of 5.35. See description for 5.35.
Fall: K. Nelson (Module 1), M. Twardowski (Module 2), T. Jamison (Module 3)
Spring: K. Nelson (Module 1), M. Twardowski (Module 2), T. Swager (Module 3)

5.36 Biochemistry and Organic Laboratory
(Subject meets with 5.36U)
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. Instruction and practice in the written and oral presentation of experimental results provided. Modules and prerequisites are as follows:

—Module 4 Spring (Prereq: 5.07 or 7.05, Module 2 or 5.310, Module 5) Expression and Purific-
CHEMISTRY

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.

Fall: M. Dinca, Y. Surendranath (Module 8), C. C. Cummins (Module 9)
Spring: T. Jamison (Module 7)

5.38 Physical Chemistry Laboratory
Prereq: See module descriptions under subject 5.38
U (Spring)
Units arranged
Can be repeated for credit
For students who might not take all modules of 5.38. Consult department when choosing a version of 5.38. See description for 5.38.

Fall: R. L. Danheiser (Module 6)
Spring: B. Pentelute (Modules 4 & 5)

5.39 Advanced Organic Chemistry
Prereq: 5.13
U (Fall)
4-0-8
Credit cannot also be received for 5.53
Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates. Photochemistry and organometallic chemistry, with an emphasis on fundamental reactivity, mechanistic studies, and applications in organic chemistry.
J. A. King

5.40 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. L. Buchwald

5.41 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 up to a total of 12 units
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.

Fall: R. L. Danheiser (Module 6)
Spring: B. Pentelute (Modules 4 & 5)

5.42 Introduction to Bioorganic Chemistry
Prereq: 5.41
U (Fall)
2-0-4 H-LEVEL Grad Credit
An introduction to bioorganic chemistry. Emphasizes the chemistry of bioactive molecules and related areas of biology and medicine.
J. H. Simpson

5.43 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.
R. L. Danheiser

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. L. Buchwald

5.45 Heterocyclic Chemistry
Prereq: 5.511, 5.53
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring; second half of term)
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

5.46 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.
R. L. Danheiser

5.48J Protein Folding and Human Disease
(Same subject as 7.88J, 10.543J)
Prereq: 7.51 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 7.88J.
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. Stubble

5.51 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

5.52 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. Klibbon

5.53 Molecular Structure and Reactivity
Prereq: 5.13, 5.60
G (Fall; partial term)
3-0-6 H-LEVEL Grad Credit

Credit cannot also be received for 5.43

Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates.

J. Van Humbeck

5.531 Organometallic Reaction Mechanisms
Prereq: 5.53

Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

Staff

5.54J Frontiers in Chemical Biology
(Same subject as 7.540J, 20.554J)
Prereq: 5.13, 5.07, 7.06, permission of instructor
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. Pentelute, M. Shoulders

5.55J Chemical Reaction Mechanisms
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: M. Bowend, A. Shalek
Spring: R. Field, M. Bowend, S. Solomon

5.56 Biophysical Chemistry
Prereq: 5.13, 5.60; 5.07 or 7.05
G (Fall)
3-0-9 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. Ting

5.59 Advanced Physical Chemistry
Prereq: 5.03, 5.07 or 7.05; 5.12, 5.13
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit

Application of physical principles and methods to contemporary problems of interest in organic chemistry.

Staff

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: M. Bowend, A. Shalek
Spring: R. Field, M. Bowend, S. Solomon

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. Griffin, R. Field

5.62 Biophysical Chemistry
Prereq: 5.13, 5.60
U (Spring)
4-0-8

Elementary statistical mechanics; transport properties; kinetic theory; solid state; reaction rate theory; and chemical reaction dynamics.

K. Nelson, J. Cao

5.64 Biophysical Chemistry
Prereq: 5.13, 5.60; 5.07 or 7.05
G (Fall)
3-0-9 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. 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

5.70] 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 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. Willard

5.72 Statistical Mechanics

Prereq: 5.70, 5.73, 18.075
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit

Staff

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, Schrödinger equation, and operator and matrix methods. Includes applications to one-dimensional potentials (harmonic oscillator), three-dimensional centrosymmetric potentials (hydrogen atom), and angular momentum and spin. Approximation methods include WKB, variational principle, and perturbation theory.
R. G. Griffin, M. Hong

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.
M. Stopa

5.78 Biophysical Chemistry Techniques

Prereq: 5.07 or 7.05
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring; first 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, T. Schwartz

5.80 Advanced Topics of Current Special Interest

Prereq: 5.61 or 8.04; 18.03
G (Fall, 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

5.892 Independent Study in Chemistry for Undergraduates

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

Program of independent study under direction of Chemistry faculty member. May not substitute for required courses for the Chemistry major or minor.
Staff

5.90 Problems in Chemistry

Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Directed research and study of special chemical problems. For Chemistry graduate students only.
R. W. Field

5.913 Seminar in Organic Chemistry

Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Discusses current journal publications in organic chemistry by graduate students and staff.
R. L. Danheiser

5.921 Seminar in Biological Chemistry

Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 [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.
Fall: C. Drennan
Spring: J. Stubbe

5.931 Seminar in Physical Chemistry

Prereq: 5.60
G (Fall, Spring)
2-0-1 [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

5.941 Seminar in Inorganic Chemistry

Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Discusses current journal publications in inorganic chemistry by staff members and students.
C. Drennan

5.95] Teaching College-Level Science and Engineering

(Same subject as 1.95J, 6.982J, 7.59J, 8.395J, 18.094J)
(Subject meets with 2.978)
Prereq: None
G (Fall)
2-0-2 [P/D/F]

Participatory seminar focuses on the knowledge and skills necessary for teaching science and
Bachelor of Science in Chemistry/Course 5

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.09 Principles of Inorganic Chemistry I, 12; 5.12</td>
<td>6</td>
</tr>
<tr>
<td>5.09 Biological Chemistry I, 12, REST; 5.12</td>
<td>8</td>
</tr>
<tr>
<td>5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)</td>
<td>2</td>
</tr>
<tr>
<td>5.13 Organic Chemistry II, 12; 5.12</td>
<td>1</td>
</tr>
<tr>
<td>5.35 Introduction to Experimental Chemistry, 12, LAB; Chemistry (GIR)</td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.09 Principles of Inorganic Chemistry II, 12; 5.03</td>
<td>6</td>
</tr>
<tr>
<td>5.08 Biological Chemistry II, 12; 5.12; 5.07 or 7.05</td>
<td>8</td>
</tr>
<tr>
<td>5.43 Advanced Organic Chemistry, 12; 5.13</td>
<td>24</td>
</tr>
<tr>
<td>5.62 Physical Chemistry, 12; 5.60, 5.61</td>
<td>60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>5.09 Principles of Inorganic Chemistry II, 12; 5.03</td>
<td>40</td>
</tr>
<tr>
<td>5.08 Biological Chemistry II, 12; 5.12; 5.07 or 7.05</td>
<td>40</td>
</tr>
<tr>
<td>5.43 Advanced Organic Chemistry, 12; 5.13</td>
<td>40</td>
</tr>
<tr>
<td>5.62 Physical Chemistry, 12; 5.60, 5.61</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing &amp; Schedule, <a href="http://student.mit.edu/catalog/index.cgi">http://student.mit.edu/catalog/index.cgi</a>.</td>
</tr>
</tbody>
</table>
6.0001 Introduction to Computer Science Programming in Python (New)
Prereq: None
2-3-1
Introduction to computer science and programming for students with little or no programming experience. Students develop skills to program and use computational techniques to solve problems. Topics include the notion of computation, Python, simple algorithms and data structures, testing and debugging, and algorithmic complexity. Combination of 6.0001 and 6.0002 counts as REST subject.
J. V. Guttag

6.0002 Introduction to Computational Thinking and Data Science (New)
Prereq: 6.0001 or permission of instructor
2-3-1
Provides an introduction to using computation to understand real-world phenomena. Topics include plotting, stochastic programs, probability and statistics, random walks, Monte Carlo simulations, modeling data, optimization problems, and clustering. Combination of 6.0001 and 6.0002 counts as REST subject.
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 integrated introduction to electrical engineering and computer science, taught using substantial laboratory experiments with mobile robots. Key issues in the design of engineered artifacts operating in the natural world: measuring and modeling system behaviors; assessing errors in sensors and effectors; specifying tasks; designing solutions based on analytical and computational models; planning, executing, and evaluating experimental tests of performance; refining models and designs. Issues addressed in the context of computer programs, control systems, probabilistic inference problems, circuits and transducers, which all play important roles in achieving robust operation of a large variety of engineered systems. 6 Engineering Design Points.
D. M. Freeman, A. Hartz, L. P. Kaelbling, T. Lozano-Perez

6.02 Introduction to EECS II
Prereq: 6.01; 18.03 or 18.06
18.00U (Fall, Spring) 4-4-4 1/2 Institute LAB
Credit cannot also be received for 6.502
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.
H. Balakrishnan, G. C. Verghese, J. K. White

6.07J Projects in Microscale Engineering for the Life Sciences
(Same subject as HST.410J)
Prereq: None
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 REST
Introduces fundamental principles and techniques of software development, i.e., how to write software that is safe from bugs, easy to understand, and ready for change. Topics include specifications and invariants; testing, test-case generation, and coverage; state machines; abstract data types and representation independence; design patterns for object-oriented
programming; concurrent programming, including message passing and shared concurrency, and defending against races and deadlock; and functional programming with immutable data and higher-order functions. Includes weekly programming exercises and two substantial group projects. 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 Solar Cells  
Prereq: Physics II (GIR) or 6.01; 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 and displays.  
V. Bulovic, R. J. Ram

6.008 Introduction to Inference (New)  
Prereq: 6.01 or permission of instructor  
U (Fall)  
4-0-8  
Introduces probabilistic modeling for problems of inference and machine learning from data, emphasizing analytical and computational aspects. Distributions, marginalization, conditioning, and structure; graphical representations. Belief propagation, decision-making, classification, estimation, and prediction. Sampling methods and analysis. Also provides introduction to asymptotic analysis and information measures, and applications. 4 Engineering Design Points.  
P. Golland, G. W. Wornell

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.  
J. Han, T. Heldt, J. Voldman

6.013 Electromagnetics and Applications  
Prereq: 6.007  
U (Spring)  
4-0-8  
Credit cannot also be received for 6.630  
Analysis and design of modern applications that employ electromagnetic phenomena, including signal and power transmission in guided communication systems and wireless and optical communications. Fundamentals include dynamic solutions to Maxwell’s equations; electromagnetic power and energy, waves in media, guided waves, radiation, and diffraction; coupling to media and structures; resonance; and acoustic analogs.  
L. Daniel, M. R. Watts

6.021J Cellular Biophysics and Neurophysiology  
(Same subject as 2.791J, 20.370J)  
(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  
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.  
J. Han, T. Heldt, J. Voldman

6.022J Quantitative Systems Physiology  
(Same subject as 2.792J, 20.371J, 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  
Application of the principles of energy and mass flow to major human organ systems. Mechanisms 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. Students taking graduate version complete additional assignments. 2 Engineering Design Points.  
T. Heldt, R. G. Mark, C. M. Stultz

6.023J Fields, Forces and Flows in Biological Systems  
(Same subject as 2.793J, 20.330J)  
Prereq: Physics II (GIR); 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
6.024| Molecular, Cellular, and Tissue Biomechanics
(Subject meets as 2.797J, 3.053J, 20.310J)
Prereq: 2.370 or 2.772J; 18.03 or 3.016; Biology (GIR)
U (Fall)
4-0-8
See description under subject 20.310J.
R. D. Kamm, A. J. Grodzinsky, K. Van Vliet

6.025| Medical Device Design
(Subject meets as 2.750J)
(Subject meets as 2.75, 6.525J)
Prereq: 2.72, 6.071, 6.115, or permission of instructor
U (Fall)
4-0-8
See description under subject 2.750J.
A. H. Slocum, C. G. Sodini

6.033| Computer System Engineering
Prereq: 6.004, 6.02
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)
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, constrained search, inheritance, and other problem-solving paradigms. Applications of identification trees, neural nets, genetic algorithms, and other learning paradigms. Speculations on the contributions of human vision and language systems to human intelligence. 4 Engineering Design Points.
P. H. Winston

6.035| Computer Language Engineering
Prereq: 6.004 and 6.005
U (Fall)
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

6.036| Introduction to Machine Learning
Prereq: 6.01
U (Spring)
4-0-8
Introduces principles, algorithms, and applications of machine learning from the point of view of modeling and prediction; formulation of learning problems; representation, over-fitting, generalization; clustering, classification, probabilistic modeling; and methods such as support vector machines, hidden Markov models, and Bayesian networks.
R. Barzilay, T. Jaakkola, L. P. Kaelbling

6.037| Structure and Interpretation of Computer Programs
Prereq: None
U (IAP)
1-0-5 [P/D/F]
Studies the structure and interpretation of computer programs which transcend specific programming languages. Demonstrates thought patterns for computer science using Scheme. Includes weekly programming projects. Enrollment may be limited.
Staff

6.041| 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 18.440
D. P. Bertsekas, J. N. Tsitsiklis

6.042| Mathematics for Computer Science
(Subject as 18.062)
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.
F. T. Leighton, A. R. Meyer, A. Moitra

6.045| Automata, Computability, and Complexity
(Subject 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, finite automata, Turing machines and computability, efficient algorithms and reducibility, the P versus NP problem, NP-completeness, the power of randomness, cryptography, computational learning theory, and quantum computing. Examines the classes of problems that can and cannot be solved in various computational models.
S. Aaronson

6.046| Design and Analysis of Algorithms
(Subject 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.
E. Demaine, M. Goemans
COURSE 6

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

6.049J Evolutionary Biology: Concepts, Models and Computation
(Subject meets as 7.33J)
Prereq: 7.03; 6.0002, 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 meets 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 operations and the physics of computation. Quantum computation.
P. Penfield, Jr., S. Lloyd

6.057 Introduction to MATLAB
Prereq: None
U (IAP)
1-0-2 [P/D/F]
Accelerated introduction to MATLAB and its popular toolboxes. Lectures are interactive, with students conducting sample MATLAB problems in real time. Includes problem-based MATLAB assignments. Students must provide their own laptop and software. Enrollment limited.

Staff

6.058 Preview of Signals and Systems
Prereq: Calculus II (GIR) or permission of instructor
U (IAP)
2-2-2 [P/D/F]
Preparation for 6.003 or 6.011, focusing on several key concepts, including LTI systems, convolution, CT and DT Fourier series and transforms, filtering, sampling, modulation, Laplace and z-transforms, and feedback.

Staff

6.061 Introduction to Electric Power Systems
(Subject meets with 6.690)
Prereq: 6.002, 6.013
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
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 Engineering Design Points.
J. L. Kirtley, Jr.

6.062–6.064 Special Subject in Electrical Engineering and Computer Science
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department Units arranged
Can be repeated for credit
Basic undergraduate subjects not offered in the regular curriculum.
Consult Department

6.070J Electronics Project Laboratory
(Shame 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, assembly, and troubleshooting. Students design, build, and keep a small electronics project to put their new knowledge into practice. Intended for students with little or no previous background in electronics. Enrollment may be limited.
J. Bales

6.071J Electronics, Signals, and Measurement
(Subject meets with 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.
A. White

6.072J Introduction to Digital Electronics
(Subject meets as EC.110J)
Prereq: None
U (Fall, IAP, Spring)
0-3-3 [P/D/F]
See description under subject EC.110J.
J. Bales

6.073J Creating Video Games
(Subject meets as CMS.611J)
Prereq: CMS.608 or 6.01
U (Fall)
3-3-6 HASS-A
See description under subject CMS.611J.
P. Tan, S. Verrilli, O. Macindoe, P. Kaelbling
6.5076–6.5084 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
6.5085–6.5099 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
Covers subject matter not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Consult Department

UNDERGRADUATE LABORATORY SUBJECTS

6.100 Electrical Engineering and Computer Science Project
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Individual experimental work related to electrical engineering and computer science. Student must make arrangements with a project supervisor and file a proposal endorsed by the supervisor. Departmental approval required. Written report to be submitted upon completion of work.
A. R. Meyer

6.101 Introductory Analog Electronics Laboratory
Prereq: 6.002 or 6.071
U (Spring)
2-9-1 Institute LAB
Introductory experimental laboratory explores the design, construction, and debugging of analog electronic circuits. Lectures and laboratory projects in the first half of the course investigate the performance characteristics of semiconductor devices (diodes, BJTs, and MOSFETs) and functional analog building blocks, including single-stage amplifiers, op amps, small audio amplifier, filters, converters, sensor circuits, and medical electronics (ECG, pulse-oximetry). Projects involve design, implementation, and presentation in an environment similar to that of industry engineering design teams. Instruction and practice in written and oral communication provided. Opportunity to simulate real-world problems and solutions that involve tradeoffs and the use of engineering judgment. Engineers from local companies help students with their design projects. 12 Engineering Design Points.
G. P. Hom

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, G. P. Hom

6.115 Microcomputer Project Laboratory
Prereq: 6.002, 6.003, 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 fluorescent 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

6.117 Introduction to Electrical Engineering Lab Skills
Prereq: None
U (IAP)
1-3-2 [P/D/F]
Introduces basic electrical engineering concepts, components, and laboratory techniques. Covers analog integrated circuits, power supplies, and digital circuits. Lab exercises provide practical experience in constructing projects using multimeters, oscilloscopes, logic analyzers, and other tools. Includes a project in which students build a circuit to display their own EKG. Enrollment limited.
G. P. Hom

6.123J Bioinstrumentation Project Lab
(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, M. Jonas, S. F. Nagle, P. So, S. Wasserman, M. F. Yanik

6.129J Biological Circuit Engineering Laboratory
(Same subject as 20.129J)
Prereq: Biology (GIR), Calculus II (GIR)
U (Spring)
2-8-2 Institute LAB
Students assemble individual genes and regulatory elements into larger-scale circuits; they characterize these circuits using quantitative techniques, including flow cytometry, and model their results computationally. Emphasizes concepts and techniques to perform independent synthetic biology research. Discusses current literature and ongoing research in the field of synthetic biology. Instruction and practice in oral and written communication provided. Enrollment limited. 12 Engineering Design Points.
T. Lu, R. Weiss

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

6.142J Robotics: Science and Systems II
(Same subject as 16.406J)
Prereq: 6.141 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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, N. Roy

6.145 Autonomous Robot Design Competition
Prereq: None
U (IAP)
1-2-2 [P/D/F]

Teams build an autonomous LEGO robot and compete for prizes. Provides an opportunity to explore closed-loop control and artificial intelligence, and apply knowledge of algorithms and signal processing. Crash course in programming available to students without experience in robotics. Enrollment limited.

Staff

6.146 Mobile Autonomous Systems Laboratory: MasLab
Prereq: None
U (IAP)
2-2-2 [P/D/F]

Can be repeated for credit

Autonomous robotics contest emphasizing technical AI, vision, mapping and navigation from a robot-mounted camera. Few restrictions are placed on materials, sensors, and/or actuators enabling teams to build robots very creatively. Teams should have members with varying engineering, programming and mechanical backgrounds. Culminates with a robot competition at the end of IAP. Enrollment limited.

Staff

6.147 The BattleCode Programming Competition
Prereq: None
U (IAP)
3-0-3 [P/D/F]

Can be repeated for credit

Artificial Intelligence programming contest in Java. Student teams program virtual robots to play BattleCode, a real-time strategy game. Competition culminates in a live BattleCode tournament. Assumes basic knowledge of programming in Java.

Staff

6.148 Web Programming Competition
Prereq: Permission of instructor
U (IAP)
1-0-5 [P/D/F]

Can be repeated for credit

Teams compete to build the most functional and user-friendly website. Competition is judged by industry experts and includes novice and advanced divisions. Prizes awarded. Lectures and workshops cover website basics. Enrollment limited.

Staff

6.149 Introduction to Programming Using Python
Prereq: None
U (IAP)
2-2-2 [P/D/F]

Face-paced introduction to Python programming language for students with little or no programming experience. Covers both function and object-oriented concepts. Includes weekly lab exercises and final project. Enrollment limited.

Staff

6.150 Mobile Applications Competition
Prereq: Permission of instructor
U (IAP)
2-2-2 [P/D/F]

Can be repeated for credit

Student teams design and build an Android application based on a given theme. Lectures and labs led by experienced students and leading industry experts, covering the basics of Android development, concepts and tools to help participants build great apps. Contest culminates with a public presentation in front of a judging panel comprised of professional developers and MIT faculty. Prizes awarded. Enrollment limited.

Staff

6.151 iOS Game Design and Development Competition
Prereq: None
U (IAP)
3-0-3 [P/D/F]

Introduction to iOS game design and development for students already familiar with object-oriented programming. Provides a set of basic tools (Objective-C and Cocos2D) and exposure to real-world issues in game design. Working in small teams, students complete a final project in which they create their own iPhone game. At the end of IAP, teams present their games in competition for prizes awarded by a judging panel of gaming experts. Enrollment limited.

Staff

6.152J Micro/Nano Processing Technology
(Same subject as 3.155J)
Prereq: Permission of instructor
U (Fall)
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 inter-relationships 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.

L. A. Kolodziejski, J. Michel, M. A. Schmidt
6.161 Modern Optics Project Laboratory
(Subject meets with 6.637)
Prereq: None.
U (Fall, Spring)
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. Recommended prerequisites: 6.007 or 8.03. 12 Engineering Design Points.
C. Worde

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, stroboscopy, motion analysis, and high-speed videography. Students write four extensive lab reports. In the second half, students work in small groups to select, design, and execute independent projects in measurement or photography that apply learned techniques. Project planning and execution skills are discussed and developed over the term. Students engage in extensive written and oral communication exercises. Enrollment limited. 12 Engineering Design Points.
J. K. Vandiver, J. W. Bales

6.169 Theory and Application of Circuits and Electronics
Prereq: None. Coreq: 6.002
U (Fall, Spring)
1-1-1
Building on the framework of 6.002, provides a deeper understanding of the theory and applications of circuits and electronics.
A. Agarwal, J. del Alamo, J. H. Lang, D. J. Perreault

6.170 Software Studio
Prereq: 6.005, 6.006
U (Fall)
4-0-8
Covers design and implementation of software systems, using web applications as the platform. Emphasizes the role of conceptual design in achieving clarity, simplicity, and modularity. Students complete open-ended individual assignments and a major team project. Enrollment may be limited. 12 Engineering Design Points.
D. N. Jackson

6.172 Performance Engineering of Software Systems
Prereq: 6.004, 6.005, 6.006
U (Fall)
3-12-3
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

6.175 Constructive Computer Architecture (New)
Prereq: 6.004
U (Fall)
3-8-1
Illustrates a constructive (as opposed to a descriptive) approach to computer architecture. Topics include combinational and pipelined arithmetic-logic units (ALU), in-order pipelined microarchitectures, branch prediction, blocking and unblocking caches, interrupts, virtual memory support, cache coherence and multicore architectures. Labs in a modern Hardware Design Language (HDL) illustrate various aspects of processor design, culminating in a term project in which students present a multicore design running on an FPGA board. 12 Engineering Design Points.
Arvind

6.177 Building Programming Experience in Python
Prereq: None
U (IAP)
1-4-1 [P/D/F]
Preparation for 6.01 aimed to sharpen skills in program design, implementation, and debugging in Python. Programming intensive, with one short structured assignment and a supervised, but highly individual, mandatory project presentation. Intended for students with some elementary programming experience (equivalent to AP Computer Science). Enrollment limited.
Staff

6.179 Introduction to C and C++
Prereq: None
U (IAP)
3-3-0 [P/D/F]
Fast-paced introduction to the C and C++ programming languages. Intended for those with experience in other languages who have never used C or C++. Students complete daily assignments, a small-scale individual project, and a mandatory online diagnostic test. Enrollment limited.
Staff

6.182 Psychoacoustics Project Laboratory
Prereq: None
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.S183–6.S192 Special Laboratory Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

D. M. Freeman

SENIOR PROJECTS

6.UAP Undergraduate Advanced Project
Prereq: 6.UAT
U (Fall, IAP, 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.
A. R. Meyer

6.UARS Undergraduate Research in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Laboratory subject that covers content not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
D. M. Freeman

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 (Spring)
4-0-8 HASS-S
See description under subject 14.15J.
Consult D. Acmoglu, M. Dahleh

6.231 Dynamic Programming and Stochastic Control
Prereq: 6.041 or 18.313; 18.100
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

D. P. Bertsekas

6.241J 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
G (Fall)
Not offered regularly; consult department
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)
Not offered regularly; consult department
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 2014–2015: G (Fall)  
Acad Year 2015–2016: 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. 6 Engineering Design Points.  
A. Megretski

6.246, 6.247 Advanced Topics in Control  
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

6.248, 6.249 Advanced Topics in Numerical Methods  
Prereq: Permission of 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 Optimization  
(Same subject as 15.084J)  
Prereq: 18.06, 18.100  
G (Spring)  
4-0-8 H-LEVEL Grad Credit  
R. M. Freund, D. P. Bertsekas, G. Perakis

6.253 Convex Analysis and Optimization  
Prereq: 18.06, 18.100  
G (Spring)  
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  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
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 sums of squares.  
P. Parrilo

6.260, 6.261 Advanced Topics in Communications  
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, communications, 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 2014–2015: Not offered
Acad Year 2015–2016: 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.
E. Modiano, D. Shah

6.264J Queues: Theory and Applications
(Same subject as 15.072J)
Prereq: 6.262
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to modern heterogeneous networks and the provision of heterogeneous services. Architectural principles, analysis, algorithmic techniques, performance analysis, and existing designs are developed and applied to understand current problems in network design and architecture. Begins with basic principles of networking. Emphasizes development of mathematical and algorithmic tools; applies them to understanding network layer design from the performance and scalability viewpoint. Concludes with network management and control, including the architecture and performance analysis of interconnected heterogeneous networks. Provides background and insight to understand current network literature and to perform research on networks with the aid of network design projects. 4 Engineering Design Points.
V. W. S. Chan, R. G. Gallager

6.268 Network Science and Models
Prereq: 6.041, 18.06
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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, P. Jaillet

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

6.291 Seminar in Systems, Communications, and Control Research
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Advanced topics in systems, communications, control, optimization, and signal processing. Topics selected according to student and instructor interest. See instructor for specific topics to be offered in a particular term.
S. K. Mitter

Electronics, Computers, and Systems

6.301 Solid-State Circuits
Prereq: 6.012, 6.003
G (Fall)
3-2-7
Analysis and design of transistor circuits, based directly on the semiconductor physics and transistor circuit models developed in 6.012. High-frequency and low-frequency design calculations and simulation of multistage transistor circuits. Trans-linear circuits. The charge-control model. Introduction to operational-amplifier design and application. Some previous laboratory experience assumed. 4 Engineering Design Points.
H. S. Lee

6.302 Feedback Systems
Prereq: 6.003, 2.003, or 16.004
G (Spring)
4-2-6
Staff

6.331 Advanced Circuit Techniques
Prereq: 6.301, 6.302; permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
4-2-6 H-LEVEL Grad Credit
Following a brief classroom discussion of relevant principles, each student completes the paper design of several advanced circuits such as multiplexers, sample-and-holds, gain-controlled amplifiers, analog multipliers,
digital-to-analog or analog-to-digital converters, 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. Enrollment limited. 12 Engineering Design Points.

Staff

6.332, 6.333 Advanced Topics in Circuits
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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.
D. J. Perreault

6.335) Fast Methods for Partial Differential and Integral Equations
(Same subject as 18.336)
Prereq: 6.336, 16.920, 18.085, 18.335, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.336).
A. Townsend

6.336) Introduction to Numerical Simulation
(Same subject as 2.096, 16.910)
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

6.337) Introduction to Numerical Methods
(Same subject as 18.335)
Prereq: 18.03 or 18.034; 18.06, 18.700, or 18.701
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.335).
S. G. Johnson

6.338) Parallel Computing
(Same subject as 18.337)
Prereq: 18.06, 18.700, or 18.701
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 18.337).
A. Edelman

(Same subject as 2.097, 16.920)
Prereq: 18.03 or 18.06
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.920).
Q. Wang, J. K. White

6.341) Discrete-Time Signal Processing
Prereq: 6.011
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
4-0-8 H-LEVEL Grad Credit
A. V. Oppenheim

6.334 Digital Image Processing
Prereq: 6.003, 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit
J. S. Lim

6.345) Automatic Speech Recognition
(Same subject as HST.728)
Prereq: 6.003, 6.041, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
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. R. Chandrairasan, V. Sze, T. Xanthopoulos

6.375 Complex Digital Systems Design
Prereq: 6.004
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 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. Sarapeshkar

Probabilistic Systems and Communication

6.431 Applied Probability
(Subject meets with 6.041)
Prereq: Calculus II (GIR)
G (Fall, Spring)
4-0-8
Credit cannot also be received for 18.440

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 2014–2015: G (Fall)
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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. Nonparametric 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

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 deviations 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, 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, D. Shah

6.440 Essential Coding Theory
Prereq: 6.006, 6.045
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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, D. Moshkovitz

6.441 Information Theory
Prereq: 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit
Mathematical definitions of information measures, convexity, continuity, and variational properties. Lossless source coding; variable-length block compression; Slepian-Wolf theorem; ergodic sources and Shannon-McMillan theorem. Hypothesis testing, large deviations and I-projection. Fundamental limits of block coding for noisy channels: capacity, dispersion, finite blocklength bounds. Coding with feedback. Joint source-channel problem. Rate-distortion theory, vector quantizers. Advanced topics include Gelfand-Pinsker problem, multiple access channels, broadcast channels (depending on available time).

M. Medard, Y. Polianskii, L. Zheng

6.442 Optical Networks
Prereq: 6.041, 6.042
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 are introduced and characterized as fundamental network building blocks on which optical transmission systems and network architectures are based. Beyond the Physical Layer, the higher network layers (Media Access Control, Network and Transport Layers) are treated together as integral parts of network design. Performance metrics, analysis and optimization techniques are developed to help guide the creation of high performance complex optical networks.

V. W. S. Chan

6.443 Quantum Information Science
(Same subject as 8.371, 18.436)
Prereq: 18.435
G (Spring, Summer)
3-0-9 H-LEVEL Grad Credit
Examines quantum computation and quantum information. Topics include quantum circuits, the quantum Fourier transform and search algorithms, the quantum operations formalism, quantum error correction, Calderbank-Shor-Steane and stabilizer codes, fault tolerant quantum computation, quantum data compression, quantum entanglement, capacity of quantum channels, and quantum cryptography and the proof of its security. Prior knowledge of quantum mechanics required.

Information: P. W. Shor

6.450 Principles of Digital Communication
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 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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: phase-matched interactions; optical parametric amplifiers; generation of squeezed states, photon-twin beams, non-classical fourth-order interference, and polarization entanglement.

Quantum systems theory: optimum binary detection; quantum precision measurements; quantum cryptography; and quantum teleportation.

J. H. Shapiro

6.454 Graduate Seminar in Area I
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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

6.503 Foundations of Algorithms and Computational Techniques in Systems Biology (Subject meets with 6.581), 20.482))
Prereq: 6.021, 6.034, 6.046, 6.336, 18.417, or permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
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 2.794), 20.470J, HST.541J)
(Same subject with 2.791J, 6.021), 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)
3-2-5 H-LEVEL Grad Credit
Meets with undergraduate subject 6.021J. Requires the completion of more advanced home problems and/or an additional project.
D. M. Freeman, J. Han, T. Heldt, J. Voldman, M. F. Yanik

6.522J Quantitative Physiology: Organ Transport Systems
(Same subject as 2.796), 20.471J)
(Same subject with 2.792J, 6.022), 20.371J, HST.542J)
Prereq: 2.006 or 6.013; 6.021
G (Spring)
4-2-6 H-LEVEL Grad Credit
Application of the principles of energy and mass flow to major human organ systems. Mechanisms 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. Students taking graduate version complete additional assignments.
T. Heldt, 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
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.410J.
R. D. Kamm, K. Van Vliet

6.525J Medical Device Design
(Same subject as 2.75J)
(Same subject with 2.750J, 6.025J)
Prereq: 2.72, 6.071, 6.115, or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 2.75J.
A. H. Slocum, C. G. Sodini

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.

6.542J Laboratory on the Physiology, Acoustics, and Perception of Speech
(Same subject as 24.966J, HST.712J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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.

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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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)
3-4-5 H-LEVEL Grad Credit
See description under subject HST.582J.
J. Greenberg, E. Adalsteinsson, W. Wells
6.556J Data Acquisition and Image Reconstruction in MRI
(Same subject as HST.580J)
Prereq: 6.011
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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, R. D. Kamm

6.580J Principles of Synthetic Biology
(Same subject as 20.405J)
(Subject meets with 6.580J, 20.305J)
Prereq: None
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 20.505J.
R. Weiss

(Same subject as 20.482J)
(Subject meets with 6.503)
Prereq: 6.021, 6.034, 6.046, 6.336, 7.91, 18.417, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
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

6.589J Principles of Synthetic Biology
(Same subject as 20.405J)
(Subject meets with 6.580J, 20.305J)
Prereq: None
G (Fall)
3-0-9
See description under subject 20.405J.
R. Weiss

Electrodynamics

6.608J Introduction to Particle Accelerators
(Same subject as 8.277J)
Prereq: 6.013 or 8.07; permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
See description under subject 8.277J.
W. Barletta

6.630J Electromagnetics
Prereq: 6.003 or 6.007
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.
L. Daniel, M. R. Watts

6.634J Nonlinear Optics
(Same subject as 8.431J)
Prereq: 6.003 or 8.07
G (Spring)
3-0-9 H-LEVEL Grad Credit
J. G. Fujimoto

6.637 Optical Signals, Devices, and Systems
(Subject meets with 6.161)
Prereq: 6.003
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
6.651J 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.
A. White

6.652J 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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. P. L. Hagelstein

6.685 Electric Machines
Prereq: 6.061 or 6.690; or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

6.690 Introduction to Electric Power Systems
(Subject meets with 6.061)
Prereq: 6.002, 6.013
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
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. J. L. Kirtley, Jr.

6.695J Engineering, Economics and Regulation of the Electric Power Sector
(Subject meets as 15.032J, ESD.162J)
Prereq: Permission of instructor
G (Spring)
3-2-7 H-LEVEL Grad Credit
See description under subject ESD.162J.
I. Perez-Arriaga, C. Knittel

Solid-State Materials and Devices

6.701 Introduction to Nanoelectronics
(Subject meets with 6.719)
Prereq: 6.003
U (Fall)
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

6.717J Design and Fabrication of Microelectromechanical Systems
(Subject meets with 2.374J, 6.777J)
Prereq: 6.603 or 2.003, Physics II (GIR); or permission of instructor
U (Spring)
3-0-9
Provides an introduction to microsystem design. Covers material properties, microfabrication technologies, structural behavior, sensing methods, electromechanical actuation, thermal
The text appears to be a catalog of courses in electrical engineering and computer science, detailing course descriptions, prerequisites, and credit hours for each course. It covers a wide range of topics, including quantum mechanics, solid-state physics, semiconductor devices, and superconductivity. Each course entry includes the course title, its subject number, brief description, prerequisites, and credit information. The catalog is organized alphabetically by course title, with each entry providing a concise overview of the course's content and requirements.
ion implantation, chemical vapor deposition, atomic layer deposition, etching, and epitaxy.
Covers topics relevant to CMOS, bipolar, and optoelectronic device fabrication, including high k gate dielectrics, gate etching, implant-damage enhanced diffusion, advanced metrology, stress effects on oxidation, non-planar and nanowire device fabrication, SiGe and fabrication of process-induced strained Si. Exposure to CMOS process integration concepts, and impacts of processing on device characteristics. Students use modern process simulation tools.
J. L. Hoyt, L. R. Reif

**6.775 CMOS Analog and Mixed-Signal Circuit Design**

Prereq: 6.301
G (Spring)
3-0-9 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.

J. L. Hoyt, S. N. Gough

**6.777J Design and Fabrication of Microelectromechanical Systems**

(Same subject as 2.372J)

Prereq: 6.003 or 2.003, Physics II (GIR); or permission of instructor
G (Spring)
3-0-9 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.

J. L. Hoyt, C. G. Sodini

**6.801 Machine Vision**

(Subject meets with 6.866)

Prereq: 6.003 or permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9

Derives 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

**6.802J Foundations of Computational and Systems Biology (New)**

(Same subject as 7.36J, 20.105J)

Prereq: Biology (GIR), 6.0002 or 6.01; or 7.05; or permission of instructor
U (Spring)
3-0-9

See description under subject 7.36J.

C. Burge, E. Fraenkel, D. Gifford

**6.803 The Human Intelligence Enterprise**

(Subject meets with 6.833)

Prereq: 6.034 or permission of instructor
U (Spring)
3-0-9

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
6.804J Computational Cognitive Science
(Same subject as 9.66J)
(Subject meets with 9.660)
Prereq: 9.40; 18.05 or 18.440; or permission of instructor
U (Fall)
3-0-9
See description under subject 9.66J.

R. C. Miller

6.805J Foundations of Information Policy
(Same subject as STS.085J)
(Subject meets with STS.487)
Prereq: Permission of instructor
U (Fall)
3-0-9
HASS-S

Studies the growth of computer and communications technology and the new legal and ethical challenges that reflect tensions between individual rights and societal needs. Topics include computer crime; intellectual property restrictions on software; encryption, privacy, and national security; academic freedom and free speech. Students meet and question technologists, activists, law enforcement agents, journalists, and legal experts. Instruction and practice in oral and written communication provided. Students taking graduate version complete additional assignments. Enrollment limited.

H. Abelson, M. Fischer, D. Weitzner

6.811 Principles and Practice of Assistive Technology
Prereq: Permission of instructor
U (Fall)
3-4-5

Interdisciplinary project-based subject focuses on the effective practice of assistive and adaptive technology for individuals with disabilities. Lectures cover design methods and problem-solving strategies; institutional review boards; human factors; human-machine interfaces; community perspectives; social and ethical aspects; and assistive technology for motor, cognitive, perceptual, and age-related impairments. Prior knowledge of one or more of the following areas useful: software; electronics; human-computer interaction; cognitive science; mechanical engineering; control; or MIT hobby shop, MIT PSC, or other relevant independent project experience.

R. C. Miller

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
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 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: Calculus II (GIR), 6.01
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 graduate version complete additional assignments. 6 Engineering Design Points.

F. P. Durand, W. T. Freeman

6.816 Multicore Programming
(Subject meets with 6.836)
Prereq: 6.006
U (Spring)
4-0-8

Introduces principles and core techniques for programming multicore machines. Topics include locking, scalability, concurrent data structures, multiprocessor scheduling, load balancing, and state-of-the-art synchronization techniques, such as transactional memory. Includes sequence of programming assignments on a large multicore machine, culminating with the design of a highly concurrent “firewall” application. Students taking graduate version complete additional assignments.

N. Shavit

6.819 Advances in Computer Vision (New)
(Subject meets with 6.869)
Prereq: 6.041 or 6.042; 18.06
U (Fall)
3-0-9

Advanced topics in computer vision with a focus on the use of machine learning techniques and applications in graphics and human-computer interface. Covers image representations, texture models, structure-from-motion algorithms, Bayesian techniques, object and scene recognition, tracking, shape modeling, and image databases. Applications may include face recognition, multimodal interaction, interactive systems, cinematic special effects, and photorealistic rendering. Covers topics complementary to 6.801. Students taking graduate version complete additional assignments.

W. T. Freeman, A. Torralba

6.820 Foundations of Program Analysis
Prereq: 6.035
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

Presents major principles and techniques for program analysis. Includes formal semantics, type systems and type-based program analysis, abstract interpretation and model checking and synthesis. Emphasis on Haskell and Ocam, but no prior experience in these languages is assumed. Student assignments include implementing of techniques covered in class, including building simple verifiers.

A. Solar-Lezama
6.823 Computer System Architecture
Prereq: 6.004
G (Spring)
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, D. Sanchez

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
G (Fall)
3-0-9 H-LEVEL Grad Credit

Topics related to the engineering and design of database systems, including data models; database and schema design; schema normalization and integrity constraints; query processing; query optimization and cost estimation; transactions; recovery; concurrency control; isolation and consistency; distributed, parallel and heterogeneous databases; adaptive databases; trigger systems; pub-sub systems; semi structured data and XML querying. Lecture and readings from original research papers. Semester-long project and paper. Students taking graduate version complete different assignments. Enrollment may be limited. 4 Engineering Design Points.
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

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

6.832 Underactuated Robotics
Prereq: 6.141, 2.12, 2.165, or permission of instructor
G (Fall)
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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 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
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

6.836 Multicore Programming
(Subject meets with 6.816)
Prereq: 6.006
G (Spring)
4-0-8 H-LEVEL Grad Credit
Introduces principles and core techniques for programming multicore machines. Topics include locking, scalability, concurrent data structures, multiprocessor scheduling, load balancing, and state-of-the-art synchronization techniques, such as transactional memory. Includes sequence of programming assignments on a large multicore machine, culminating with the design of a highly concurrent “firewall” application. Students taking graduate version complete additional assignments.

N. Shavit

6.837 Computer Graphics
Prereq: Calculus II (GIR), 6.005; or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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, W. Matusik

6.838 Advanced Topics in Computer Graphics
Prereq: 6.837
G (Spring)
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.

W. Matusik

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.

W. Matusik

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 for Course 18 students)
See description under subject 18.404J.

M. Sipser

6.841J Advanced Complexity Theory
(Same subject as 18.405J)
Prereq: 18.404
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 18.405J.

D. Moshkovitz

6.842 Randomness and Computation
Prereq: 6.046, 6.840
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Introduction to quantum computational complexity theory, the study of the fundamental capabilities and limitations of quantum computers. Topics include complexity classes, lower bounds, communication complexity, proofs and advice, and interactive proof systems in the quantum world; classical simulation of quantum circuits. The objective is to bring students to the research frontier.

S. Aaronson

6.846 Parallel Computing
Prereq: 6.004 or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit
Introduction to parallel and multicore computer architecture and programming. Topics include the design and implementation of multicore processors; networking, video, continuum, particle and graph applications for multicores; communication and synchronization algorithms and mechanisms; locality in parallel computations; computational models, including shared memory, streams, message passing, and data parallel; multicore mechanisms for synchronization, cache coherence, and multithreading. Performance evaluation of multicores; compilation and runtime systems for parallel computing. Substantial project required. 4 Engineering Design Points.

A. Agarwal

6.849 Geometric Folding Algorithms: Linkages, Origami, Polyhedra
Prereq: 6.046 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers discrete geometry and algorithms underlying the reconfiguration of foldable structures, with applications to robotics, manufacturing, and biology. Linkages made from one-dimensional rods connected by hinges; constructing polynomial curves, characterizing rigidity, characterizing unfoldable versus locked, protein folding. Folding two-dimensional paper (origami): characterizing flat foldability, algorithmic origami design, one-cut magic trick. Unfolding and folding three-dimensional polyhedra: edge unfolding, vertex unfolding, gluings, Alexandrov’s Theorem, hinged dissections.

E. D. Demaine

6.850 Geometric Computing
Prereq: 6.046
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
for massive data sets: external memory and streaming algorithms. Geometric optimization.
P. Indyk

6.851 Advanced Data Structures
Prereq: 6.046
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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

6.852J Distributed Algorithms
(Same subject as 18.437J)
Prereq: 6.046
G (Fall)
3-0-9 H-LEVEL Grad Credit

Design and analysis of concurrent algorithms, emphasizing those suitable for use in distributed networks. Process synchronization, allocation of computational resources, distributed consensus, distributed graph algorithms, election of a leader in a network, distributed termination, deadlock detection, concurrency control, communication, and clock synchronization. Special consideration given to issues of efficiency and fault tolerance. Formal models and proof methods for distributed computation.
N. A. Lynch

6.853 Topics in Algorithmic Game Theory
Prereq: 6.006 or 6.046
G (Fall)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

Presents research topics at the interface of computer science and game theory, with an emphasis on algorithms and computational complexity. Explores the types of game-theoretic tools that are applicable to computer systems, the loss in system performance due to the conflicts of interest of users and administrators, and the design of systems whose performance is robust with respect to conflicts of interest inside the system. Algorithmic focus is on algorithms for equilibria, the complexity of equilibria and fixed points, algorithmic tools in mechanism design, learning in games, and the price of anarchy.
K. Daskalakis

6.854J Advanced Algorithms
(Same subject as 18.415J)
Prereq: 6.041, 6.042, or 18.440; 6.046
G (Fall)
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

6.856 Randomized Algorithms
(Same subject as 18.416)
Prereq: 6.854J, 6.041 or 6.042J
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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, 6.042J
G (Spring)
4-0-8 H-LEVEL Grad Credit

Emphasis on applied cryptography and may include: basic notion of systems security, cryptographic hash functions, symmetric cryptography (one-time pad, stream ciphers, block ciphers), cryptanalysis, secret-sharing, authentication codes, public-key cryptography (encryption, digital signatures), public-key attacks, web browser security, biometrics, electronic cash, viruses, electronic voting. Assignments include a group final project. Topics may vary year to year.
R. L. Rivest

6.858 Computer Systems Security
Prereq: 6.033, 6.005
G (Fall)
3-6-3 H-LEVEL Grad Credit

Design and implementation of secure computer systems. Lectures cover attacks that compromise security as well as techniques for achieving security, based on recent research papers. Topics include operating system security, privilege separation, capabilities, language-based security, cryptographic network protocols, trusted hardware, and security in web applications and mobile phones. Labs involve implementing and compromising a web application that sandboxes arbitrary code, and a group final project. 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
4-0-8 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-3-6 H-LEVEL Grad Credit

Explores the relationship between computer representation of knowledge and the structure of natural language. Emphasizes development of 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; Treebank grammars and statistical parsing. 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, semantic 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.

B. K. P. Horn

6.865 Advanced Computational Photography
(Subject meets with 6.815)
Prereq: Calculus II (GIR), 6.01
G (Spring)
3-0-9 H-LEVEL Grad Credit

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-dimensional imaging, human visual perception and color, single view 3-D model reconstruction, morphing, data-rich photography, super-resolution, and image-based rendering. Students taking graduate version complete additional assignments.

F. P. Durand, W. T. Freeman

6.866 Machine Vision
(Subject meets with 6.801)
Prereq: 6.003 or permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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: 6.041, 18.05, or 18.06
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, non-parametric Bayesian methods, hidden Markov models, and Bayesian networks. Recommended prerequisite: 6.036. T. Jaakkola, L. P. Kaelbling

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 (Fall)
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
(Subject meets with 6.819)
Prereq: 6.041 or 6.042; 18.06
G (Fall)
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. Covers image representations, texture models, structure-from-motion algorithms, Bayesian techniques, object and scene recognition, tracking, shape modeling, and image databases. Applications may include face recognition, multimodal interaction, interactive systems, cinematic special effects, and photorealistic rendering. Covers topics complementary to 6.866. Students taking graduate version complete additional assignments.

W. T. Freeman, A. Torralba

6.870 Advanced Topics in Computer Vision
Prereq: 6.801, 6.869, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.

G. Alterovitz, P. Zolovits

6.874J Computational Systems Biology
(Same subject as HST.506J)
Prereq: Biology (GIR); 18.440 or 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit

Presents computational approaches and algorithms for contemporary problems in systems biology, with a focus on models of biological systems, including regulatory network discovery and validation. Topics include genotypes, regulatory factor binding and motif discovery, and whole genome RNA expression; regulatory networks (discovery, validation, data integration, protein-protein interactions, signaling, whole genome chromatin immunoprecipitation analysis); and experimental design (model validation, interpretation of interventions). Discusses computational methods, including directed and undirected graphical models, such as Bayesian networks, factor graphs, Dirichlet processes, and topic models. Multidisciplinary team-oriented final research project.

D. K. Gifford, T. S. Jaakkola
6.875 Advanced Topics in Cryptography (Same subject as 18.425)
Prereq: 6.046
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

6.876 Advanced Topics in Cryptography (Same subject as 18.426)
Prereq: 6.875
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

6.878 Advanced Computational Biology: Genomes, Networks, Evolution (Same subject as HST.507J)
(Same subject as 15.628J)
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 Advanced Topics in Artificial Intelligence (Same subject as 15.628J)
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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)
Not offered regularly; consult department
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)
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

6.902 Engineering Innovation and Design (Same subject as 2.723J, ESD.051J)
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.
A. R. Meyer

6.905 Large-scale Symbolic Systems (New)
(Subject meets with 6.945)
Prereq: 6.034 or permission of instructor
U (Spring)
3-0-9
Concepts and techniques for the design and implementation of large software systems that can be adapted to uses not anticipated by the designer. Applications include compilers, computer-algebra systems, deductive systems, and some artificial intelligence applications. Covers means for decoupling goals from strategy, mechanisms for implementing additive data-directed invocation, work with partially-specified entities, and how to manage multiple viewpoints. Topics include combinators, generic operations, pattern matching, pattern-directed invocation, rule systems, backtracking, dependencies, indeterminacy, memoization, constraint propagation, and incremental refinement. Students taking graduate version complete additional assignments.
G. J. Sussman

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.
A. R. Meyer

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.
A. R. Meyer
6.921 VI-A Internship
Prereq: None
U (Summer)
0-12-0 [P/D/F]
Provides academic credit for the first assignment of VI-A undergraduate students at companies affiliated with the department's VI-A internship program. Limited to students participating in the VI-A internship program.
M. Zahn

6.922 Advanced VI-A Internship
Prereq: 6.921
U (Spring, Summer)
0-12-0 [P/D/F]
Provides academic credit for the second assignment of VI-A undergraduate students at companies affiliated with the department's VI-A internship program. Limited to students participating in the VI-A internship program.
M. Zahn

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

6.932J Linked Data Ventures
(Same subject as 15.377J)
Prereq: 6.005, 6.033, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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, L. Kagal, K. Rae, R. Sturdevant

6.933 Entrepreneurship in Engineering: The Founder's Journey
Prereq: None
G (Fall)
4-0-8
Immerses students in the experience of an engineer who founded a start-up company. Examines leadership, innovation, and creativity through the lens of an entrepreneur. Suitable for students interested in transforming an idea into a business or other realization for wide-scale societal impact. Covers critical aspects of validating ideas and assessing personal attributes needed to activate and lead a growing organization. Teams explore the basics of new venture creation and experimentation. Emphasizes personal skills and practical experiences. No listeners.
C. Chase

6.935J Financial Market Dynamics and Human Behavior
(Same subject as 15.481J)
Prereq: 15.401, 15.414, or 15.415
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
4-0-5 H-LEVEL Grad Credit
See description under subject 15.481J.
A. Lo

6.941 Statistics for Research Projects: Statistical Modeling and Experiment Design
Prereq: None
G (IAP)
2-2-2 [P/D/F]
Practical introduction to data analysis, statistical modeling, and experimental design, intended to provide essential skills for conducting research. Covers basic techniques such as hypothesis testing and regression models for both traditional experiments and newer paradigms such as evaluating simulations. Assignments reinforce techniques through analyzing sample datasets and reading case studies. Students with research projects will be encouraged to share their experiences and project-specific questions.
Staff

6.945 Large-scale Symbolic Systems
(Subject meets with 6.905)
Prereq: 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. Covers means for decoupling goals from strategy, mechanisms for implementing additive data-directed invocation, work with partially-specified entities, and how to manage multiple viewpoints. Topics include combinators, generic operations, pattern matching, pattern-directed invocation, rule systems, backtracking, dependencies, indeterminacy, memoization, constraint propagation, and incremental refinement. Students taking graduate version complete additional assignments.
G. J. Sussman

6.946J Classical Mechanics: A Computational Approach
(Same subject as 8.351J, 12.620J)
(Subject meets with 12.008)
Prereq: Physics I (GIR), 18.03, permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-3-6 H-LEVEL Grad Credit
See description under subject 12.620J.
J. Wisdom, G. J. Sussman

6.951 Graduate VI-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 graduate VI-A students at companies affiliated with the department's VI-A internship program. Limited to graduate students participating in the VI-A internship program.
M. Zahn

6.952 Graduate VI-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 VI-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 VI-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

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

6.980 Teaching Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For qualified students interested in gaining teaching experience. Classroom, tutorial, or laboratory teaching under the supervision of a faculty member. Enrollment limited by availability of suitable teaching assignments.

H. S. Lee, R. C. Miller

6.981 Teaching Electrical Engineering and Computer Science
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For Teaching Assistants in Electrical Engineering and Computer Science, in cases where teaching assignment is approved for academic credit by the department.

H. S. Lee, R. C. Miller

6.982 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.

A. R. Meyer

6.999 Practical Experience in EECS
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For Course 6 students in the SM/PhD track who seek practical off-campus research experiences or internships in electrical engineering or computer science. Before enrolling, students must have a firm employment offer from a company or organization and secure a research supervisor within EECS. Employers required to document the work accomplished. Research proposals subject to departmental approval; consult departmental Graduate Office.

L. A. Kolodziejski

6.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 20.EPE, 22.EPE)
Prereq: None
U (Fall, IAP)
1-0-0 [P/D/F]
See description under subject 2.EPE.

Staff

6.6P UPOP Engineering Practice Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 20.EPE, 22.EPE)
Prereq: None
U (Fall, IAP)
1-0-0 [P/D/F]
See description under subject 2.EPE.

Staff

6.S897–6.S899 Special Subject in Computer Science
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.S911–6.S919 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
Covers subject matter not offered in the regular curriculum.

Consult Department

Prereq: None
G (Fall, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Opportunity for study of graduate-level topics related to electrical engineering and computer science but not included elsewhere in the curriculum. Registration under this subject normally used for situations involving small study groups. Normal registration is for 12 units. Registration subject to approval of professor in charge. Consult the department for details.

L. A. Kolodziejski
6.974–6.979 Special Subject in Electrical Engineering and Computer Science
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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

6.11 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

6.711 Master of Engineering Program Thesis
Prereq: 6.UR
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.
A. R. Meyer

6.211 Undergraduate Research in Electrical Engineering and Computer Science
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Individual research project arranged with appropriate faculty member or approved supervisor. Forms and instructions for the proposal and final report are available in the EECS Undergraduate Office.
A. R. Meyer

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

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</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 [satisfied by the mathematics requirement in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [satisfied by 6.01 and 6.02 together 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).

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; 6.011, 18.03*
6.1AP Oral Communication, 6
Plus one of the following:
6.UR Undergraduate Research in Electrical Engineering and Computer Science
6.11 Graduate Thesis
6.UR Seminar in Undergraduate Advanced Research, 12, CI-M; 6.UR

Restricted Electives
132–144
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. Students in Course 6-1 must select 6.041 (or 18.440); students in Course 6-3 must select 6.042.
2. One department laboratory:
   One subject selected from the undergraduate laboratory subjects 6.035, 6.101, 6.111, 6.155, 6.123, 6.129, 6.131, 6.141, 6.142, 6.152, 6.161, 6.165, 6.170, 6.172, 6.182, or 6.813; students in Course 6-3 must select a CS laboratory subject from 6.035, 6.141, 6.170, 6.172, or 6.813. 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 at least one 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: 6.033, 6.034, 6.046.
   (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, 6.046], 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.
   To complete the required Communication-Intensive subjects in the major, students must take one of the following Communication Intensive (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, 6.141, 6.151, 6.161, 6.163, 6.182, or 6.805. Students in Course 6-3 may take 6.1AP plus 6.UR, or 6.1AP plus CI-M subjects in the EECS foundation list (6.101, 6.111, 6.115, 6.131, 6.141, 6.151), 6.161, 6.163, 6.182) to fulfill the CI-M component of the Communication Requirement.

Departmental Program Units That Also Satisfy the GIRs

Unrestricted Electives
180–192

Total Units Beyond the GIRs Required for SB Degree

Notes
*Alternate prerequisites are listed in the subject descriptions.
(1) See the description of required communication-intensive subjects for information about acceptable substitutions for the 6.1AP/6.UR or 6.1AP/6.UR sequence.
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.
Master of Engineering in Electrical Engineering and Computer Science/Course 6-P

See Notes on Master of Engineering and Bachelor's Degree Programs (next page)

<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></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 (satisfied by 6.01 and 6.02 together in the Departmental Program)</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for the SB and MEng Degrees</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);
- 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*
- 6.041 Oral Communication, 6
- Plus one of the following:**
  - 6.042J Undergraduate Advanced Project, 6, CI-M; 6.041
  - or 6.042J Seminar in Undergraduate Advanced Research, 12, CI-M; 6.041
- 6.043M MEng Program Thesis, 24**

**Restricted Electives**

1. Two mathematics subjects (also satisfies REST requirement):
   - Either 18.03 or 18.06 (alternatively 18.700)
   - and
   - Either 6.041 (alternatively 18.440) or 6.042J 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 6.042J.

2. One department laboratory:
   - One subject selected from the undergraduate laboratory subjects 6.035, 6.101, 6.111, 6.112, 6.123, 6.129, 6.131, 6.141, 6.142, 6.152, 6.161, 6.163, 6.170, 6.172, 6.182 or 6.813; students in Course 6-3 must select a CS laboratory subject from 6.035, 6.141, 6.170, 6.172, or 6.813. 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 EEC 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: 6.033, 6.034, 6.044J.
   - (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, 6.044J, with at least one chosen from the EE header list and at least one from the CS header list.

5. Two undergraduate subjects from a departmental list of advanced undergraduate subjects and four graduate subjects totaling at least 42 units, of which at least 36 units must be offered by EECS. At least three of the five required EECS subjects must fall within a single concentration field as defined by the department. Four H-level graduate subjects totaling at least 42 units, of which at least 36 units must come from subjects taken within the department.

6. 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, 6.025J, 6.033, 6.101, 6.111, 6.115, 6.129J, 6.131, 6.141J, 6.152J, 6.161, 6.163, 6.182, or 6.805. 6.041 plus 6.042J or 6.042J typically constitutes the second CI-M. Students may also take 6.041 plus a second CI-M undergraduate laboratory subject (6.01, 6.111, 6.115, 6.129J, 6.131, 6.141J, 6.152J, 6.161, 6.163, 6.182) to fulfill the CI-M component of Communication Requirement.

**Departmental Program Units That Also Satisfy the GIRs**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

**Unrestricted Electives**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td></td>
</tr>
</tbody>
</table>

**Total Units Beyond the GIRs Required for Simultaneous Award of the MEng and SB Degrees**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>270–282</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

*Alternate prerequisites are listed in the subject description.

**6-PA Program requires performance of thesis at company location.

15) See the description of required communication-intensive subjects for information about acceptable substitutions for the 6.041/6.042 or 6.041/6.043 sequence.
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 5 and 6 and the MEng thesis (6.ThM).

The graduate subjects required under restricted elective category 5 are selected with departmental review and approval to ensure that the combination of these with the two advanced undergraduate subjects 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

<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>8</td>
<td></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>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 7.02 or 20.109 in the Departmental Program]</td>
<td>1</td>
<td></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**

1. **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)*

2. **Chemistry**
   - **5.12** Organic Chemistry I, 12, REST; *Chemistry (GIR)*
   - **5.60** Thermodynamics and Kinetics, 12, REST; *Calculus II (GIR), Chemistry (GIR)*
   - **or**
   - **7.10J** Physical Chemistry of Biomolecular Systems, 12; *Calculus II (GIR), Chemistry (GIR), Physics I (GIR), Physics II (GIR)*
   - **or**
   - **20.110J** Thermodynamics of Biomolecular Systems, 12; *Calculus II (GIR), Chemistry (GIR)*

3. **Introductory Laboratory**
   - **7.02** Introduction to Experimental Biology and Communication, 18, CI-M, LAB; *Biology (GIR)*
   - **or**
   - **20.109** Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; *Biology (GIR), Chemistry (GIR), 6.0002, 18.03, 20.110J*

4. **Foundational Subjects**
   - **Three Computer-Science subjects:**
     - **6.005** Elements of Software Construction, 12; REST; *6.01, 6.042J*
     - **6.006** Introduction to Algorithms, 12; *6.01, 6.042J*
     - **6.046J** 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**
     - **5.07J** Biological Chemistry I, 12, REST; *5.12*

5. **Restricted Electives**
   - **24**
     - **One subject in Computational Biology:**
       - **6.047** Computational Biology: Genomes, Networks, Evolution, 12; *6.006, 6.041, Biology (GIR)*
     - **6.503** Foundations of Algorithms and Computational Techniques in Systems Biology, 12; *6.046J*
     - **7.36** Foundations of Computational and Systems Biology, 12; *7.05*
     - **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, 6.0002*

6. **Advanced Undergraduate Project**
   - **12**
     - **6.UAT** Oral Communication, 6
     - **Plus one of the following:**
     - **6.UAP** Undergraduate Advanced Project, 6, CI-M; *6.UAT*
     - **or**
     - **6.UAR** Seminar in Undergraduate Advanced Research, 12, CI-M; *6.UR*

**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**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>195–198</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.

See the description of required communication-intensive subjects for information about acceptable substitutions for the 6.UAT/6.UAP or 6.UAT/6.UAR sequence.

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.
# Master of Engineering in Computer Science and Molecular Biology/Course 6-7P

## 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 [REST]</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [GIRs]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [GIRs]</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>Course</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematics and Introductory</td>
<td>213–216</td>
</tr>
<tr>
<td>18.03</td>
<td>Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>18.06</td>
<td>Linear Algebra, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>6.01</td>
<td>Introduction to EECS I, 12, 1/2 LAB; Physics II (GIR)</td>
</tr>
<tr>
<td>6.042J</td>
<td>Mathematics for Computer Science, 12, REST; Calculus I (GIR)</td>
</tr>
<tr>
<td>2. Chemistry</td>
<td></td>
</tr>
<tr>
<td>5.12</td>
<td>Organic Chemistry I, 12, REST; Chemistry (GIR)</td>
</tr>
<tr>
<td>5.60</td>
<td>Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>7.10J</td>
<td>Physical Chemistry of Biomolecular Systems, 12; Calculus II (GIR), Chemistry (GIR), Physics I (GIR), Physics II (GIR)</td>
</tr>
<tr>
<td>7.10J</td>
<td>Physical Chemistry of Biomolecular Systems, 12; Calculus II (GIR), Chemistry (GIR), Physics I (GIR), Physics II (GIR)</td>
</tr>
<tr>
<td>20.110J</td>
<td>Thermodynamics of Biomolecular Systems, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
</tr>
<tr>
<td>3. Introductory Laboratory</td>
<td></td>
</tr>
<tr>
<td>7.02J</td>
<td>Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)</td>
</tr>
<tr>
<td>20.109</td>
<td>Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; Biology (GIR), Chemistry (GIR), 6.0002, 18.03, 20.110J</td>
</tr>
<tr>
<td>4. Foundational Subjects</td>
<td></td>
</tr>
<tr>
<td>Three Computer Science subjects:</td>
<td></td>
</tr>
<tr>
<td>6.005</td>
<td>Elements of Software Construction, 12; REST; 6.01, 6.042J</td>
</tr>
<tr>
<td>6.006</td>
<td>Introduction to Algorithms, 12; 6.01, 6.042J</td>
</tr>
<tr>
<td>6.046J</td>
<td>Design and Analysis of Algorithms, 12; 6.006</td>
</tr>
<tr>
<td>Three Biological Science subjects:</td>
<td></td>
</tr>
<tr>
<td>7.03</td>
<td>Genetics, 12, REST; Biology (GIR)</td>
</tr>
<tr>
<td>7.06</td>
<td>Cell Biology, 12; 7.03, 7.05</td>
</tr>
<tr>
<td>7.05</td>
<td>General Biochemistry, 12, REST; 5.12</td>
</tr>
<tr>
<td>or</td>
<td>Biological Chemistry I, 12, REST; 5.12</td>
</tr>
<tr>
<td>5. Restricted Electives</td>
<td>24</td>
</tr>
<tr>
<td>One subject in Computational Biology:</td>
<td></td>
</tr>
<tr>
<td>6.497</td>
<td>Computational Biology: Genomes, Networks, Evolution, 12; 6.006, 6.041, Biology (GIR)</td>
</tr>
<tr>
<td>6.503</td>
<td>Foundations of Algorithms and Computational Techniques in Systems Biology, 12; 6.046J</td>
</tr>
<tr>
<td>7.36J</td>
<td>Foundations of Computational and Systems Biology, 12; 7.05</td>
</tr>
<tr>
<td>One subject in Biology:</td>
<td></td>
</tr>
<tr>
<td>7.20J</td>
<td>Human Physiology, 12; 7.05</td>
</tr>
<tr>
<td>7.23J</td>
<td>Immunology, 12; 7.05</td>
</tr>
<tr>
<td>7.07</td>
<td>Principles of Human Disease, 12; 7.03, 7.05, 7.06</td>
</tr>
<tr>
<td>7.08</td>
<td>Molecular Biology, 12; 7.03, 7.05</td>
</tr>
<tr>
<td>7.23J</td>
<td>Evolutionary Biology: Concepts, Models, and Computation, 12; 7.03, 6.0002</td>
</tr>
<tr>
<td>6. Advanced Undergraduate Project</td>
<td>12</td>
</tr>
<tr>
<td>6.UAT</td>
<td>Oral Communication, 6</td>
</tr>
</tbody>
</table>

Plus one of the following:
- 6.0A2 Undergraduate Advanced Project, 6, CI-M; 6.UAT |
| 6.UAR  | Seminar in Undergraduate Advanced Research, 12, CI-M; 6.UR |
| 7. Four graduate subjects totaling at least 42 units, which includes two concentration subjects (approved by the department) plus a third graduate subject in electrical engineering and computer science and/or biology. |
| 8. Two subjects from a restricted departmental list of math electives. |
Departmental Program Units That Also Satisfy the GIRs (36)

Unrestricted Electives 48

Total Units Beyond the GIRs Required for SB Degree 285–288

* 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 and corequisites are listed in the subject description.

(i) To complete the required Communication-Intensive subjects in the major, students must take 7.02J or 20.109 or 6.UAT/6.UAP by the end of the third year. The second CI-M should be chosen to complete the requirements in categories 3 and 6 above.

(ii) See the description of required communication-intensive subjects for information about acceptable substitutions for the 6.UAT/6.UAP or 6.UAT/6.UAR sequence.

Notes on Master of Engineering and Bachelor’s Degree Programs

The Master of Engineering program builds on the bachelor’s degree program (6–7), with restricted elective categories 7 and 8 and the MEng thesis.

The Master of Engineering in Computer Science and Molecular Biology is only awarded to students who have received, or are simultaneously receiving, the 6–7 bachelor’s degree. Students who receive the Master of Engineering degree after having obtained the 6–7 bachelor’s degrees must fulfill the requirements for Course 6–7P as described above.

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**

7.012 Introductory Biology  
Prereq: None  
U (Fall)  
5-0-7 BIOLOGY  
Credit cannot also be received for 7.013, 7.014, 7.015, 7.016, ES.7012, ES.7013  
Exploration into areas of current research in cell biology, immunology, neurobiology, human genetics, developmental biology, and evolution. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.  
*E. Lander, R. Weinberg*

7.013 Introductory Biology  
Prereq: None  
U (Spring)  
5-0-7 BIOLOGY  
Credit cannot also be received for 7.012, 7.014, 7.015, 7.016, ES.7012, ES.7013  
Genomic approaches to human biology, focusing on neuroscience, development, repair and disease (including infectious agents, inherited diseases and cancer). Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.  
*H. Sive*

7.014 Introductory Biology  
U (Spring)  
5-0-7 BIOLOGY  
Credit cannot also be received for 7.012, 7.013, 7.015, 7.016, ES.7012, ES.7013  
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. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.  
*G. C. Walker, S. W. Chisholm*

7.015 Introductory Biology  
Prereq: Advanced high school course covering cellular and molecular biology, or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
5-0-7 BIOLOGY  
Credit cannot also be received for 7.012, 7.013, 7.014, 7.016, ES.7012, ES.7013  
Emphasizes the application of the fundamental principles to trending topics in microbiology- and immunology-related issues, and allows students to understand how biological principles are used in a direct, human health context. Introduces evolutionary principles, demonstrating their relevance to current topics in infectious diseases. Includes written assignments, discussions, and group presentations. Enrollment limited to 60. Admittance may be controlled by lottery.  
*M. Laub, H. Ploegh*

7.016 Introductory Biology  
Prereq: None  
U (Fall)  
5-0-7 BIOLOGY  
Credit cannot also be received for 7.012, 7.013, 7.014, 7.015, ES.7012, ES.7013  
Introduction to fundamental principles of biochemistry, molecular biology and genetics for understanding the functions of living systems. Covers examples of the use of chemical biology and 21st-century molecular genetics in understanding human health and therapeutic intervention. Enrollment limited to seating capacity of classroom. Admittance may be controlled by lottery.  
*A. Amon, B. Imperiali*

7.021 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, P. Gupta, K. D. Wittrup  
Spring: M. Gehring, T. Schwartz, K. 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, C. Kaiser, P. Reddiens  
Spring: M. Hemann, A. Regev*

7.05 General Biochemistry  
Prereq: 5.12, Biology (GIR), or permission of instructor  
U (Fall, Spring)  
5-0-7 REST  
Credit cannot also be received for 5.07, 20.507  
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.  
*M. Vander Heiden, M. Yaffe*

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 biosynthesis of cellular membranes and organelles; cell growth and oncogenic transformation; transport, receptors, and cell signaling; the cytoskeleton, the extracellular matrix, and cell movements; cell division and cell cycle; functions of specialized cell types. Emphasizes the
current molecular knowledge of cell biological processes as well as the genetic, biochemical, and other experimental approaches that resulted in these discoveries.
Fall: A. Martin, F. Solomon
Spring: I. Cheeseman, T. Orr-Weaver

7.08 Biological Chemistry II
(Same subject as 5.08)
Prereq: 5.12; 5.07 or 7.05
U (Spring)
4-0-8
See description under subject 5.08).
J. Stubble, E. Nolan

7.10 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 2.772, 20.110
See description under subject 20.111J.
E. Alm, A. Jasanoff, C. Voigt

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

7.15 Experimental Molecular Genetics
Prereq: 7.02, 7.03
U (Spring)
4-16-10
In this project-based laboratory subject, students carry out independent experiments that develop skills in the planning, execution, and analysis of original experimental biological research. Specific research topic, which is determined by teaching staff, involves the application of modern methods of molecular genetics. Reading and writing assignments focus on the critical evaluation and discussion of relevant scientific literature. Emphasis placed on instruction in laboratory methods and the testing of hypotheses, as well as the critical analysis of experimental results.
J. Weng

7.16 Experimental Molecular Biology
Prereq: 7.02, 7.03, 7.05
U (Fall)
4-16-10
Applies high-throughput genetic approaches to study the response of mammalian cells to cytotoxic or infectious stimuli. RNA interference (RNAi) screening and microarray expression analysis 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 conserved pathogen molecules. Instruction and practice in written and oral communication provided.
J. Saei

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: D. Kim, M. L. Pardue
Spring: U. Rajbhandary

Permission of the instructor and the Biology Education Office must be obtained in advance.
Fall: D. Kim, M. L. Pardue
Spring: U. Rajbhandary

7.20 Human Physiology
(Same subject as HST.540J)
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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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: 7.06
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
5-0-7
Topics include development of animal body plans, tissue patterning, cell type determination, organogenesis, morphogenesis, stem cells, and the evolution of developmental diversity and processes. Covers experimental approaches to problems of development and evolution, such as the study of vertebrate (mouse, chick, frog, fish) and invertebrate (fly, worm) models.
R. O. Hynes, P. Reddien
7.23 Immunology
(Subject meets with 7.63)
Prereq: 7.06, or permission of instructor
U (fall)
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; immunoglobulin, T cell receptor, and major histocompatibility complex (MHC) proteins and genes; development and functions of B and T lymphocytes; immune responses to infections and tumors; hypersensitivity, autoimmunity, and immunodeficiencies. Particular attention to the development and function of the immune system as a whole, as studied by modern methods and techniques. Students taking the graduate version are expected to explore the subject in greater depth.

H. Ploegh

7.24 Immunology in Medicine (New)
(Subject meets with 7.84)
Prereq: 7.06 or permission of instructor
U (Spring)
5-0-7

Studies the development and function of the immune system at molecular, cellular and systems levels with emphasis on the role of immune system in disease pathogenesis and interventions. Discusses in depth the application of immunological principles in development of antibody therapeutics, cancer immunotherapies, vaccines, and other medical interventions. Lectures supplemented with discussions of original papers and team projects. Students taking graduate version complete additional assignments.

J. Chen

7.26 Molecular Basis of Infectious Disease
(Subject meets with 7.66)
Prereq: 7.06
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. Kim, J. Saeij

7.27 Principles of Human Disease
Prereq: 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, W. Gilbert

7.29 Cellular and Molecular Neurobiology
(Same subject as 9.09J)
Prereq: 7.05 or 9.01
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, T. Littleton

7.30A Fundamentals of Ecology I (New)
(Subject meets with 1.018A, 12.031A)
Prereq: None
U (Fall; first half of term)
2-0-4

See description under subject 1.018A.

S. Chisholm, M. Follows

7.30B Fundamentals of Ecology II (New)
(Same subject as 1.018B, 12.031B)
Prereq: 1.018A
U (Fall; second half of term)
2-0-4

See description under subject 1.018B.

S. Chisholm, M. Follows

7.31 Current Topics in Mammalian Biology: Medical Implications
Prereq: 7.06 or permission of instructor
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: 18.03, 18.05; or permission of instructor
U (Fall)
3-0-9

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
7.33] Evolutionary Biology: Concepts, Models and Computation  
(Same subject as 6.049J)  
Prereq: 7.03; 6.0002, 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, and human evolution, and evolution of disease.  
R. Berwick, D. Bartel

7.340–7.344 Advanced Undergraduate Seminar  
Prereq: 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 conducted. Contact Biology Education Office for topics.  
H. R. Horvitz

7.345–7.349 Advanced Undergraduate Seminar  
Prereq: 7.06 or 7.28  
U (Fall, Spring)  
2-0-4 [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 conducted. Contact Biology Education Office for topics.  
H. R. Horvitz

7.36] Foundations of Computational and Systems Biology  
(Same subject as 6.802J, 20.390J)  
(Same subject as 6.874J, 7.91J, 20.490J, HST.506J)  
Prereq: Biology (GIR), 6.0002 or 6.01; or 7.05; or permission of instructor  
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 the graduate version complete additional assignments.  
I. Cheeseman, A. Martin

7.36J Foundations of Computational and Systems Biology  
(Same subject as 6.802J, 20.390J)  
Prereq: Biology (GIR), 6.0002 or 6.01; or 7.05; or permission of instructor  
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 the graduate version complete additional assignments.  
I. Cheeseman, A. Martin

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, L. Griffith

7.38] Forces in Cell Biology and Development  
(Subject meets with 7.83)  
Prereq: 7.03, 7.05, 7.06  
U (Spring)  
3-0-9  
Covers the current understanding of how physical forces are generated in cells and how these forces organize and shape cells and tissues. Topics include methods to measure and detect forces for single molecules or in cells, mechanisms of force generation, sensing of force in signal transduction, and the roles of force in key cell biological and developmental processes and human disease. Includes lectures on concepts and experimental approaches related to forces in biology and discussions of representative recent papers. Students taking the graduate version are expected to explore the subject in greater depth.  
E. Nedivi, M. Heiman

7.39] Developmental Neurobiology  
(Subject meets with 7.69J, 9.181J)  
Prereq: 9.01, 7.03, 7.05, or permission of instructor  
U (Spring)  
3-0-9  
See description under subject 9.18J.  
E. Nedivi, M. Heiman
7.395 Independent Study in Cell and Molecular Biology
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Program of study or research to be arranged with department faculty member.
Staff

7.396 Independent Study in Experimental Biology
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Program of study or research to be arranged with department faculty member.
Staff

7.390, 7.391 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Staff

7.392 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
Staff

7.399 Special Subject in Biology (New)
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Staff

7.400, 7.401 Special Subject in Marine Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Staff

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
Staff

7.422 Topics in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Staff

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
Staff

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
Staff

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
Staff

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
Staff

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
Staff

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
Staff

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
Staff

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
Staff

Staff

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

7.396 Independent Study in Experimental Biology
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Program of study or research to be arranged with a department faculty member.

7.390, 7.391 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Staff

7.392 Special Subject in Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
Staff

7.399 Special Subject in Biology (New)
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Staff

7.400, 7.401 Special Subject in Marine Biology
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Staff

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
Staff

7.422 Topics in Biological Oceanography
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Staff

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
Staff

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
Staff

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
Staff

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
Staff

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
Staff

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
Staff

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
Staff

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
Staff

Staff

MIT-WHOI Joint Program in Oceanography

7.410 Applied Statistics
Prereq: Permission of instructor
G (Spring)
3-0-9 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Provides an introduction to modern applied statistics. Topics include likelihood-based methods for estimation, confidence intervals, and hypothesis-testing; bootstrapping; time series modeling; linear models; nonparametric regression; and model selection. Organized around examples drawn from the recent literature.
A. Solow

7.421 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: M. Neubert (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.
WHOI Staff

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 ecological principles and processes in marine populations, communities, and ecosystems. Topics vary from year to year.
WHOI Staff

7.432 Topics in Marine Physiology and Biochemistry
Prereq: Permission of instructor
G (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.
WHOI Staff

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.
WHOI Staff

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.
WHOI Staff

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.
WHOI Staff

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.
WHOI Staff

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.
WHOI Staff

Staff

Undergraduate research opportunities in the Department of Biology. For further information, consult departmental coordinator, Gene Brown.
Staff
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.
WHOI Staff

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.
WHOI Staff

7.440 An Introduction to Mathematical Ecology
Prereq: Calculus I (GIR), 7.30B, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Covers the basic models of population growth, demography, population interaction (competition, predation, mutualism), food webs, harvesting, and infectious disease, and the mathematical tools required for their analysis. Because these tools are also basic to the analysis of models in biochemistry, physiology, and behavior, subject also broadly relevant to students whose interests are not limited to ecological problems.
M. Neubert, H. Caswell (WHOI)

7.47 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.
WHOI Staff

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 initiated prior to the qualifying exam.
WHOI Staff

Microbiology (MICRO)

7.492J Methods and Problems in Microbiology
(Same subject as 1.86J, 20.446J)
Prereq: Permission of instructor or Coreq: 7.493
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.
M. Polz

7.493J Microbial Genetics and Evolution
(Same subject as 1.87J, 20.445J)
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, E. Alm

7.494 Research Problems in Microbiology
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 fields of microbial science and engineering.
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. Limited to students in the microbiology program.
Staff

7.MTHG Microbiology 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 thesis. To be arranged by the student and the appropriate MIT faculty member.
Staff

Biology

7.50 Method and Logic in Molecular Biology
Prereq: Permission of instructor or Coreq: 7.51, 7.52
G (Fall)
4-0-8 H-LEVEL Grad Credit
Logic, experimental design and methods in biology, using discussions of the primary literature to discern the principles of biological investigation in making discoveries and testing hypotheses. In collaboration with faculty, students also apply those principles to generate a potential research project, presented in both written and oral form. Limited to Course 7 graduate students.
Staff

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.
A. Keating, R. T. Sauer
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, yeast genetics, developmental genetics, neurogenetics, and human genetics.  
P. Amon, D. Housman, H. R. Horvitz

7.540J Frontiers in Chemical Biology  
(Same subject as 5.54j, 20.554j)  
Prereq: 5.13, 5.07, 7.06, permission of instructor  
G (Fall)  
4-0-8 H-LEVEL Grad Credit  
See description under subject 5.54j.  
B. Penetelute, M. Shoulders

7.547J Principles and Practice of Drug Development  
(Same subject as 10.547j, 15.136j, ESD.691j, HST.920j)  
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, A. J. Sinskey, G. K. Raju

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)  
2-0-4  
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  
Focuses on enhancing students’ ability to analyze, design and present experiments, emphasizing modern techniques. Class discussions begin with papers that developed or utilized contemporary approaches (e.g., quantitative microscopy, biophysical and molecular genetic methods) to address important problems in biology. Each student prepares one specific aim of a standard research proposal for a project that emphasizes research strategy, experimental design, and writing.  
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, cell biology, genomics, and systems biology.  
P. Gupta, A. Regev

7.58 Molecular Biology  
(Subject meets with 7.28)  
Prereq: 7.03; 7.05  
G (Spring)  
5-0-7 H-LEVEL Grad Credit  
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, W. Gilbert

7.59 Teaching College-Level Science and Engineering  
(Same subject as 1.95j, 5.95j, 6.982j, 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

7.60 Cell Biology: Structure and Functions of the Nucleus  
Prereq: 7.06  
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 structure and function of eukaryotic cells in diverse systems (e.g., yeast, fly, worm, mouse, human; development, stem cells, neurons). Combines lectures and in-depth roundtable discussions of literature readings with the active participation of faculty experts. Focuses on membranes (structure, function, traffic), organelles, the cell surface, cytoskeleton and extracellular matrix. Ranges from basic studies to applications to human disease, while stressing 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  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
4-0-8 H-LEVEL Grad Credit  
Biochemical properties of bacteria and other microorganisms that enable them to grow under a variety of conditions. Interaction between bacteria and bacteriophages. Genetic and metabolic regulation of enzyme action and enzyme formation. Structure and function of components of the bacterial cell envelope. Protein secretion with a special emphasis on its various roles in pathogenesis. Additional topics include bioenergetics, symbiosis, quorum sensing, global responses to DNA damage, and biofilms. Students taking the graduate version are expected to explore the subject in greater depth.  
G. C. Walker, A. J. Sinskey

7.63 Immunology  
(Subject meets with 7.23)  
Prereq: Permission of instructor  
G (Fall)  
5-0-7 H-LEVEL Grad Credit  
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; immunoglobulins, 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

7.64 Molecular Mechanisms, Pathology and Therapy of Human Neuromuscular Disorders
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Investigates the molecular and clinical basis of central nervous system and neuromuscular disorders with particular emphasis on strategies for therapeutic intervention. Considers the in-depth analysis of clinical features, pathological mechanisms, and responses to current therapeutic interventions. Covers neurodegenerative diseases, such as Huntington’s disease, Parkinson’s disease, Alzheimer’s disease, Amyotrophic Lateral Sclerosis, Frontal Temporal Dementia, and neuromuscular disorders, such as Myotonic Dystrophy, Facio Scapular Humoral Dystrophy, and Duchenne Muscular Dystrophy.

D. Housman

7.65J Molecular and Cellular Neuroscience Core I
(Same subject as 9.015J)
Prereq: None
G (Fall)
3-0-9

See description under subject 9.015J.
J. T. Littleton, H. Sive, F. Gertler

7.66 Molecular Basis of Infectious Disease
(Subject meets with 7.26)
Prereq: 7.06
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
4-0-8 H-LEVEL Grad Credit

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. Kim, J. Saeij

7.67J Genetic Methods in Neurobiology
(Same subject as 9.322J)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 9.322J.
W. G. Quinn

7.68J Molecular and Cellular Neuroscience Core II
(Same subject as 9.013J)
Prereq: Permission of instructor
G (Spring)
3-0-9

See description under subject 9.013J.
G. Feng, L.-H. Tsai, Y. Lin

7.69J Developmental Neurobiology
(Same subject as 9.181J)
Prereq: 9.011 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 9.181J.
E. Nedivi, M. Heiman

7.70 Regulation of Gene Expression
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
4-0-8 H-LEVEL Grad Credit

Seminar examines basic principles of biological regulation of gene expression. Focuses on examples that underpin these principles, as well as those that challenge certain long-held views. Topics covered may include the role of transcription factors, enhancers, DNA modifications, non-coding RNAs, and chromatin structure in the regulation of gene expression and mechanisms for epigenetic inheritance of transcriptional states. Limited to 40.

L. Boyer, M. Gehring

7.71 Biophysical Chemistry Techniques
Prereq: 5.13, 5.60; 5.07 or 7.05
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 crystal-
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, 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

7.78 Methods and Topics in Protein Biochemistry and Biophysics (New)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Students read and discuss papers dealing with protein structure and function and biophysical techniques used to characterize biological macromolecules. Topics include cooperativity and allosterity, protein folding and misfolding, pathways of macromolecular assembly, motor proteins, and protein design. Methods include CD spectroscopy, isothermal calorimetry, analytical ultracentrifugation, light scattering, and real-time kinetic measurements. Covers theoretical principles behind the techniques. Students complete practical exercises using instrumentation available at MIT.
R. T. Sauer, T. Schwartz

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.
J. Stubbe, E. Nolan

7.81J Systems Biology
(Same subject as 8.591J)
(Subject meets with 7.32)
Prereq: 18.03, 18.05; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 8.591J.
J. Chen

7.82 Topics of Mammalian Development and Genetics
Prereq: Permission of instructor
G (Spring)
3-0-9 [P/D/F] H-LEVEL Grad Credit

Covers the current understanding of how physical forces are generated in cells and how these forces organize and shape cells and tissues. Topics include methods to measure and detect forces for single molecules or in cells, mechanisms of force generation, sensing of force in signal transduction, and the roles of force in cell biological and developmental processes and human disease. Includes lectures on concepts and experimental approaches related to forces in biology and discussions of representative recent papers. Students taking the graduate version are expected to explore the subject in greater depth.
R. Jaenisch, R. Young

7.83 Forces in Cell Biology and Development
(Subject meets with 7.38)
Prereq: 7.06
G (Spring)
3-0-9 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.
J. A. King

7.86J 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

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, and Bayesian networks. This subject examines traditional 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.
J. A. King

7.87J Topics in Computational and Systems Biology
(Subject meets with CSB.100J)
Prereq: Permission of instructor
G (Fall)
2-0-10 H-LEVEL Grad Credit

See description under subject CSB.100J.
C. Burge

7.89J Topics in Computational and Systems Biology
(Same subject as 20.490J)
(Subject meets with 6.802J, 6.874J, 7.36J, 20.390J, HST.506J)
Prereq: Biology (GIR), 6.0002 or 6.01; or 7.05; or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

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, and Bayesian networks. This subject examines traditional 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.
J. A. King
Students taking graduate version complete additional assignments.
C. Burge, E. Fraenkel, D. Gifford

7.931 Independent Study in Biology
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
Prereq: Permission of instructor
G (Fall, Spring)
Units arranged 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

7.935 Responsible Conduct in Biology (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Sessions focus on the responsible conduct of science. Considers recordkeeping and reporting; roles of mentor and mentee; authorship, review, and confidentiality; resolving conflicts; misfeasance and malfeasance; collaborations, competing interests, and intellectual property; and proper practices in the use of animal and human subjects. Limited to second-year graduate students in Biology.
Staff

7.941 Research Problems
Prereq: Permission of instructor
G (Fall, Summer)
Units arranged [P/D/F] 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: 7.06
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.
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

7.5930, 7.5931 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
7.5932 Special Subject in Biology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
7.5938 Special Subject in Biology (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
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, 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
**Bachelor of Science in Biology/Course 7**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Institute Requirements (GIRs)</td>
<td></td>
</tr>
<tr>
<td>Science Requirement [two subjects can be satisfied by 5.111, 5.112, or 3.091, and 7.012, 7.013, 7.014, 7.015, or 7.016 in the Departmental Program]</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 from among 5.12, 5.60, and 7.03 or 7.05 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>
<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).

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLUS Department Program</td>
<td></td>
</tr>
<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></td>
</tr>
<tr>
<td>5.111 or 5.112 Principles of Chemical Science, 12; Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>or 3.091 Introduction to Solid-State Chemistry, 12; Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>20.110 Thermodynamics of Biomolecular Systems, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
<td></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></td>
</tr>
<tr>
<td>or 5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>7.012, 7.023, 7.014, 7.015, or 7.016 Introductory Biology, 12</td>
<td></td>
</tr>
<tr>
<td>7.02 Introduction to Experimental Biology and Communication, 18, LAB, CI-M; Biology (GIR)</td>
<td></td>
</tr>
<tr>
<td>or 20.109 Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; Biology (GIR), (GIR), Chemistry (GIR), 6.0002, 18.05, 20.110*</td>
<td></td>
</tr>
<tr>
<td>7.03 Genetics, 12, REST; Biology (GIR)</td>
<td></td>
</tr>
<tr>
<td>7.05 General Biochemistry, 12, REST; Biology (GIR)*</td>
<td></td>
</tr>
<tr>
<td>or 5.07 Biological Chemistry I, 12; 5.12</td>
<td></td>
</tr>
<tr>
<td>7.06 Cell Biology, 12; 7.03, 7.05</td>
<td></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: 7.30AJ and 7.30BJ are 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, 7.21, 7.22, 7.23, 7.25, 7.27, 7.28, 7.29J, 7.30AJ, 7.30BJ, 7.31, 7.32, 7.33, 7.35, 7.36, 7.37, 7.38, 7.41, and 7.49J.

| One of the 30-unit project laboratory subjects in the department curriculum. Those currently offered are: |       |
| 7.13 Experimental Microbial Genetics, 30, CI-M; 7.023, 7.03, 7.05         |       |
| 7.15 Experimental Molecular Genetics, 30, CI-M; 7.021, 7.03             |       |
| 7.16 Experimental Molecular Biology, 30, CI-M; 7.021, 7.03, 7.05        |       |
| 7.18 Topics in Experimental Biology, 30, CI-M; 7.021, 7.03, 7.05        |       |

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>(60)</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>180</td>
</tr>
<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**
*Alternative prerequisites are listed in the subject description.
*The department recommends 20.110, 7.10, or 5.60 to fulfill the biology requirements, but will also accept 2.005, 3.012, 8.044, or 10.213 as a substitution.
*The combination of 7.30AJ and 7.30BJ counts as one Biology restricted elective.

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 Biology/Course 7-A

General Institute Requirements (GIRs) Subjects
Science Requirement [two subjects can be satisfied by 5.111, 5.112, or 3.091, and 7.012, 7.013, 7.014, 7.015, or 7.016 in the Departmental Program] Humanities, Arts, and Social Sciences Requirement Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 5.12, 5.60(ii) and 7.09 or 7.05 in the Departmental Program] Laboratory Requirement [can be satisfied by 7.02 in the Departmental Program](ii) Total GIR Subjects Required for SB Degree

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
5.111 or 5.112 Principles of Chemical Science, 12, Chemistry (GIR) or 3.091 Introduction to Solid-State Chemistry, 12, Chemistry (GIR) 5.12 Organic Chemistry I, 12, REST; Chemistry (GIR) 20.110J Thermodynamics of Biomolecular Systems,(ii) 12, REST; Calculus II (GIR), Chemistry (GIR) or 7.10J Physical Chemistry of Biomolecular Systems, (ii) 12; Calculus II (GIR), Chemistry (GIR), Physics I (GIR), Physics II (GIR) or 5.60 Thermodynamics and Kinetics, (ii) 12, REST; Calculus II (GIR), Chemistry (GIR) 7.012, 7.013, 7.014, or 7.016 Introductory Biology, 12, Biology (GIR) 7.02 J Introduction to Experimental Biology and Communication, 18, LAB, CI-M; Biology (GIR) or 20.109 Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; Biology (GIR), Chemistry (GIR), 6.0002, 18.03, 20.110J* 7.03 Genetics, 12, REST; Biology (GIR) 7.05 General Biochemistry, 12, REST; Biology (GIR)* or 5.07 Biological Chemistry I, 12; 5.12 7.06 Cell Biology, 12; 7.03, 7.05

Restricted Electives (ii)
Three undergraduate-level 12-unit subjects offered by the Department of Biology for which 7.03 and/or 7.05 are prerequisites. 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, 7.26, 7.27, 7.28, 7.29J, 7.30AJ and/or 7.30BJ(counts as one Biology restricted elective). and One of the following CI-M subjects: 3.014, 5.36, 5.38, 7.19, 8.13, 9.12, 10.26, 10.27, 10.28, 10.39, 20.380, or 6.021.

Departmental Program Units That Also Satisfy the GIRs (60)

Unrestricted Electives 90–93

Total Units Beyond the GIRs Required for SB Degree 180

Notes
*Alternate prerequisites are listed in the subject description.
(ii)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.
(iii)The combination of 7.30AJ and 7.30BJ counts as one Biology restricted elective.

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 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 or 20.109 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 | 147–150
--- | ---
1. 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)

2. Chemistry
   5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)
   5.6a 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)

3. Introductory Laboratory
   7.02J Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)
   or
   20.109 Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; Biology (GIR), Chemistry (GIR), 6.0002, 18.03, 20.110*

4. Foundational Subjects
   *Three Computer Science subjects:
   6.005 Elements of Software Construction, 12; REST; 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
   5.07J Biological Chemistry I, 12, REST; 5.12

5. Restricted Electives | 24
   One subject in Computational Biology:
   6.047 Computational Biology: Genomes, Networks, Evolution, 12; 6.006, 6.041, Biology (GIR)*
   6.043 Foundations of Algorithms and Computational Techniques in Systems Biology, 12; 6.046*  
   7.36J Foundations of Computational and Systems Biology, 12; 7.05*
   One subject in Biology:
   7.20J 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, 6.0002*

6. Advanced Undergraduate Project | 12
   6.UAT Oral Communication, 6
   *Plus one of the following:*
   6.UAP Undergraduate Advanced Project, 6, CI-M; 6.UAT
   or
   6.UR Seminar in Undergraduate Advanced Research, 12, CI-M; 6.UR
<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree 195–198

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.

(1) See the description of required communication-intensive subjects for information about acceptable substitutions for the 6.UAT/6.UAR or 6.UAT/6.UAR sequence.

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).
### Master of Engineering in Computer Science and Molecular Biology/Course 6-7P

#### General Institute Requirements (GIRs)
- **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);
- 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>Subject Name</th>
<th>Units</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Subjects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1. Mathematics and Introductory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 18.03 ) Differential Equations, 12, REST; Calculus II (GIR)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>or ( 18.06 ) Linear Algebra, 12, REST; Calculus II (GIR)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>2. Chemistry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 5.12 ) Organic Chemistry I, 12, REST; Chemistry (GIR)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>or ( 5.60 ) Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
<td>12</td>
<td></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>12</td>
<td></td>
</tr>
<tr>
<td>or ( 20.110 ) Thermodynamics of Biomolecular Systems, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>3. Introductory Laboratory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 7.02 ) Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>or ( 20.109 ) Laboratory Fundamentals in Biological Engineering, 15, LAB, CI-M; Biology (GIR), Chemistry (GIR), 6.0002, 18.03, 20.110*</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td><strong>4. Foundational Subjects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Three Computer Science subjects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 6.005 ) Elements of Software Construction, 12; REST; 6.01, 6.042*</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Three Biological Science subjects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>5. Restricted Electives</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>One subject in Computational Biology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 6.047 ) Computational Biology: Genomes, Networks, Evolution, 12; 6.006, 6.041, Biology (GIR)*</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Two subjects from a restricted departmental list of math electives</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Advanced Undergraduate Project
- **6.UAT Oral Communication, 6**
- Plus one of the following:(2)
  - **6.UAP Undergraduate Advanced Project, 6, CI-M; 6.UAT**
  - or **6.UAR Seminar in Undergraduate Advanced Research, 12, CI-M, 6.UR**

<table>
<thead>
<tr>
<th>Prerequisite</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.33 Evolutionary Biology: Concepts, Models, and Computation, 12; 7.03, 6.0002*</td>
<td>12</td>
</tr>
<tr>
<td>Departmental Program Units That Also Satisfy the GIRs</td>
<td>(36)</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>285–288</td>
</tr>
</tbody>
</table>

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 and corequisites are listed in the subject description.

(1) To complete the required Communication-Intensive subjects in the major, students must take 7.02J or 20.109 or 6.UAT/6.UAP by the end of the third year. The second CI-M should be chosen to complete the requirements in categories 3 and 6 above.

(2) See the description of required communication-intensive subjects for information about acceptable substitutions for the 6.UAT/6.UAP or 6.UAT/6.UAR sequence.

Notes on Master of Engineering and Bachelor’s Degree Programs

The Master of Engineering program builds on the bachelor’s degree program (6-7), with restricted elective categories 7 and 8 and the MEng thesis.

The Master of Engineering in Computer Science and Molecular Biology is only awarded to students who have received, or are simultaneously receiving, the 6-7 bachelor’s degree. Students who receive the Master of Engineering degree after having obtained the 6-7 bachelor’s degrees must fulfill the requirements for Course 6-7P as described above.

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

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)
3-2-7 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. Williams

8.01L Physics I
Prereq: None
U (Fall, IAP)
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.

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. Time-varying fields and Faraday’s law of induction. Basic electric circuits. Electromagnetic waves and Maxwell’s equations. Designed for students with previous experience in 8.02; the subject is designated as 8.02 on the transcript. Enrollment limited.

G. Stephans

8.02 Physics II
Prereq: Physics I (GIR), Coreq: 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: P. Zuccon
Spring: Staff
PHYSICS

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: Staff
Spring: N. Weinberg

8.033 Relativity
Prereq: Physics II (GIR), Calculus II (GIR)
U (Fall)
5-0-7 REST

Einstein’s postulates; consequences for simultaneity, time dilation, length contraction, and clock synchronization; Lorentz transformation; relativistic effects and paradoxes; Minkowski diagrams; invariants and four-vectors; 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.

P. Fisher

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: Schroedinger’s equation, wave functions, wave packets, probability amplitudes, stationary states, the Heisenberg uncertainty principle, and zero-point energies. Solutions to Schroedinger’s equation in one dimension: transmission and reflection at a barrier, barrier penetration, potential wells, the simple harmonic oscillator. Schroedinger’s equation in three dimensions: central potentials and introduction to hydrogenic systems.

Fall: E. Farhi
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

Credit cannot also be received for 8.505


B. Zwiebach

8.05 Special Subject: Quantum Physics II (New)
Prereq: 8.04, permission of instructor
U (Spring)
2-0-10

Credit cannot also be received for 8.05

Experimental version of 8.05, which offers a combination of online and in-person instruction. See description of 8.05. Licensed by the Committee on Curricula as an acceptable alternative to 8.05 for Spring 2015. Limited to 20.

B. Zwiebach, S. Rayyan

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-dimension, low-energy approximations, resonance, Born approximation. Time-dependent perturbation theory. Students research and write a paper on a topic related to the content of 8.05 and 8.06.

Staff

8.07 Electromagnetism II
Prereq: 8.03, 18.03
U (Fall)
4-0-8


S. Hughes

8.08 Statistical Physics II
Prereq: 8.044, 8.05
U (Spring)
4-0-8


Staff
8.09 Classical Mechanics III
Prereq: 8.223
U (Fall)
4-0-8
Covers Lagrangian and Hamiltonian mechanics, systems with constraints, rigid body dynamics, vibrations, central forces, Hamilton-Jacobi theory, action-angle variables, perturbation theory, and continuous systems. Provides an introduction to ideal and viscous fluid mechanics, including turbulence, as well as an introduction to nonlinear dynamics, including chaos.
I. Stewart

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

8.223 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 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered 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

8.225J Einstein, Oppenheimer, Feynman: Physics in the 20th Century
(Same subject as STS.042J)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered 3-0-9 HASS-H
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 2014–2015: Not offered
Acad Year 2015–2016: U (Spring) 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
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.

L. Fu

8.251 String Theory for Undergraduates
Prereq: 8.033, 8.044, 8.05
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
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

8.276 Nuclear and Particle Physics
Prereq: 8.033, 8.04
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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; permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

Principles of acceleration: beam properties; linear accelerators, synchrotrons, and storage rings. Accelerator technologies: radio frequency cavities, bending and focusing magnets, beam diagnostics. Particle beam optics and dynamics. Special topics: measures of accelerators performance in science, medicine and industry; synchrotron radiation sources; free electron lasers; high-energy colliders; and accelerators for radiation therapy. May be repeated for credit for a maximum of 12 units.

W. Barletta

8.282J 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 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
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.

D. Cziczo

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 I. Stewart

8.299 Physics Teaching
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For qualified undergraduate students interested in gaining some experience in teaching, laboratory, tutorial, or classroom teaching under the supervision of a faculty member. Students selected by interview.
Consult N. Mavalvala

8.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

8.321 Quantum Theory I
Prereq: 8.05
G (Fall)
4-0-8 H-LEVEL Grad Credit
8.322 Quantum Theory II
Prereq: 8.07, 8.321
G (Spring)
4-0-8 H-LEVEL Grad Credit
R. Jackiw

8.323 Relativistic Quantum Field Theory I
Prereq: 8.321
G (Spring)
4-0-8 H-LEVEL Grad Credit
Staff

8.324 Relativistic Quantum Field Theory II
Prereq: 8.322, 8.323
G (Fall)
4-0-8 H-LEVEL Grad Credit
The second term of the quantum field theory sequence. Develops in depth some of the topics discussed in 8.323 and introduces some advanced material. Topics: perturbation theory and Feynman diagrams, scattering theory, Quantum Electrodynamics, one loop renormalization, quantization of non-abelian gauge theories, the Standard Model of particle physics, other topics.
H. Liu

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
8.334 Statistical Mechanics II
Prereq: 8.333
G (Spring)
4-0-8 H-LEVEL Grad Credit
8.333: M. Kardar; 8.334: Staff

8.351J Classical Mechanics: A Computational Approach
(Same subject as 6.946J, 12.620J)
(Subject meets with 12.008)
Prereq: Physics I (GIR), 18.03, permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-3-6 H-LEVEL Grad Credit
See description under subject 8.260J.
J. Wisdom, G. J. Sussman
8.361 Quantum Theory of Many-Particle Systems
Prereq: 8.322, 8.333
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

8.370 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

8.371 Quantum Information Science
(Same subject as 6.443J, 18.436J)
Prereq: 18.435
G (Spring, Summer)
3-0-9 H-LEVEL Grad Credit
Examines quantum computation and quantum information. Topics include quantum circuits, the quantum Fourier transform and search algorithms, the quantum operations formalism, quantum error correction, Calderbank-Shor-Steane and stabilizer codes, fault tolerant quantum computation, quantum data compression, quantum entanglement, capacity of quantum channels, and quantum cryptography and the proof of its security. Prior knowledge of quantum mechanics required.
Information: P. W. Shor

8.381, 8.382 Selected Topics in Theoretical Physics
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
8.392 Pre-Thesis Research
Prereq: Permission of instructor
G (Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Advanced problems in any area of experimental or theoretical physics, with assigned reading and consultations.
Staff

8.395J Teaching College-Level Science and Engineering
(Same subject as 1.95J, 5.95J, 6.634J, 7.59J, 18.094J)
Prereq: None
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

8.421 Atomic and Optical Physics I
Prereq: 8.05
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: 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. The interaction of radiation with atoms: resonance; absorption, stimulated and spontaneous emission; methods of resonance, dressed atom formalism, masers and lasers, cavity quantum electrodynamics; structure of simple atoms, behavior in very strong fields; fundamental tests: time reversal, parity violations, Bell’s inequalities; and experimental methods.
Staff

8.422 Atomic and Optical Physics II
Prereq: 8.05
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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.
J. G. Fujimoto

8.481, 8.482 Selected Topics in Physics of Atoms and Radiation
Prereq: 8.321
G (Fall, Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit
Presentation of topics of current interest, with content varying from year to year. Subject not
8.514 Strongly Correlated Systems in Condensed Matter Physics
Prereq: 8.322, 8.333
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.

X. Wen

8.581, 8.582 Selected Topics in Condensed Matter Physics
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
3-0-9
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

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

See description under subject 20.416J.

M. Bathe, J. Gore

8.591J Systems Biology
(Same subject as 7.81J)
Subject meets with 7.32
Prereq: 18.03, 18.05; or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

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: 8.333 or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit


M. Kardar, L. Mirny

8.593J Biological Physics
(Same subject as HST.450J)
Prereq: 8.044 recommended but not necessary
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
4-0-8 H-LEVEL Grad 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

8.613J 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.

A. White
8.614 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 2014-2015: Not offered
Acad Year 2015-2016: 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 (ECRH), and lower hybrid (LHH) wave heating. Quasi-linear theory and applications to RF current drive in tokamaks. Extensive discussion of relevant experimental observations.

M. Porkolab

8.641 Physics of High-Energy Plasmas I
Prereq: 8.613J
Acad Year 2014-2015: Not offered
Acad Year 2015-2016: 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-ß" (pressure) regimes and ballooning modes. Convective modes in configuration and velocity space. Trapped particle regimes. Nonlinear and explosive instabilities. Interaction of positive and negative energy modes. Each subject can be taken independently.

Staff

8.681, 8.682 Selected Topics in Fluid and Plasma Physics
Prereq: 8.613J
G (Fall, Spring)

Not offered regularly; consult department
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.

F. Wilczek

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
Acad Year 2014-2015: Not offered
Acad Year 2015-2016: 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)
Not offered regularly; consult department
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

Modern review of particles, interactions, and recent experiments. Experimental and analytical methods. QED, electroweak theory, and the Standard Model as tested in recent key experiments at ee and pp colliders. Mass generation,
W, Z, and Higgs physics. Weak decays of mesons, including heavy flavors with QCD corrections. Mixing phenomena for K, D, B mesons and neutrinos. CP violation with results from B-factories. Future physics expectations: Higgs, SUSY, sub-structure as addressed by new experiments at the LHC collider.

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, gamma-gamma nuclear correlations, and modern particle localization.
U. Becker

8.821 String Theory
Prereq: 8.324
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.
Staff

8.831J Supersymmetric Quantum Field Theories
(Same subject as 18.396I)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 18.396I.
D. Z. Freedman

8.841 Electroweak Interactions
Prereq: 8.324
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad 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.

I. Stewart

8.851 Effective Field Theory
Prereq: 8.324
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Credit cannot also be received for 8.851
Covers the framework and tools of effective field theory, including: identifying degrees of freedom and symmetries; power counting expansions (dimensional and otherwise); field redefinitions, bottom-up and top-down effective theories; fine-tuned effective theories; matching and Wilson coefficients; reparameterization invariance; and advanced renormalization group techniques. Main examples are taken from particle and nuclear physics, including the Soft-Collinear Effective Theory.

8.861 Advanced Topics in Superfluidity
Prereq: 8.324
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

8.871, 8.872 Selected Topics in Theoretical Particle Physics
Prereq: 8.323
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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)
Not offered regularly; consult department
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 B. Wyslouch

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

8.903J Advanced Particle Physics
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Presents topics of current interest in particle physics, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult B. Wyslouch

8.904J Advanced Topics in Cosmology
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Presents topics of current interest in cosmology, with content varying from year to year. Subject not routinely offered; given when sufficient interest is indicated.
Consult B. Wyslouch
8.913 Plasma Astrophysics I
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

8.914 Plasma Astrophysics II
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

For students interested in space physics, astrophysics, and plasma physics in general. Magnetoospheres 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

8.922 Cosmology
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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 2014–2015: Not offered
Acad Year 2015–2016: 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 Astrophysics Seminar
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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: astronomical instrumentation, numerical and statistical methods in astrophysics, gravitational lenses, neutron stars and pulsars.

Consult D. Chakrabarty

8.972 Astrophysics Seminar
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 (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

8.5301 Special Subject: Physics
Prereq: Permission of instructor
G (Spring)
Units arranged

Covers topics in Physics that are not offered in the regular curriculum. Limited enrollment; preference to Physics graduate students.

A. Lightman

8.THG Graduate Physics 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.

Consult I. Stewart
# Bachelor of Science in Physics/Course 8

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</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 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>
</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 are indicated in italics).

### Required Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.03</td>
<td>12, REST; Physics II (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>18.03</td>
<td>Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>or 18.034</td>
<td>Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>8.04</td>
<td>Quantum Physics I, 12, REST; 8.03*, 18.03*</td>
</tr>
<tr>
<td>8.044</td>
<td>Statistical Physics I, 12; 8.03, 18.03</td>
</tr>
</tbody>
</table>

**Physics: Flexible Option**
One of the following subjects:
- 8.21 Physics of Energy, 12; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)
- 8.223 Classical Mechanics II, 6; Physics I (GIR), Calculus II (GIR)

One of the following subjects:
- 8.04 Quantum Physics II, 12; 8.04
- 8.20 Introduction to Special Relativity, 9, REST; Physics I (GIR), Calculus I (GIR)
- 8.033 Relativity, 12; Physics II (GIR), Calculus II (GIR)

One of the following experimental experiences, subject to the approval of the department:
- 8.13 Experimental Physics I, 18, LAB, CI-M, 8.04
- A laboratory subject of similar intensity in another department
- An experimental research project or senior thesis
- An experimentally oriented summer externship

**Physics: Focused Option**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.03</td>
<td>Relativity, 12; Physics II (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>8.05</td>
<td>Quantum Physics II, 12; 8.04</td>
</tr>
<tr>
<td>8.06</td>
<td>Quantum Physics III, 12, CI-M, 8.05</td>
</tr>
<tr>
<td>8.13</td>
<td>Experimental Physics I, 18, LAB, CI-M, 8.04</td>
</tr>
<tr>
<td>8.14</td>
<td>Experimental Physics II, 18, LAB, 8.05, 8.13</td>
</tr>
<tr>
<td>8.223</td>
<td>Classical Mechanics II, 6; Physics I (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>8.14</td>
<td>Undergraduate Physics Thesis (12 units)</td>
</tr>
</tbody>
</table>

**Restricted Electives**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>36–48</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.033</td>
<td>Relativity, 12; Physics II (GIR), Calculus II (GIR)</td>
</tr>
<tr>
<td>8.05</td>
<td>Quantum Physics II, 12; 8.04</td>
</tr>
<tr>
<td>8.06</td>
<td>Quantum Physics III, 12, CI-M, 8.05</td>
</tr>
<tr>
<td>8.13</td>
<td>Experimental Physics I, 18, LAB, CI-M; 8.04</td>
</tr>
<tr>
<td>8.14</td>
<td>Experimental Physics II, 18, LAB; 8.05, 8.13</td>
</tr>
<tr>
<td>8.223</td>
<td>Classical Mechanics II, 6; Physics I (GIR), Calculus II (GIR)</td>
</tr>
</tbody>
</table>

**Departmental Program Units That Also Satisfy the GIRs**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>(24–36)</th>
</tr>
</thead>
</table>

**Unrestricted Electives**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>48–87</th>
</tr>
</thead>
</table>

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

<table>
<thead>
<tr>
<th>Subjects</th>
<th>180–186</th>
</tr>
</thead>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 180–186 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) 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.

(2) 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 Psychological Science  
Prereq: None  
U (Spring)  
4-0-8 HASS-S

A survey of the scientific study of human nature, including how the mind works, and how the brain supports the mind. Topics include the mental and neural bases of perception, emotion, learning, memory, cognition, child development, personality, psychopathology, and social interaction. Consideration of how such knowledge relates to debates about nature and nurture, free will, consciousness, human differences, self, and society.

*J. D. Gabrieli*

9.01 Introduction to Neuroscience  
Prereq: 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. Bear*

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.

*M. Wilson, E. K. Miller*

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 genetic neurotrophin signaling, adult neurogenesis, G-protein coupled receptor signaling, glia function, epigenetics, neuronal and homeostatic plasticity, neuromodulators of circuit function, and neurological/psychiatric disease mechanisms. Includes lectures and exams, and involves presentation and discussion of primary literature. 9.015 recommended, though the core subjects can be taken in any sequence.

*G. Feng, L.-H. Tsai, Y. Lin*

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 topics in molecular and cellular neurobiology. Covers neurogenomics, nervous system formation, axonal pathfinding, cytoskeletal regulation, synapse formation, neurotransmitter release, and cellular neurophysiology. Includes lectures and weekly paper write-ups, together with student presentations and discussion of primary literature. A final two-page research write-up is also due at the end of the term.

*J. T. Littleton, H. Sive, F. Gertler*

9.04 Sensory Systems  
Prereq: 9.01 or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-0-9

Examines the neural bases of sensory perception. Focuses on physiological and anatomical studies of the mammalian nervous system as well as behavioral studies of animals and humans. Topics include visual pattern, color and depth perception, auditory responses and sound localization, olfactory and somatosensory perception.

*P. H. Schiller, M. C. Brown*

9.07 Statistics for Brain and Cognitive Science  
Prereq: 9.40  
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 organized around three key theories: probability, statistical, and the linear model. Probability theory covers axioms of probability, discrete and continuous probability models, law of large numbers, and the Central Limit Theorem. Statistical theory covers estimation, likelihood theory, Bayesian methods, bootstrap and other Monte Carlo methods, as well as hypothesis testing, confidence intervals, elementary design of experiments principles and goodness-of-fit. The linear model theory covers the simple regression model and the analysis of variance. Places equal emphasis on theory, data analyses, and simulation studies.

*E. N. Brown*

9.073J Statistics for Neuroscience Research  
(Same subject as HST.460J)  
Prereq: Permission of instructor  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
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*

9.09 Cellular and Molecular Neurobiology  
(Same subject as 7.29J)  
Prereq: 7.05 or 9.01  
U (Spring)  
4-0-8

See description under subject 7.29J.

*W. G. Quinn, T. Littleton*
9.10 Cognitive Neuroscience
Prereq: 9.01
U (Spring)
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

9.110 Nonlinear Control System Design (New)
(Same subject as 2.152J)
Prereq: 2.151, 6.241, 16.31, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.152J.
J.-J. E. Slotine

9.12 Experimental Molecular Neurobiology
Prereq: 9.01, Biology (GIR)
U (Spring)
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, immunocytochemistry, and fluorescent microscopy. One lab session plus one paper review session per week. Instruction and practice in written communication provided. Enrollment limited.
Y. Lin, G. Choi

9.14 Brain Structure and its Origins
Prereq: 9.01
U (Spring)
3-0-9
Provides an introduction to functional neuroanatomy with a focus on mammals, aided by studies of comparative neuroanatomy and evolution and of brain development. Topics include early steps to a central nervous system, basic patterns of brain and spinal cord connections, regional development and differentiation, regeneration, motor and sensory pathways and structures, systems underlying motivations, innate action patterns, formation of habits, and various cognitive functions. Review of lab techniques. Optional brain dissections.
G. E. Schneider

9.15 Neuromodulatory and Neuroendocrine Systems
Prereq: 9.40
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9
Examines the brain from a neuropharmacological perspective, specifically interactions governed by catecholamines, monoamines, neuropeptides, and more. Covers the functional contribution of neuromodulatory systems to both health and disease, and their influence on behaviors relevant to appetite and feeding, social behavior, reward and motivation, anxiety and fear, as well as how drugs alter neural activity.
K. Tye

9.16 Cellular Neurophysiology
Prereq: 9.40
U (Fall)
3-0-9
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.
W. Xu

9.17 Systems Neuroscience Laboratory
Prereq: 9.40; 18.05 or 18.440; or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 how these techniques are used to study nervous system function. Involves the use of experimental animals. Assignments include weekly preparation for lab sessions, two major lab reports and a series of basic computer programming tutorials (MATLAB). Instruction and practice in written communication provided. Enrollment limited.
J. J. DiCarlo, M. Jazayeri, K. Tye

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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 22.56J.
A. Jasanoff

9.175J Robotics (New)
(Same subject as 2.165J)
Prereq: 2.151 or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 2.165J.
J.-J. E. Slotine, H. Asada

9.18 Developmental Neurobiology
(Same subject as 7.69J)
Prereq: 9.01, 7.03, 7.05, or permission of instructor
U (Spring)
3-0-9
Consider molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Topics include: neural induction and pattern formation, cell lineage and fate determination, neuronal migration, axon guidance, synapse formation and stabilization, activity-dependent development and critical periods, development of behavior. In addition to final exam, analysis and presentation of research papers required for final grade. Students taking graduate version complete additional assignments.
E. Nedivi, M. Heiman

9.19 Animal Behavior
Prereq: 9.00
U (Fall)
3-0-9 HASS-S
Reviews studies of animal behavior to stress major ideas and principles, with emphasis on concepts developed in ethology and sociobiology. Examines foraging and feeding, defensive and aggressive behavior, courtship and reproduction, migration and navigation, as well as various social activities and communica-
9.24 Disorders and Diseases of the Nervous System
Prereq: 9.00, 9.01, 9.09
U (Spring)
3-0-9
Topics examined include regional functional anatomy of the CNS; brain systems and circuits; neurodevelopmental disorders including autism; neuropsychiatric disorders such as schizophrenia; neurodegenerative diseases such as Parkinson's and Alzheimer's; autoimmune disorders such as multiple sclerosis; gliomas. Emphasis on diseases for which a molecular mechanism is understood. Diagnostic criteria, clinical and pathological findings, genetics, model systems, pathophysiology, and treatment are discussed for individual disorders and diseases.
M. Sur

9.26J Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience
(Subjects meet with 20.205J)
Prereq: 7.28, 7.32, or 20.020; 9.01 or 9.09
U (Spring)
3-0-9
Covers principles underlying current and future genetic engineering approaches, ranging from single cellular organisms to whole animals. Focuses on development and invention of technologies for engineering biological systems at the genomic level, and applications of engineered biological systems for medical and biotechnological needs, with particular emphasis on genetic manipulation of the nervous system. Design projects by students.
F. Zhang

9.27J Topics in Neural Signal Processing
(Subjects meet with HST.576J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

9.28 Current Topics in Developmental Neurobiology (New)
Prereq: None. Coreq: 9.18
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-12
Considers recent advances in the field of developmental neurobiology based on primary research articles that address molecular control of neural specification, formation of neuronal connections, construction of neural systems, and the contributions of experience to shaping brain structure and function. Also considers new techniques and methodologies as applied to the field. Students critically analyze articles and prepare concise and informative presentations based on their content. Instruction and practice in written and oral communication provided. Requires class participation, presentations, and final exam.
E. Nedivi, M. Heiman

9.285J Neural Coding and Perception of Sound
(Subjects meet with HST.723J)
Prereq: Permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject HST.723J.

9.301J Neural Plasticity in Learning and Memory
(Subjects meet with 7.98B)
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 supported by introductory lectures. Juniors and seniors require instructor's permission.
S. Tonegawa, W. Quinn

9.31 Neurophysiology of Learning and Memory
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

9.32J Genetic Methods in Neurobiology
(Subjects meet with 7.67J)
Prereq: Permission of instructor
G (Spring)
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

9.34J Biomechanics and Neural Control of Movement (New)
(Subjects meet with 2.184)
Prereq: 2.004, 2.04A, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.183J.
N. Hogan

9.35 Perceptual Systems
Prereq: 9.40; 18.05 or 18.440; 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 make inferences about the world. Emphasizes vision and audition, and the relationship of engineering principles (e.g., from signal processing and machine learning) to perceptual processing. Provides experience with computational models of perceptual systems as well as with psychophysical methods.
J. McDermott
9.357 Current Topics in Vision Science  
Prereq: Permission of instructor  
G (Fall)  
2-0-7  
Can be repeated for credit  
Advanced seminar on issues of current interest in human and machine vision. Topics vary from year to year. Participants discuss current literature as well as their ongoing research.  
E. H. Adelson

9.40 Introduction to Neural Computation  
Prereq: 6.0001, 6.0002, 9.01  
U (Spring)  
4-0-8  
Introduces quantitative approaches to understanding brain and cognitive functions. Topics include mathematical description of neurons, the response of neurons to sensory stimuli, simple neuronal networks, statistical inference and decision making. Also covers foundational quantitative tools of data analysis in neuroscience: correlation, convolution, spectral analysis, principal components analysis. Mathematical concepts include simple differential equations and linear algebra.  
M. Fee

9.41 Research and Communication in Neuroscience and Cognitive Science  
Prereq: 9.URG, permission of instructor  
U (Fall)  
2-12-4  
Emphasizes research and scientific communication. Instruction and practice in written and oral communication provided. Based on results of his/her UROP research, each student creates a full-length paper and a poster as part of an oral presentation at the end of the term. Other assignments include peer editing and reading/critiquing published research papers. Prior to starting class, students must have collected enough data from their UROP research projects to write a paper. Limited to juniors and seniors.  
S. Jhaeri, L. Schulz

9.42J Principles of Neuroengineering  
(Same subject as 20.452J, MAS.881J)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject MAS.881J.  
E. S. Boyden, III

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.  
J. Bonsen, E. S. Boyden, R. Ellis-Behnke

9.46 Neuroscience of Morality  
Prereq: 9.00, 9.01; 9.10, 9.20, or 9.85  
U (Fall)  
3-0-9  
Advanced seminar that covers both classic and cutting-edge primary literature from psychology and the neuroscience of morality. Addresses questions about how the human brain decides which actions are morally right or wrong (including neural mechanisms of empathy and self-control), how such brain systems develop over childhood and differ across individuals and cultures, and how they are affected by brain diseases (such as psychopathy, autism, tumors, or addiction).  
Instruction and practice in written and oral communication provided. Limited to 24.  
R. Saxe

9.47J Neuroimaging Cells and Circuits  
(Same subject as 20.472J)  
Prereq: Permission of instructor  
G (Fall)  
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. Jasanoﬀ, P. T. So

9.48J Philosophical Issues in Brain Science  
(Same subject as 24.08J)  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-0-9 HASS-H; CI-H  
See description under subject 24.08J.  
A. Byrne

9.50 Research in Brain and Cognitive Sciences  
Prereq: 9.00, permission of instructor  
U (Fall, Spring)  
0-12-0  
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 L. Schulz

9.520 Statistical Learning Theory and Applications  
Prereq: 6.867, 6.041, 18.06, or permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Provides students with the knowledge needed to use and develop advanced machine learning solutions to challenging problems. Covers foundations and recent advances of machine learning in the framework of statistical learning theory. Focuses on regularization techniques key to high-dimensional supervised learning. Starting from classical methods such as regularization networks and support vector machines, addresses state-of-the-art techniques based on principles such as geometry or sparsity, and discusses a variety of algorithms for supervised learning, feature selection, structured prediction, and multitask learning. Also focuses on unsupervised learning of data representations, with an emphasis on hierarchical (deep) architectures.  
T. Poggio, L. Rosasco

9.54 Computational Aspects of Biological Learning  
Prereq: 9.40  
U (Fall)  
3-0-9  
Takes a computational approach to learning in the brain by neurons and synapses. Examines supervised and unsupervised learning as well as possible biological substrates, including Hebb synapses and the related topics of Oja flow and principal components analysis. Discusses hypothetical computational primitives in the nervous system, and the implications for unsupervised learning algorithms underlying the development of tuning properties of cortical neurons. Also focuses on a broad class of biologically plausible learning strategies.  
T. Poggio, S. Ullman
9.56J Abnormal Language
(Same subject as 24.907J)
Prereq: 24.900 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
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 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
See description under subject 24.904J.
K. Wexler

9.59J Laboratory in Psycholinguistics
(Same subject as 24.905J)
Prereq: 9.00 or 24.900
U (Spring)
3-3-6 Institute LAB
Hands-on experience designing, conducting, analyzing, and presenting experiments on the structure and processing of human language. Focuses on constructing, conducting, analyzing, and presenting an original and independent experimental project of publishable quality. Develops skills in reading and writing scientific research reports in cognitive science, including evaluating the methods section of a published paper, reading and understanding graphical displays and statistical claims about data, and evaluating theoretical claims based on experimental data. Instruction and practice in oral and written communication provided.
E. Gibson

9.601J 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, M. Hackl

9.611J Natural Language and the Computer Representation of Knowledge
(Same subject as 6.863J)
Prereq: 6.034
G (Fall)
3-3-6 H-LEVEL Grad Credit
See description under subject 6.863J.
R. C. Berwick

9.63 Laboratory in Visual Cognition
Prereq: 9.00, 9.40, or permission of instructor
U (Fall)
2-1-9 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. Assignments include individual reports on experimental designs, written articles, and presentations critiquing three team experiments observed in class. Instruction and practice in written and oral communication provided. Experience with MATLAB is recommended. Limited to 16.
P. Sinha

9.65 Cognitive Processes
Prereq: 9.00
U (Spring)
3-0-9 HASS-S
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, as well as reasoning and problem-solving.
M. C. Potter

9.66J Computational Cognitive Science
(Same subject as 6.804J)
(Same subject as 24.949J)
Prereq: 9.40; 18.05 or 18.440; or permission of instructor
U (Fall)
3-0-9
9.660 Computational Cognitive Science
(Same subject 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, nonparametric statistical models and the Bayesian Occam’s razor, sampling algorithms for approximate learning and inference, and probabilistic models defined over structured representations such as first-order logic, grammars, or relational schemas. Applications to understanding core aspects of cognition, such as concept learning and categorization, causal reasoning, theory formation, language acquisition, and social inference. Graduate students complete a final project.
J. Tenenbaum

9.75J Psychology of Gender and Race
(Same subject as WGS.228J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-S
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.

C. Kapungu

9.77 Computational Perception
Prereq: 9.00, 9.40; 9.35 or 9.65
U (Spring)
3-0-9

 Begins with a review of the experimental paradigms, findings and theories used to evaluate the capabilities and limits of human visual perception. 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 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. Limited to 8.

E. Adelson

9.822J Psychology and Economics
(Same subject as 14.137J)
Prereq: None
G (Spring)
4-0-8

See description under subject 14.137J.
Consult D. Prelec

9.85 Infant and Early Childhood Cognition
Prereq: 9.00
U (Fall)
3-0-9 HASS-S

Introduction to cognitive development focusing on children's understanding of objects, agents, and causality. Develops a critical understanding of experimental design. Discusses how developmental research might address philosophical questions about the origins of knowledge, appearance and reality, and the problem of other minds. Provides instruction and practice in written communication as necessary to research in cognitive science (including critical reviews of journal papers, a literature review and an original research proposal), as well as instruction and practice in oral communication in the form of a poster presentation of a journal paper.

L. Schulz

9.901 Responsible Conduct in Science
Prereq: None
G (IAP)
1-0-1 [P/D/F]

Provides instruction and dialogue on practical ethical issues relating to the responsible conduct of human and animal research in the brain and cognitive sciences. Specific emphasis on topics relevant to young researchers including data handling, animal and human subjects, misconduct, mentoring, intellectual property, and publication. Preliminary assigned readings and initial faculty lecture followed by discussion groups of four to five students each. A short written summary of the discussions submitted at the end of each class. See IAP Guide for registration information.

M. Wilson

9.91 Independent Study in Brain and Cognitive Sciences
Prereq: 9.00 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
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
H-LEVEL Grad Credit
Can be repeated for credit

Guided research under the sponsorship of individual members of the faculty. Ordinarily restricted to candidates for the doctoral degree in Course 9.
Staff

9.941 Graduate Thesis Proposal
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]
H-LEVEL Grad Credit
Can be repeated for credit

Students submit written proposals for thesis according to stated deadlines.
Staff

9.95 Research Topics in Neuroscience
Prereq: None
U (IAP)
1-0-0 [P/D/F]
Can be repeated for credit

Lecture series that highlights faculty research in various fields of neuroscience. Each of the six lectures focuses on a specific area of brain research, delineating issues, methods, and findings pertinent to the topic. Exam administered during seventh and final class session. Pre-register on WebSIS; must attend first class.

P. H. Schiller

9.97 Introduction to Neuroanatomy
Prereq: None
U (IAP)
1-0-0 [P/D/F]

Intensive introduction to neuroanatomy that consists of lectures, demonstrations, and interactive laboratories, including a brain dissection. No prior knowledge of neuroanatomy required, although general knowledge of brain structures is helpful. Pre-register on WebSIS; must attend first class. Limited to 100.

R. Ellis-Behnke

9.551, 9.552 Special Subject in Brain and Cognitive Sciences
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
9.591—9.5917 Special Subject in Brain and Cognitive Sciences
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. 9.5911 is graded P/D/F.
Staff

9.592 Special Subject in Brain and Cognitive Sciences
Prereq: 9.00
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Undergraduate study in brain and cognitive sciences; covers material not offered in regular curriculum.
Consult Staff

9.593—9.599 Special Subject in Brain and Cognitive Sciences
Prereq: None
U (IAP)
Units arranged [P/D/F]
For undergraduate study in brain and cognitive sciences during Independent Activities Period; covers material not offered in regular curriculum. See IAP Guide for details.
Staff

9.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, 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 Graduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
9.UR Graduate 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/Course 9

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
<td></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>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (can be satisfied by among 6.0002, 6.042, 9.01, 18.05, and 18.440 in the Departmental Program)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (can be satisfied by a laboratory in the Departmental Program)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
<td></td>
</tr>
</tbody>
</table>

Communication Requirement
The program includes a Communication Requirement of four 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>Tier 1: Five subjects required</td>
<td>168–174</td>
</tr>
<tr>
<td>6.0001 Introduction to Computer Science Programming in Python, 6</td>
<td></td>
</tr>
<tr>
<td>6.0002 Introduction to Computational Thinking and Data Science, 6, 6.0002*</td>
<td></td>
</tr>
<tr>
<td>9.00 Introduction to Psychological Science, 12, HASS-S</td>
<td></td>
</tr>
<tr>
<td>9.01 Introduction to Neurosensory Science, 12, REST; Physics II (GIR)*</td>
<td></td>
</tr>
<tr>
<td>9.40 Introduction to Neural Computation, 12; 6.0002, 9.01</td>
<td></td>
</tr>
<tr>
<td>6.044 Probabilistic Systems Analysis, 12, REST; Calculus II (GIR) or 18.05 Introduction to Probability and Statistics, 12, REST; Calculus I (GIR) or 18.440 Probability and Random Variables, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>Tier 2: Three subjects required; up to seven may be taken</td>
<td></td>
</tr>
<tr>
<td>9.04 Sensory Systems, 12; 9.01*</td>
<td></td>
</tr>
<tr>
<td>9.07 Statistics for Brain and Cognitive Science, 12; 9.40</td>
<td></td>
</tr>
<tr>
<td>9.09j Cellular and Molecular Neurobiology, 12; 7.05</td>
<td></td>
</tr>
<tr>
<td>9.10 Cognitive Neuroscience, 12; 9.01</td>
<td></td>
</tr>
<tr>
<td>9.14 Brain Structure and Its Origins, 12; 9.01</td>
<td></td>
</tr>
<tr>
<td>9.15 Neuroendocrinology and Neuroendocrine Systems, 12; 9.40</td>
<td></td>
</tr>
<tr>
<td>9.16 Cellular Neurophysiology, 12; 9.40</td>
<td></td>
</tr>
<tr>
<td>9.18j Developmental Neurobiology, 12, CI-M; 9.01*</td>
<td></td>
</tr>
<tr>
<td>9.20 Animal Behavior, 12, HASS-S; 9.00</td>
<td></td>
</tr>
<tr>
<td>9.31 Neuropharmacology of Learning and Memory, 12; 9.01</td>
<td></td>
</tr>
<tr>
<td>9.35 Perceptual Systems, 12; 9.40*</td>
<td></td>
</tr>
<tr>
<td>9.36j Computational Aspects of Biological Learning, 12; 9.40</td>
<td></td>
</tr>
<tr>
<td>9.45 Cognitive Processes, 12, HASS-S; 9.00</td>
<td></td>
</tr>
<tr>
<td>9.46j Computational Cognitive Science, 12; 9.40*</td>
<td></td>
</tr>
<tr>
<td>9.85 Infant and Early Childhood Cognition, 12, HASS-S, CI-M; 9.00</td>
<td></td>
</tr>
<tr>
<td>Laboratory [Tier 2]: One subject required</td>
<td></td>
</tr>
<tr>
<td>9.12j Experimental Molecular Neurobiology, 12, LAB, CI-M; 9.01, Biology (GIR)</td>
<td></td>
</tr>
<tr>
<td>9.17 Systems Neuroscience Laboratory, 12, LAB, CI-M; 9.01*</td>
<td></td>
</tr>
<tr>
<td>9.59j Laboratory in Psycholinguistics, 12, LAB, CI-M; 9.01*</td>
<td></td>
</tr>
<tr>
<td>9.63 Laboratory in Visual Cognition, 12, LAB, CI-M; 9.00, 9.40*</td>
<td></td>
</tr>
<tr>
<td>Tier 3: Up to four subjects</td>
<td></td>
</tr>
<tr>
<td>9.24 Disorders and Diseases of the Nervous System, 12; 9.00, 9.01, 9.09</td>
<td></td>
</tr>
<tr>
<td>9.28 Current Topics in Developmental Neurobiology, 15, CI-M; 9.18</td>
<td></td>
</tr>
<tr>
<td>9.26j Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience, 12; 7.28*, 9.01*</td>
<td></td>
</tr>
<tr>
<td>9.26 Neuroscience of Morality, 12, CI-M; 9.00, 9.01, 9.10*</td>
<td></td>
</tr>
<tr>
<td>9.56j Abnormal Language, 12, HASS-S; 24.900*</td>
<td></td>
</tr>
<tr>
<td>9.57j Language Acquisition, 12, HASS-S; 24.900*</td>
<td></td>
</tr>
<tr>
<td>9.71 Functional MRI Investigations of the Human Brain, 12, CI-M; 9.40*</td>
<td></td>
</tr>
<tr>
<td>9.77j Computational Perception, 12; 9.00, 9.40, 9.35*</td>
<td></td>
</tr>
<tr>
<td>Research: One subject; Laboratory cannot also count for Research</td>
<td></td>
</tr>
<tr>
<td>9.12j Experimental Molecular Neurobiology, 12, LAB, CI-M; 9.01, Biology (GIR)</td>
<td></td>
</tr>
<tr>
<td>9.17j Systems Neuroscience Lab, 12, LAB, CI-M; 9.40*</td>
<td></td>
</tr>
<tr>
<td>9.41 Research and Communication in Neuroscience and Cognitive Science, 18, CI-M; 9.URG, permission of instructor</td>
<td></td>
</tr>
<tr>
<td>9.40j Research in Brain and Cognitive Sciences, 12; 9.00; permission of instructor</td>
<td></td>
</tr>
<tr>
<td>9.59j Laboratory in Psycholinguistics, 12, LAB, CI-M; 9.00*</td>
<td></td>
</tr>
<tr>
<td>9.63 Laboratory in Visual Cognition, 12, LAB, CI-M; 9.00, 9.40*</td>
<td></td>
</tr>
<tr>
<td>9.URG Undergraduate Research, 12</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives
Zero to four subjects. 9.URG cannot count as a Restricted Elective.

COURSE 9
<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives(^a)</td>
<td>66–72</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 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.

\(^a\) The combination of 6.0001 and 6.0002 counts as a REST subject.

\(^{a}(\text{alt})\) 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.
10.01 Ethics for Engineers
Engineering School-Wide Elective Subject
(Offered under: 1.082, 2.900, 10.01)
Prereq: None
U (Fall)
2-0-4
Integrates classical readings that provide an overview of ethics with a survey of case studies that focus on ethical problems arising in the practice of engineering. Readings taken from a variety of sources, such as Aristotle, Machiavelli, Bacon, Hobbes, Locke, the Founding Fathers, and the Bible. Case studies include written analyses and films that address engineering disasters, biotechnology, court cases, ethical codes, and the ultimate scope and aims of engineering.
D. Doneson, B. L. Trout

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

10.04A A Philosophical History of Energy
(Same subject as 24.114A)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H; CI-H
Philosophic and historical approach to concepts of energy through the 19th century. Relation of long standing scientific and philosophic problems in the field of energy to 21st-century debates. Topics include the development of thermodynamics and kinetic theories, the foundation of the scientific project, the classical view of energy, and the harnessing of nature. Authors include Bacon, Boltzmann, Carnot, Compte, Descartes, Gibbs, Plato, Aristotle, Leibniz, Kant, Hegel, Mill, Peirce, Whitehead, and Maxwell. Key texts and controversies form topics of weekly writing assignments and term papers.
B. L. Trout, A. Schulman

10.10 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.
B. S. Johnston, P. T. Hammond, W. H. Dalzell

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, H. D. Sikes

10.22 Molecular Engineering
Prereq: 5.60, 10.213
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
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.

C. K. Colton, M. S. Strano, J. F. Hamel, W. A. Tisdale, G. Stephanopoulos

10.28 Chemical-Biological Engineering Laboratory
Prereq: 5.310 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 modules spanning microbial fermentation and animal cell culture. With the bioreactor as 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, Greg Stephanopoulos

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.


10.291 Introduction to Sustainable Energy
(Same subject as 2.650J, 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

10.301 Fluid Mechanics
Prereq: 18.03, 10.10
U (Spring)
4-0-8


P. S. Doyle, F. R. Brushett

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.

T. A. Hatton, W. A. Tisdale

10.303 Chemical Kinetics and Reactor Design
Prereq: 5.60, 10.301
U (Spring)
3-0-6

Introduces the complete design of the 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.

K. D. Wittrup, Y. Roman

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

See description under subject 3.021.

M. Buehler, M. Demkowicz

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.

R. D. Braatz, J. W. Swan

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.

K. D. Wittrup, Y. Roman
10.390J Fundamentals of Advanced Energy Conversion
(Same subject as 2.60)
Prereq: 2.006, or 2.051 and 2.06, or permission of instructor
U (Spring)
4-0-8
Credit cannot also be received for 2.62, 10.392, 22.40
See description under subject 2.60).
A. F. Ghoniem, W. Green, M. Kazimi

10.391J Sustainable Energy
(Same subject as 1.818J, 2.65J, 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

10.392J Fundamentals of Advanced Energy Conversion
(Same subject as 2.62), 22.40)
Prereq: 2.006, or 2.051 and 2.06, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Credit cannot also be received for 2.60, 10.390
See description under subject 2.62).
A. F. Ghoniem, W. Green, M. Kazimi

10.40 Chemical Engineering Thermodynamics
Prereq: 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. Blankschtein

10.407 Funding Strategies for Startups (New)
Prereq: None
G (Spring)
2-0-4
Introduction to the substance and process of funding technology startups. Topics include a comparative analysis of various sources of capital; templates to identify the optimal investor; legal frameworks, US and offshore, of the investment process and its related jargon; an introduction to understanding venture capital as a business; and market practice and standards for term sheet negotiation. Emphasizes strategy as well as tactics necessary to negotiate and build effective, long-term relationships with investors, particularly venture capital firms (VCs). Students taking graduate version complete additional assignments.
S. Loessberg

10.424 Pharmaceutical Engineering
(Same subject as 10.524)
Prereq: 10.213
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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, tabletting 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
(Same subject as 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 Frontiers in Therapeutics and Drug Delivery
Prereq: 2.005, 3.012, 5.60, 20.110, or 20.111; 7.06; or permission of instructor
U (Fall)
3-0-9
D. Blankschtein

10.437 Quantum Chemical Simulation (New)
(Same subject as 10.527)
Prereq: None
U (Fall)
3-0-9
Addresses both the theory and application of first-principles computer simulations methods (i.e., quantum, chemical, or electronic structure), including Hartree-Fock theory, density functional theory, and correlated wavefunction methods. Covers enhanced sampling, ab initio molecular dynamics, and transition-path-finding approaches as well as errors and accuracy in total and free energies. Discusses applications such as the study and prediction of properties of chemical systems, including heterogeneous, molecular, and biological catalysts (enzymes), and physical properties of materials. Students taking graduate version complete additional assignments. Limited to 30.
H. J. Kulik

10.441J Molecular and Engineering Aspects of Biotechnology
(Same subject as 7.37), 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 7.37).
H. Lodish, L. Griffith

10.444 Frontiers in Therapeutics and Drug Delivery
(Subject meets with 10.644J, HST.914J)
Prereq: 7.05 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-6
Provides an introduction to pharmaceutics and conventional oral, injected, transdermal and inhaled drug delivery systems. Includes studies of drug delivery devices and systems, e.g., stents, pumps, depo systems, responsive drug delivery systems, and biological/cell based therapies. Covers nano- and micro drug delivery systems, including polymer-drug conjugates, modified proteins, liposomes and polymer nanoparticles, viral and non-viral genetic therapy, and microencapsulated vaccines. Discusses reviews and current
technology. Students taking graduate version complete additional assignments. Limited to 40.

D. G. Anderson

10.450 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

10.466 Structure of Soft Matter
(Subject meets with 10.566)
Prereq: 5.60
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-6

Provides an introduction to the basic thermodynamic language used for describing the structure of materials, followed by a survey of the scattering, microscopy and spectroscopic techniques for structure and morphology characterization. Applies these concepts to a series of case studies illustrating the diverse structures formed in soft materials and the common length, time and energy scales that unify this field. For students interested in studying polymer science, colloid science, nanotechnology, biomaterials, and liquid crystals. Students taking graduate version complete additional assignments.

B. D. Olsen

10.467 Polymer Science Laboratory
Prereq: 5.12, 5.310
U (Fall)
2-7-6

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.

J. C. Love, D. G. Anderson

10.489 Concepts in Modern Heterogeneous Catalysis
(Subject meets with 10.689)
Prereq: 10.37, 10.302
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-6

Explores topics in the design and implementation of heterogeneous catalysts for chemical transformations. Emphasizes use of catalysis for environmentally benign and sustainable chemical processes. Lectures address concepts in catalyst preparation, catalyst characterization, quantum chemical calculations, and microkinetic analysis of catalytic processes. Shows how experimental and theoretical approaches can illustrate important reactive intermediates and transition states involved in chemical reaction pathways, and uses that information to help identify possible new catalysts that may facilitate reactions of interest. Draws examples from current relevant topics in catalysis. Includes a group project in which students investigate a specific topic in greater depth. Students taking graduate version complete additional assignments.

Y. Roman

10.490 Integrated Chemical Engineering 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)
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.

K. F. Jensen, R. C. Armstrong

10.495 Molecular Design and Bioprocess Development of Immunotherapies
(Subject meets with 10.595)
Prereq: 7.06 or permission of instructor
U (Spring)
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, M. Z. Bazant
10.52 Mechanics of Fluids
Prereq: 10.50
G (Fall)
Not offered regularly; consult department
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

10.524 Pharmaceutical Engineering
(Subject meets with 10.424)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (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

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

10.531J Macromolecular Hydrodynamics
(Same subject as 2.341J)
Prereq: 2.25, 10.301, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-2-7 H-LEVEL Grad Credit
See description under subject 22.313J.
E. Baglietto

10.537J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.798J, 3.971J, 6.524J, 20.410J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302
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 20.420J)
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 2.795J, 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. Grodzinsky, R. D. Kamm

10.540 Intracellular Dynamics
Prereq: 18.03, 7.06, 10.302, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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

10.542 Biochemical Engineering
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.
J. A. King
10.544 Metabolic and Cell Engineering  
Prereq: 7.05, 10.302, 18.03  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-0-9 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. Stephanopouloas

10.544J 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.  
J. Cao

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  
See description under subject 15.136J.  
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

10.548J Tumor Pathophysiology and Transport Phenomena: A Systems Biology Approach  
(Same subject as HST.525J)  
Prereq: 18.03; 10.301  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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. Stephanopouloas, R. D. Braatz

10.552 Advanced Systems Engineering  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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  
(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, drug design, and biotechnology also discussed.  
Gr. Stephanopouloas, 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

10.56 Advanced Topics in Surfactant Science  
Prereq: Permission of instructor  
G (Spring)  
3-0-6 H-LEVEL Grad Credit  
Introduces fundamental advances and practical aspects of surfactant self-assembly in aqueous media. In-depth discussion of surfactant micellization, including statistical-thermodynamics of micellar solutions, models of micellar growth, molecular models for the free energy of
micellization, and geometric packing theories. Presents an introductory examination of mixed micelle and vesicle formation, polymer-surfactant complexation, biomolecule-surfactant interactions, and micellar-assisted solubilization. Discusses molecular dynamics simulations of self-assembling systems. Covers recent advances in surfactant-induced dispersion and stabilization of colloidal particles (e.g., carbon nanotubes and graphene) in aqueous media. Examines surfactant applications in consumer products, environmental and biological separations, enhanced oil recovery using surfactant flooding, mitigation of skin irritation induced by surfactant-containing cosmetic products, and enhanced transdermal drug delivery using ultrasound and surfactants.

D. Blankschtein

10.560 Structure and Properties of Polymers
Prereq: 10.213 or permission of instructor
G (Spring)
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

10.566 Structure of Soft Matter
(Subject meets with 10.466)
Prereq: 5.60
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-6 H-LEVEL Grad Credit

Provides an introduction to the basic thermodynamic language used for describing the structure of materials, followed by a survey of the scattering, microscopy and spectroscopic techniques for structure and morphology characterization. Applies these concepts to a series of case studies illustrating the diverse structures formed in soft materials and the common length, time and energy scales that unify this field. For students interested in studying polymer science, colloid science, nanotechnology, biomaterials, and liquid crystals. Students taking graduate version complete additional assignments.

B. D. Olsen

10.568 Physical Chemistry of Polymers
Prereq: 5.60, 10.213, or 10.40
Acad Year 2014–2015: G (Fall, Spring)
Acad Year 2015–2016: Not offered
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
(Subject same as 12.806J)
Prereq: 5.60 or 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

10.580 Solid-State Surface Science
Prereq: 10.213
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

10.586 Crystallization Science and Technology
Prereq: 10.213
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-6 H-LEVEL Grad Credit

Studies the nucleation and growth of crystals from a melt or a liquid solution and their important role in a wide range of applications, including pharmaceuticals, proteins, and semiconductor materials. Provides background information and covers topics needed to understand, perform experiments, construct and simulate mechanistic models, and design, monitor, and control crystallization processes. Limited to 30.

A. S. Myerson, R. D. Braatz

10.591 Case Studies in Bioengineering
Prereq: Biology (GIR) or permission of instructor
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
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  
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.  
M. Z. Bazant

10.606 Visual Strategies for Scientists and Engineers  
Prereq: None  
G (Spring; first half of term)  
1-2-2 [P/D/F]  
Provides instruction in best practices for creating more effective graphics and photographs to support and communicate research in science and engineering. Discusses in depth specific examples from a range of scientific contexts, such as journal articles, presentations, grant submissions, and cover art. Topics include graphics for figures depicting form and structure, process, and change over time. Prepares students to create effective graphics for submissions to existing journals and calls attention to the future of published graphics with the advent of interactivity. Limited to 10.  
F. Frankel

10.625J Electrochemical Energy Conversion and Storage: Fundamentals, Materials and Applications  
(Same subject as 2.625J)  
Prereq: 2.005, 3.046, 3.53, 10.40, or 2.051 and 2.06, or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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  
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

10.631 Structural Theories of Polymer Fluid Mechanics  
Prereq: 10.301  
G (Spring)  
3-0-6 H-LEVEL Grad Credit  
R. C. Armstrong

10.637 Quantum Chemical Simulation (New)  
(Subject meets with 10.437)  
Prereq: None  
G (Fall)  
3-0-9  
Addresses both the theory and application of first-principles computer simulations methods (i.e., quantum, chemical, or electronic structure), including Hartree-Fock theory, density functional theory, and correlated wavefunction methods. Covers enhanced sampling, ab initio molecular dynamics, and transition-path-finding approaches as well as errors and accuracy in total and free energies. Discusses applications such as the study and prediction of properties of chemical systems, including heterogeneous, molecular, and biological catalysts (enzymes), and physical properties of materials. Students taking graduate version complete additional assignments. Limited to 30.  
H. J. Kulik

10.644J Frontiers in Therapeutics and Drug Delivery  
(Subject meets as HST.914J)  
Prereq: 7.05 or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-0-6  
Provides an introduction to pharmaceutics and conventional oral, injected, transdermal and inhaled drug delivery systems. Includes studies of drug delivery devices and systems, e.g., stents, pumps, depo systems, responsive drug delivery systems, and biological/cell based therapies. Covers nano- and micro drug delivery systems, including polymer-drug conjugates, modified proteins, liposomes and polymer nanoparticles, viral and non-viral genetic therapy, and microencapsulated vaccines. Discusses reviews and current technology. Students taking graduate version complete additional assignments. Limited to 40.  
D. G. Anderson

10.65 Chemical Reactor Engineering  
Prereq: 10.37 or permission of instructor  
G (Spring)  
4-0-8 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 biological processes; mechanism formulation and sensitivity analysis. Reactor topics include nonideal flow reactors, residence time distribution and dispersion models; multiphase reaction systems; nonlinear reactor phenomena. Examples are drawn from different applications, including heterogeneous catalysis, polymerization, combustion, biochemical systems, and materials processing.  
M. Strano, G. Stephanopoulos

10.652J Kinetics of Chemical Reactions  
(Subject meets 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 3.941J)
Prereq: 10.568 or permission of instructor
G (Fall)
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, A. Alexander-Katz

10.677 Topics in Applied Microfluidics (New)
Prereq: 10.301 or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

Provides an introduction to the field of microfluidics. Reviews fundamental concepts in transport phenomena and dimensional analysis, focusing on new phenomena which arise at small scales. Discusses current applications, with an emphasis on the contributions engineers bring to the field. Local and visiting experts in the field discuss their work. Limited to 30.

P. Doyle

10.689 Concepts in Modern Heterogeneous Catalysis
(Subject meets with 10.489)
Prereq: 10.37, 10.302
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-6

Explores topics in the design and implementation of heterogeneous catalysts for chemical transformations. Emphasizes use of catalysis for environmentally benign and sustainable chemical processes. Lectures address concepts in catalyst preparation, catalyst characterization, quantum chemical calculations, and microkinetic analysis of catalytic processes. Shows how experimental and theoretical approaches can illustrate important reactive intermediates and transition states involved in chemical reaction pathways, and uses that information to help identify possible new catalysts that may facilitate reactions of interest. Draws examples from current relevant topics in catalysis. Includes a group project in which students investigate a specific topic in greater depth. Students taking graduate version complete additional assignments.

Y. Roman

10.702J 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, P. Gupta, K. D. Wittrup
Spring: M. Gehring, T. Schwartz, K. D. Wittrup

10.74j Radiative Transfer
(Same subject as 2.58J)
Prereq: 2.51, 10.302, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad 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
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

See description under subject 15.792J.
D. B. Rosenfield

10.805J Technology, Law, and the Working Environment
(Same subject as ESD.136J)
(Subject meets with 1.84J, 12.807J)
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
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. Caldwell

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

See description under subject 2.96.
H. S. Marcus, J.-H. Chun

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

10.817J Atmospheric Chemistry
(Same subject as 1.84J, 12.807J)
Prereq: 5.60
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 1.84J.
J. H. Kroll

SCHOOL OF CHEMICAL ENGINEERING PRACTICE

10.80 (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 Engi-
neering Practice for details. Enrollment limited and subject to plant availability.

**T. A. Hatton**

**10.910 Independent Research Problem**

Prereq: None

U (Fall, IAP, Spring, Summer)

Units arranged [P/D/F]

Can be repeated for credit

For undergraduate students who wish to carry out a special investigation in a particular field. Topic and hours arranged.

**B. S. Johnston**

**10.911 Independent Research Problem**

Prereq: None

U (Fall, IAP, Spring, Summer)

Units arranged [P/D/F]

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 special and graduate students who wish to carry out some minor investigation in a particular field. Subject and hours to fit individual requirements.

**P. S. Doyle**

**10.90 Independent Research Problem**

Prereq: Permission of instructor

G (Fall, Spring, Summer)

0-6-0 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.

**T. A. Hatton**

**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**

**10.954 Seminar in Applied Optical Spectroscopy**

Prereq: Permission of instructor

G (Fall, Spring)

2-0-4 [P/D/F]

Can be repeated for credit

Research seminars given by students, postdocs, and visitors. Topics covered include applied optical spectroscopy and imaging, with particular emphasis on nanomaterials and how they relate to alternative energy technologies.

**W. A. Tisdale**

**10.955 Seminar in Electrochemical Engineering**

Prereq: Permission of instructor

G (Fall, Spring)

2-0-4 [P/D/F]

Can be repeated for credit

Designed to allow students to present and discuss their research in the area of electrochemical engineering with a particular emphasis on energy storage and conversion (e.g., batteries, fuel cells, electroreactors). Specific topics include active materials design, electroanalytical platform development, and integration of electrochemical and imaging techniques.

**F. R. Brushett**

**10.956 Seminar in Atomistic Simulation**

Prereq: Permission of instructor

G (Fall, Spring)

2-0-4 [P/D/F]

Can be repeated for credit

Seminar allows students to present their research to other students and staff. The research topics include electronic structure theory, computational chemistry techniques, and density functional theory with a focus on applications to catalysis and materials science.

**H. J. Kulik**

**10.957 Seminar in Bioengineering Technology**

Prereq: Permission of instructor

G (Fall, Spring)

2-0-4 [P/D/F]

Can be repeated for credit

Research seminars presented by students and guest speakers on emerging biotechnologies.

**K. Chung**

**10.958 Seminar in the Fluid Mechanics and Self-assembly of Soft Matter**

Prereq: Permission of instructor

G (Fall, Spring)

2-0-4 [P/D/F]

Can be repeated for credit

Covers topics related to low Reynolds number hydrodynamics and the statistical physics of particulate media. Specifics include the kinetics of phase transitions in soft matter and the time-varying deformation of colloidal dispersions, glasses and gels.

**J. W. Swan**

**10.960J 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.

**A. Alexander-Katz, R. E. Cohen, D. Irvine**

**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**

**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 cell biology. Emphasis is on quantita-tive aspects of physicochemical mechanisms involved in receptor/ligand interactions, receptor signal transduction processes, receptor-mediated cell behavioral responses, and applications of these in biotechnology and medicine.

D. A. Lauffenburger

10.964 Seminar on Transport Theory
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [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, electrodynamics, and microfluidics.

M. Z. Bazant

10.965 Seminar in Biosystems Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
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. Anderson

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: Permission of instructor
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, J. W. Swans

10.972 Biochemical Engineering Research Seminar
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

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.

K. F. Jensen

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 colloidial systems; interfacial phenomena in colloidial 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 microstructured materials. Discussions guided by the research interests of participating students. Includes techniques from applied mathematics and numerical methods, multiscale systems analysis, and control theory.

R. D. Braatz

10.987 Solid Thin Films and Interfaces
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [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, P. S. Doyle

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
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 of current literature and research on the engineering of protein biopharmaceuticals. Topics include combinatorial library construction and screening strategies, antibody engineering, gene therapy, cytokine engineering, and immunotherapy engineering strategies.

K. D. Wittrup

10.995 Cellular and Metabolic Engineering
Prereq: Permission of instructor
G (Fall, Spring)
2-0-4 [P/D/F]
Can be repeated for credit
Graduate students, postdoctoral fellows, visiting scientists, and guest industrial practitioners to present their own research and highlight important advances from the literature in biochemical and bioprocess engineering. Topics of interest include metabolic engineering, novel microbial pathway design and optimization, synthetic
biology, and applications of molecular biology to bioprocess development.

K. J. Prather, 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

10.594, 10.595 Special Problems in Chemical Engineering
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

Focuses on problem of current interest not covered in regular curriculum; topic varies from year to year.
Staff

10.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.
P. S. Doyle

10.ThU Undergraduate Thesis
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Program of research leading to writing an SB thesis; topic arranged between student and MIT faculty member.
B. S. Johnston

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

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

Opportunity for participation in a research group, or for special investigation in a particular field. Topic and hours to fit individual requirements.
B. S. Johnston
Bachelor of Science in Chemical Engineering/Course 10

**General Institute Requirements (GIRs)**

**Science Requirement**
- Humanities, Arts, and Social Sciences Requirement

**Restricted Electives in Science and Technology (REST) Requirement**
- [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]

**Laboratory Requirement**
- [can be satisfied by 5.310]

**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**

- 5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)
- 5.07 Biological Chemistry I, 12, REST; 5.12
- 7.05 General Biochemistry, 12, REST; 5.12*
- 5.310 Laboratory Chemistry, 12, LAB; 5.12
- 5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (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
- 10.28 Chemical-Biological Engineering Laboratory, 15, CI-M; 7.05*; 10.702J*; 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

**plus**

- 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
- 10.303 Separation Processes, 6; 10.213, 10.302
- 10.37 Chemical Kinetics and Reactor Design, 5; 5.60, 10.301
- 10.490 Integrated Chemical Engineering I, 8; 10.37
- 10.491 Integrated Chemical Engineering II, 8; 10.490

**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

- 10.801 Differential Equations, 12, REST; Calculus II (GIR)
- 10.816 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, 10.888, Materials Laboratory, 12, LAB, CI-M

- 5.36 Biochemistry and Organic Laboratory, 12, CI-M
- Module 4 Expression and Purification of Enzyme Mutants, 4; 10.302; or permission of instructor
- Module 5 Organic Structure Determination, 4; 10.302; or permission of instructor
- Module 6 Organic Structure Determination, 4; 10.302; or permission of instructor
- Module 7 Organic Structure Determination, 4; 10.302; or permission of instructor
- Module 8 Organic Structure Determination, 4; 10.302; or permission of instructor
- Module 9 Organic Structure Determination, 4; 10.302; or permission of instructor
- Module 10 Organic Structure Determination, 4; 10.302; or permission of instructor
- Module 11 Organic Structure Determination, 4; 10.302; or permission of instructor
- Module 12 Organic Structure Determination, 4; 10.302; or permission of instructor

**Departmental Program Units That Also Satisfy the GIRs**

**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.
- 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.
- Students may substitute 10.01 Ethics for Engineers.

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 Chemical-Biological Engineering/Course 10-B

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</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 from among 5.07, 5.12, 5.60, 7.03, 7.05, 10.301, and 18.03 or 18.034 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 7.02 or 10.702]</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).

### 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>5.12 Organic Chemistry I, 12; REST; Chemistry (GIR)</td>
<td>186</td>
</tr>
<tr>
<td>5.60 Thermodynamics and Kinetics, 12; REST; Calculus II (GIR), Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>10.702J Introduction to Experimental Biology and Communication, 18, CI-M, LAB; Biology (GIR)</td>
<td></td>
</tr>
<tr>
<td>7.03 Genetics, 12; REST; Biology (GIR)</td>
<td></td>
</tr>
<tr>
<td>7.05 General Biochemistry, 12; REST; 5.12*</td>
<td></td>
</tr>
<tr>
<td>or 5.07 Biological Chemistry I, 12, REST; 5.12</td>
<td></td>
</tr>
<tr>
<td>7.06 Cell Biology, 12; 7.03, 7.05</td>
<td></td>
</tr>
<tr>
<td>10.10 Introduction to Chemical Engineering, 12; Physics I (GIR), Calculus I (GIR), Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>10.213 Chemical and Biological Engineering Thermodynamics, 12; 5.60, 10.10</td>
<td></td>
</tr>
<tr>
<td>10.218 Chemical-Biological Engineering Laboratory, 15, CI-M; 7.05; 10.702*; or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>or one of the following two subjects:</td>
<td></td>
</tr>
<tr>
<td>10.27 Energy Engineering Projects Laboratory, 15, CI-M; 7.02*; 10.302; or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>10.29 Biological Engineering Projects Laboratory, 15, CI-M; 7.02*; 10.302; or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>10.301 Fluid Mechanics, 12, REST; 18.03, 10.10</td>
<td></td>
</tr>
<tr>
<td>10.302 Transport Processes, 12; 5.60, 10.301, 10.213; or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>plus 10.37 Chemical Kinetics and Reactor Design, 9; 5.60, 10.301</td>
<td></td>
</tr>
<tr>
<td>10.490 Integrated Chemical Engineering I, 8; 10.37</td>
<td></td>
</tr>
<tr>
<td>10.492 Integrated Chemical Engineering II, 8; 10.490</td>
<td></td>
</tr>
<tr>
<td>plus two of the following three subjects:</td>
<td></td>
</tr>
<tr>
<td>10.493 Integrated Chemical Engineering Topics I, 4; 10.301 and permission of instructor</td>
<td></td>
</tr>
<tr>
<td>10.494 Integrated Chemical Engineering Topics II, 4; 10.301 and permission of instructor</td>
<td></td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>or 18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td><strong>Departmental Program Units That Also Satisfy the GIRs</strong></td>
<td><strong>(36)</strong></td>
</tr>
<tr>
<td><strong>Unrestricted Electives</strong></td>
<td><strong>48</strong></td>
</tr>
<tr>
<td><strong>Total Units Beyond the GIRs Required for SB Degree</strong></td>
<td><strong>198</strong></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 are listed in the subject description.

* Students may substitute 10.01 Ethics for Engineers.

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 as Recommended by the Department of Chemical Engineering/Course 10-ENG

General Institute Requirements (GIRs) | Subjects | Units
--- | --- | ---
Science Requirement | 6 | 
Humanities, Arts, and Social Sciences Requirement | 8 | 
Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 5.60 and 10.301, in the Departmental Program] | 2 | 
Laboratory Requirement [can be satisfied by 1.106 and 1.107, or 2.671, 3.014, 5.310, 10.702J, or 12.335 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) | Units |
--- | ---
**Required Subjects** | 81 |
5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (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 | 
18.03 Differential Equations, 12, REST; Calculus II (GIR) | 
**Foundational Concepts** | 39–45 |
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:** | 
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 | 
10.46 Polymer Science Laboratory, 15, CI-M*; 5.12; 5.310* | 
**Group II. Choose one of the following Institute Laboratory subjects:** | 
1.106 Environmental Fluid Transport Processes and Hydrology Laboratory, 6, LAB*; 1.061, 1.070 and 1.107 Environmental Chemistry and Biology Laboratory, 6, LAB*; 2.080 | 
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; 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 1 | 
—Module 3 Polymeric Light Emitting Devices, 4; 5.12; Module 2 | 
10.702J Introduction to Experimental Biology and Communication, 18, CI-M, LAB*; 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), 6.0002, 18.03, 20.110* | 
**Group III. Choose one of the following:** | 
1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR) | 
1.01B1A Fundamentals of Ecology I, 6 and 1.01B1B Fundamentals of Ecology II, 6; 1.01B1A* | 
1.08 Environmental Chemistry, 12; Chemistry (GIR) | 
3.012 Fundamentals of Materials Science and Engineering, 15, REST*; 18.03* | 
3.155J 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) | 
6.0001 Introduction to Computer Science Programming in Python, 6 and 6.0002 Introduction to Computational Thinking and Data Science, 6, 6.0001* | 
7.05 Genetics, 12, REST; Biology (GIR) | 
8.21 Physics of Energy, 12, REST*; Physics II (GIR), Calculus II (GIR), Chemistry (GIR) | 
**Engineering Concentration** | 39–48 |
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. Additional information on current subject offerings is available on the Chemical Engineering Department website, [http://mit.edu/cheme/academics/course/](http://mit.edu/cheme/academics/course/). 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.TU Undergraduate Thesis, 12

Option 2. Any combination of the following:
10.490 Integrated Chemical Engineering I, 8; 10.37
10.491 Integrated Chemical Engineering II, 8; 10.490
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

Option 3
10.910 Independent Research Problem, units arranged
and any combination of the following:
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

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.
(5) The combination of 1.018A and 1.018B counts as a REST subject.
(6) The combination of 6.0001 and 6.0002 counts as a REST subject.
(7) Students may substitute 10.01 Ethics for Engineers.

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 SUBJECTS

11.001J Introduction to Urban Design and Development
(Same subject as 4.250J)
Prereq: None
U (Spring)
3-0-9 HASS-S

Examines the evolving structure of cities and the way that cities, suburbs, and metropolitan areas can be designed and developed. Surveys the ideas of a wide range of people who have addressed urban problems. Stresses the connection between values and design. Demonstrates how physical, social, political and economic forces interact to shape and reshape cities over time.

L. Vale

11.002J Making Public Policy
(Same subject as 17.30J)
Prereq: None
U (Fall)
4-0-8 HASS-S; CI-H

Examines how the struggle among competing advocates shapes the outputs of government. Considers how conditions become problems for government to solve, why some political arguments are more persuasive than others, why some policy tools are preferred over others, and whether policies achieve their goals. Investigates the interactions among elected officials, think tanks, interest groups, the media, and the public in controversies over global warming, urban sprawl, Social Security, health care, education, and other issues.

J. Layzer, C. Warshaw

11.003J Methods of Policy Analysis
(Same subject as 17.303J)
Prereq: 11.002J; Coreq: 14.01
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

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

Staff

11.005 Introduction to International Development
Prereq: None
U (Spring)
3-0-9 HASS-S

Introduces the political economy of international economic development planning, using an applied, quantitative approach. Considers why some countries are able to develop faster than others. Presents major theories and models of development and underdevelopment, providing tools to understand the mechanisms and processes behind economic growth and broader notions of progress. Offers an alternative view of development, focusing on the persistence of dichotomies in current theory and practice. Using specific cases, explores how different combinations of actors and institutions at various scales may promote or inhibit economic development. Students re-examine conventional knowledge and engage critically with the assumptions behind current thinking and policy.

Staff

11.006 Poverty and Economic Security
Prereq: None
U (Fall)
2-0-7 HASS-S

Explores the evolution of poverty and economic security in the US within a global context. Examines the impacts of recent economic restructuring and globalization. Reviews current debates about the fate of the middle class, sources of increasing inequality, and approaches to advancing economic opportunity and security.

P. Clay

11.011 The Art and Science of Negotiation
Prereq: None
U (Spring)
3-0-9 HASS-S

Introduction to negotiation theory and practice. Applications in government, business, and nonprofit settings are examined. Combines a “hands-on” personal skill-building orientation with a look at pertinent theory. Strategy, communications, ethics, and institutional influences are examined as they shape the ability of actors to analyze problems, negotiate agreements, and resolve disputes in social, organizational, and political circumstances characterized by interdependent interests.

T. Schenk

11.013J American Urban History I
(Same subject as 21H.217J)
Prereq: None
U (Spring)
2-0-7 HASS-H; CI-H

Seminar on the history of institutions and institutional change in American cities from roughly 1850 to the present. Among the institutions to be looked at are political machines, police departments, courts, schools, prisons, public authorities, and universities. Focuses on readings and discussions.

R. M. Fogelson

11.014J American Urban History II
(Same subject as 21H.218J)
Prereq: None
U (Fall)
2-0-7 HASS-H; CI-H

Seminar on the history of selected features of the physical environment of urban America. Among the features considered are parks, cemeteries, tenements, suburbs, zoos, skyscrapers, department stores, supermarkets, and amusement parks.

R. M. Fogelson

11.015J Riots, Strikes, and Conspiracies in American History
(Same subject as 21H.226J)
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H

See description under subject 21H.226J.

R. M. Fogelson

11.016J The Once and Future City
(Same subject as 4.211J)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

Examines the evolving structure of cities, the dynamic processes that shape them, and the significance of a city’s history for its future development. Develops the ability to read urban form as an interplay of natural processes and
human purposes over time. Field assignments in Boston provide the opportunity to use, develop, and refine these concepts. Enrollment limited.

A. Spirn

11.019J Migration and Immigration in US History
(Same subject as 21H.310J)
Prereq: None
Acad Year 2014–2015; U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S
See description under subject 21H.310J.
C. Capozzola

11.021J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.801J, 17.393J)
(Same subject with 11.630J, ESD.133J)
Prereq: None
U (Fall)
3-0-9 HASS-S
See description under subject 1.801J.
N. Ashford, C. Caldart

11.022J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 1.802J)
(Same subject with 1.811J, 10.805J, 11.631J,
ESD.134J, ESD.136J)
Prereq: 1.801 or permission of instructor
U (Spring)
Not offered regularly; consult department
3-0-9
See description under subject 1.802J.
N. Ashford, C. Caldart

11.025J D-Lab: Development
(Same subject as EC.701J)
(Same subject with 11.472J, EC.781J)
Prereq: None
U (Fall)
3-2-7 HASS-S
See description under subject EC.701J.
A. B. Smith, B. Sanyal

11.026J Downtown
(Same subject as 21H.321J)
(Same subject with 11.339)
Prereq: None
U (Spring)
2-0-7 HASS-H
See description under subject 21H.321J.
R. M. Fogelson

11.027 City to City: Comparing, Researching and Writing about Cities
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-S
Introduces client-oriented research and the use of urban planning tools. Students work directly with government and community agencies to find solutions to real-world problems; interview planners and other field experts, and write and present findings to client and community audiences. Opportunity to travel for research. Limited to 14; preference to Course 11 majors.
C. Abbanat

11.028J Construction: Design and Building Projects
(Same subject as CMS.590J)
(Same subject with 11.252J, CMS.863J)
Prereq: None
U (Spring)
3-6-3 HASS-S; CI-H
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.
E. Klopfer

11.123 Big Plans and Mega-Urban Landscapes
Prereq: None
U (Spring)
3-0-6 HASS-S
Explores the physical, ecological, technological, political, economic and cultural implications of big plans and mega-urban landscapes in a global context. Uses local and international case studies to understand the process of making major changes to urban landscape and city fabric, and to regional landscape systems. Includes lectures by leading practitioners. Assignments consider planning and design strategies across multiple scales and time frames.
Staff

11.124 Introduction to Education: Looking Forward and Looking Back on Education
Prereq: None
U (Fall)
3-6-3 HASS-S; CI-H
One of two introductory subjects on teaching and learning science and mathematics in a variety of K-12 settings. Topics include student misconceptions, formative assessment, standards and standardized testing, multiple intelligences, and educational technology. Students gain practical experience through weekly visits to schools, classroom discussions, selected readings, and activities to develop a critical and broad understanding of past and current forces that shape the goals and processes of education, and explores the challenges and opportunities of teaching. Students work collaboratively and individually on papers, projects, and in-class presentations.
E. Klopfer

11.125 Introduction to Education: Understanding and Evaluating Education
Prereq: None
U (Spring)
3-6-3 HASS-S; CI-H
One of two introductory subjects on teaching and learning science and mathematics in a variety of K-12 settings. Topics include student misconceptions, formative assessment, standards and standardized testing, multiple intelligences, and educational technology. Students gain practical experience through weekly visits to schools, classroom discussions, selected readings, and activities to develop a critical and broad understanding of past and current forces that shape the goals and processes of education, and explores the challenges and opportunities of teaching. Students work collaboratively and individually on papers, projects, and in-class presentations.
E. Klopfer

11.127J Computer Games and Simulations for Investigation and Education
(Same subject as CMS.590J)
(Same subject with 11.252J, CMS.863J)
Prereq: None
U (Spring)
3-6-3 HASS-H
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

11.129 Educational Theory and Practice I
Prereq: None. Coreq: 11.124
U (Fall)
3-0-9 HASS-S
Concentrates on core set of skills and knowledge necessary for teaching in secondary schools. Topics include classroom management, student behavior and motivation, curriculum design, educational reform, and the teaching profession. Classroom observation is a key component. Assignments include readings from educational literature, written reflections on classroom
observations, practice teaching and constructing curriculum. The first of the three-course sequence necessary to complete the Teacher Education Program. Limited to 15s; preference to juniors and seniors.

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. Students assume responsibility for full-time teaching of two or more classes at their designated school. Class sessions focus on debriefing and problem-solving. Second of a three-course sequence necessary to complete the Teacher Education Program.

R. Gibb

11.131 Educational Theory and Practice III
Prereq: 11.130
U (Spring)
3-0-9 HASS-S
Students continue their IAP student teaching through mid March. Topics include educational psychology, theories of learning, and using technology and evaluating its effectiveness to enhance student learning. Assignments include readings from educational literature, written reflections on student teaching, presentations on class topics and creating a project that supports student learning at the school where the MIT student is teaching. This is the third of the three-course sequence necessary to complete the Teacher Education Program.

R. Gibb

11.137 Financing Economic Development
(Subject meets with 11.437)
Prereq: None
U (Fall)
3-0-9
Focuses on financing tools and program models to support local economic development. Provides an overview of private capital markets and financing sources to understand capital market imperfections that constrain economic development, business accounting, financial statement analysis, federal economic development programs, and public finance tools. Covers policies and program models, including revolving loan funds, guarantee programs, venture capital funds, bank holding companies, community development loan funds and credit unions, micro enterprise funds, and the Community Reinvestment Act. Students taking graduate version complete additional assignments.

K. Seidman

11.140 Urbanization and Development
(Subject meets with 11.480)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
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.

Staff

11.142 Geography of the Global Economy
Prereq: None
U (Spring)
3-0-9 HASS-S
Analyzes implications of economic globalization for communities, regions, international businesses and economic development organizations. Uses spatial analysis techniques to model the role of energy resources in shaping international political economy. Investigates key drivers of human, physical, and social capital flows and their roles in modern human settlement systems. Surveys contemporary models of industrialization and places them in geographic context. Connects forces of change with their implications for the distribution of wealth and human well-being.

A. Glasmeier

11.144 Project Appraisal in Developing Countries
(Subject meets with 11.484)
Prereq: Permission of instructor
U (Spring)
3-0-9
Covers techniques of financial analysis of investment expenditures, as well as the economic and distributive appraisal of development projects. Critical analysis of these tools in the political economy of international development is discussed. Topics include appraisal's role in the project cycle, planning under conditions of uncertainty, constraints in data quality and the limits of rational analysis, and the coordination of an interdisciplinary appraisal team. Students taking graduate version complete additional assignments. Enrollment limited; preference to majors.

Staff

11.145 International Housing Economics and Finance
(Subject meets with 11.355)
Prereq: 14.01
U (Spring)
3-0-6
Presents a theory of comparative differences in international housing outcomes. Introduces institutional differences in the ways housing expenditures are financed, and the economic determinants of housing outcomes, such as construction costs, land values, housing quality, and ownership rates. Analyzes the flow of funds to and from the different national housing finance sectors. Develops an understanding of the greater financial and macroeconomic implications of the mortgage credit sector, and how policies affect the ways in which housing asset fluctuations impact national economies. Considers the perspective of investors in international real estate markets and the risks and rewards involved. Draws on lessons from an international comparative approach, and applies them to economic and finance policies at the local, state/provincial, and federal levels within a country of choice. Students taking graduate version complete additional assignments.

A. Saiz

11.146 Urbanizing China (New)
(Subject meets with 11.476)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9
Discusses China’s daunting urban challenges: congestion and smog, housing affordability, land reform and urban financing, migrants and locals, and social and spatial inequality. Provides examples of laudable achievements and diverse and innovative responses across more than six hundred cities. Presents China’s urbanization as the joint result of natural socioeconomic processes and conscious actions by governments, markets, and the public. Presents multidisciplinary approaches and alternative narratives. Examines the intricate interaction between state and market in China’s context, yielding a variety of state-market ‘cocktails’ devised and experimented in different cities in response to local problems, each involving a multilayered projection onto urban space.
Students taking graduate version complete additional assignments.

J. Zhao

11.147 Innovative Budgeting and Finance for the Public Sector

(Subject meets with 11.487)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-S

Examines globally relevant challenges of adequately and effectively attending to public sector responsibilities for basic services with limited resources. Particular attention to the contexts of fiscal crises, rapid population growth, as well as shrinkage: through an introduction to methods and processes of budgeting, accounting, and financial mobilization in the public sector; use of case studies and practice exercises to explore revenue strategies and to gain fiscal analytical competencies; study of pioneering examples of promising budget and accounting processes as well as innovative funding mobilization via taxation, capital markets, and experimental experiences with mechanisms such as land-value capture. Students taking graduate version are expected to explore the subject in greater depth.

G. Carolini

11.150J Metropolis: A Comparative History of New York City

(Same subject as 21H.220J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

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 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
2-0-10 HASS-S

See description under subject 21H.385J.

C. Wilder

11.153J Shanghai and China's Modernization

(Same subject as 21H.351J)
Prereq: None
U (Spring)
2-0-10 HASS-H

See description under subject 21H.351J.

C. Leighton

11.160J Re-Energizing MIT: Innovating Energy Management at the Institute

(Same subject as 2.601J)
Prereq: None
U (Spring)
4-0-8

Designed to enable students to make a direct contribution to MIT’s efforts to improve energy management. Working in teams, students explore how energy is used on campus and then propose and implement ideas to reduce environmental and climate impact. Projects may include topics focused on improving building and appliance efficiency, transportation choices, and energy demand in dorms, offices, and laboratories. Limited to 15; preference to freshmen and sophomores.

Staff


(Same subject as 14.43J, 15.031J, 17.397J, 21A.415J)
Prereq: 14.01, 15.016, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S

See description under subject 15.031J.

D. Lessard, R. Schmalensee, S. Silbey, C. Warshaw

11.162 Politics of Energy and the Environment

Prereq: None
U (Spring)
3-0-9 HASS-S

Focuses on the politics of making local, state, national and international decisions on energy and the environment. Topics include implementing energy efficiency measures, siting nuclear and alternative energy plants, promoting oil and gas development 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.

J. Layzer

11.163J Law and Society

(Same subject as 17.249J, 21A.455J)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-S

See description under subject 21A.455J.

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 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
2-0-10 HASS-S

Provides a rigorous and critical introduction to the history, foundation, structure, and operation of the human rights movement. Focuses on key ideas, actors, methods, and sources, and critically evaluates the field. Addresses current debates in human rights, including 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

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

Studies the interaction between law, courts, and social movements in shaping domestic and global public policy. Examines how groups mobilize to use law to affect change and why
they succeed and fail. Uses case studies to explore 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

LABORATORIES

11.188 Urban Planning and Social Science Laboratory
Prereq: None
U (Spring)
3-3-6 Institute LAB
Credit cannot also be received for 11.205

An introduction to the research and empirical analysis of urban planning issues using geographic information systems. Extensive hands-on exercises provide experience with various techniques in spatial analysis and querying databases. Includes a small project on an urban planning problem involving the selection of appropriate methods, the use of primary and secondary data, computer-based modeling, and spatial analysis. Requires some computing experience.

J. Ferreira

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

Undergraduate research opportunities in Urban Studies and Planning. For further information, consult the Departmental Coordinators.

E. Klopfer

11.189–11.190 Urban Fieldwork
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Practical application of city and regional planning techniques to towns, cities, and regions, including problems of replanning, redevelopment, and renewal of existing communities. Includes internships, under staff supervision, in municipal and state agencies and departments.

Staff

11.191–11.192 Independent Study
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

For undergraduates wishing to pursue further study in specialized areas of urban studies or city and regional planning not covered in regular subjects.

Staff

11.193–11.194 Supervised Readings
Prereq: None
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Reading and discussion of topics in urban studies and planning.

Staff

11.5195–11.5199 Special Subject: Urban Studies and Planning
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

For undergraduates wishing to pursue further study or fieldwork in specialized areas of urban studies or city and regional planning not covered in regular subjects of instruction. 11.5198 is graded P/D/F.

Staff

MASTER'S CORE SUBJECTS

11.201 Gateway: 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.

J. Buckley, L. Vale

11.202 Planning Economics
Prereq: 11.203
G (Fall; partial 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.

A. Saiz

11.203 Microeconomics
Prereq: None
G (Fall; partial 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.

A. Saiz

11.205 Introduction to Spatial Analysis
Prereq: None
G (Fall; partial term)
2-2-2

Credit cannot also be received for 11.188

Practical introduction to spatial analysis and geographic information systems (GIS). Examines how geography is represented digitally and
how nonrandom distributions of phenomena as diverse as poverty and scenic resources can be better understood by examining their spatial characteristics. Limited enrollment; preference to first-year MCP students.

S. Williams

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.

C. Zegras

DEPARTMENT-WIDE SUBJECTS

11.225 Argumentation and Communication
Prereq: None
G (Fall)
Not offered regularly; consult department
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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

11.236 Theory of Participatory Action Research (PAR) (New)
Prereq: None
G (Fall; partial term)
2-0-4
Introduces the theory of participatory action research (PAR) and competing ideas about the uses of social research to promote social change. Focuses on the epistemological foundation for and knowledge generation in action research, as well as on approaches to co-producing research that requires engagement of the subjects, communities, or organizations that are being studied in the design, implementation and interpretation of applied social research. Explores the ethical obligations of outsiders along with rights and responsibilities of insiders in the research findings. Emphasizes recent scholarship, including arguments for and against phonetic social science.

L. Susskind, D. Cunningham

11.237 Theory of Participatory Action Research (PAR) (New)
Prereq: 11.236 or permission of instructor
G (Spring; partial term)
2-0-4
Introduces the theory of participatory action research (PAR) and practice of case study research. Presents competing ideas about context-independent vs. context-dependent knowledge, arguments for and against generating theory on the basis of a single case, and problems of verification in participatory action research (i.e. disconfirming the researchers preconceptions). Focuses on actual cases in which PAR-like methods have been used with greater or lesser success. Integrates interactions with representatives of communities, organizations, and individuals who have been the focus of PAR. Analyzes techniques for co-designing and co-conducting all aspects of applied social research.

D. Cunningham

11.238J Ethics of Intervention
(Same subject as 21A.609J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 21A.609J.

E. C. James

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)
3-6-3
Understand how we learn from computer games and simulations, and delve into the process of building and testing their own simulations. First, students explore the design and use of games and simulations in the classroom, and the research and development issues associated with desktop computer-based, handheld computer based and non-computer based media. Students then develop their own simulations and games, study what and how people 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
11.255 Negotiation and Dispute Resolution in the Public Sector  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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

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  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
3-0-9 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

11.303J Real Estate Development Studio: Complex Urban Projects  
(Same subject as 4.254J)  
Prereq: Permission of instructor  
G (Spring)  
6-0-12 H-LEVEL Grad Credit  
Focuses on the synthesis of projects for the real estate development industry, including the integration of physical design and programming with finance and marketing. Interdisciplinary student teams analyze how to maximize value in large-scale, mixed use projects in the process of preparing professional development proposals, involving sites in US cities and internationally. Reviews emerging real estate products and innovative developments to provide a foundation for studio work. Two major projects are interspersed with lectures, 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 H-LEVEL Grad Credit  
Introduces a range of practical approaches involved in evaluating and planning sites within the context of natural and cultural systems. Develops the knowledge and skills to analyze and plan a site for development through exercises and an urban design project. Topics include land inventory, urban form, spatial organization of uses, parcelization, design of roadways, grading, utility systems, off-site impacts, and landscape architecture.  
S. Gray, M. A. Ocampo

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 Shenzen and Shanghai, China.  
T. Lee

11.307 Beijing Urban Design Studio  
(Subject meets with 4.166)  
Prereq: Permission of instructor  
Acad Year 2014–2015: G (Fall)  
Acad Year 2015–2016: Not offered  
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, C. Zegras

11.308J Ecological Urbanism Seminar  
(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: Photography as Inquiry  
(Same subject as 4.215J)  
Prereq: None  
G (Fall)  
3-0-9  
Explores photography as a disciplined way of seeing, of investigating urban landscapes and expressing ideas. Readings, observations, and photographs form the basis of discussions on light, detail, place, poetics, narrative, and how photography can inform design and planning.  
Enrollment limited.  
A. Spirn

11.311J 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
11.312 Engaging Community: Models and Methods for Designers and Planners
Prereq: None
G (Spring)
3-0-9
Reviews a range of models for engaging communities, from a client-consultant relationship to advocacy, community organizing, consensus building, capacity building, and knowledge building. Explores the ways these different models have been used in design and planning practice and community building.  
C. McDowell

11.313 Advanced Research Workshop in Landscape and Urbanism
Prereq: Permission of Instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
In-depth research workshop on pressing environmental design issue of our time, includes discussion and practices of various Landscape-based disciplines used to generate design-based solutions and landscape infrastructural responses to physical urban entropy and decline. Specific focus is adjusted each year.  
A. Berger

11.314J Water, Landscape and Urban Design
(Same subject as 4.214J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
(Same subject as 4.217J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 (Spring)
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 representing the urban environment. Through visual observation, field analysis, measurements, interviews, and other means, students draw on their senses and develop their ability to deduce, conclude, question, and test conclusions about how the environment is used and valued. Using representational tools such as drawing, photographing, computer modeling and desktop publishing, students communicate what they observe along with their impressions and design ideas. Intended as a foundation for future studio work in urban design. Includes design-based projects.  
S. Gray, M. A. Ocampo

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.  
Architecture Staff

11.332J Urban Design Studio
(Same subject as 4.163J)
Prereq: 4.145, 4.162, or permission of instructor
G (Fall, Spring)
3-0-7
Can be repeated for credit
See description under subject 4.163J.  
Architecture Design Staff

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 4.266J)
Prereq: Permission of instructor
G (Fall)
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 multidisciplinary topics, including current works from P-REX lab. Students conduct independent and group research that is future-oriented.  
A. Berger
11.337 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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 via application and lottery.
B. Ryan

11.339 Downtown
(Subject meets with 11.026J, 21H.321J)
Prereq: None
G (Spring)
2-0-7
Seminar on downtown in US cities from the late 19th century to the late 20th. Emphasis on downtown as an idea, place, and cluster of interests, on the changing character of downtown, and on recent efforts to rebuild it. Topics considered include subways, skyscrapers, highways, urban renewal, and retail centers. Focus on readings, discussions, and individual research projects. Students taking graduate version complete additional assignments.
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

11.344J 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
Researches 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 in the built environment. 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
Prereq: None
G (Fall)
3-0-9
Focuses on key business and legal issues within the principal agreements used to control, entitle, capitalize, and construct a mixed-use real estate development. Through the lens of the real estate developer and its counter-parties, students identify, discuss, and negotiate the most important business issues in right of entry, purchase and sale, development, and joint-venture agreements, as well as a construction contract and construction loan agreement. Students work closely with attorneys who specialize in the construction of such agreements. Enrollment limited; preference to MSRED students.
P. Roth

11.352 Real Estate Ventures II: Negotiating Leases, Financings, and Restructurings
Prereq: 11.351 or permission of instructor
G (Spring)
3-0-9
Focuses on the key business and legal issues within the principal agreements used to lease, finance, and restructure a real estate venture. Through the lens of the real estate developer and its counter-parties, students identify, discuss and negotiate the most important business issues in office and retail leases, and permanent loan, mezzanine loan, intercreditor, standstill/forbearance, and loan modification (workout) agreements. In doing so, students work closely with attorneys who specialize in the construction of such agreements. Also touches on single-asset real estate bankruptcy and the federal income tax consequences of debt restructurings. Enrollment limited; preference to MSRED students.
W. T. McGrath

11.353J Securitization of Mortgages and Other Assets
(Same subject as 15.429J)
Prereq: 15.426, 15.401, or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 15.429J.
W. Torous

11.354 Real Estate Products Seminar
Prereq: None
G (Fall)
3-0-3
Examines the fundamentals of real estate development products, including residential, hotel, office, research and development/lab, retail, and industrial uses. Includes faculty lectures, guest presentations, and field trips to local case study projects. Prepares MSRED candidates for the spring Real Estate Development Studio.
P. Roth
11.355 International Housing Economics and Finance
(Subject meets with 11.145)
Prereq: 11.202, 11.203, 14.01 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

Presents a theory of comparative differences in international housing outcomes. Introduces institutional differences in the ways housing expenditures are financed, and the economic determinants of housing outcomes, such as construction costs, land values, housing quality, and ownership rates. Analyzes the flow of funds to and from the different national housing finance sectors. Develops an understanding of the greater financial and macroeconomic implications of the mortgage credit sector, and how policies affect the ways in which housing asset fluctuations impact national economies. Considers the perspective of investors in international real estate markets and the risks and rewards involved. Draws on lessons from an international comparative approach, and applies them to economic and finance policies at the local, state/provincial, and federal levels within a country of choice. Students taking graduate version complete additional assignments.
A. Saiz

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

11.363 Civil Society and the Environment
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
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 Treaties and Their Implementation
Prereq: 11.601, 11.255, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-6 H-LEVEL Grad Credit

Examines the history and dynamics of international environmental treaty-making, or what is called environmental diplomacy. Emphasis is on climate change and other atmospheric, marine resource, global waste management and sustainability-related treaties and the problems of implementing them. Reviews the legal, economic, and political dynamics of managing shared resources, involving civil society on a global basis, and enforcing transboundary agreements. Focuses especially on principles from international relations, international law, environmental management and negotiation theory as they relate to common-pool resource management.
L. Suzskind

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

11.369J Energy Policy for a Sustainable Future
(Same subject as 17.398)
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.
Staff

11.371J Sustainable Energy
(Same subject as 1.818J, 2.65J, 10.391J, 22.811J, ESD.166J)
(Subject meets with 2.65J, 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

11.373J Science, Politics, and Environmental Policy (New)
(Same subject as 12.885J)
(Subject meets with 12.385)
Prereq: 12.806, 12.807, or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 12.885J.
S. Solomon, J. Layzer

11.376 Urban Sustainability in Action
Prereq: Permission of instructor
G (Spring)
3-0-9 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 work in and around the City of Boston on local sustainability initiatives.
J. Layzer

International issues and perspectives also considered.
J. Carmin

11.369J Energy Policy for a Sustainable Future
(Same subject as 17.398)
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.
Staff

11.371J Sustainable Energy
(Same subject as 1.818J, 2.65J, 10.391J, 22.811J, ESD.166J)
(Subject meets with 2.65J, 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

11.373J Science, Politics, and Environmental Policy (New)
(Same subject as 12.885J)
(Subject meets with 12.385)
Prereq: 12.806, 12.807, or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
See description under subject 12.885J.
S. Solomon, J. Layzer

11.376 Urban Sustainability in Action
Prereq: Permission of instructor
G (Spring)
3-0-9 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 work in and around the City of Boston on local sustainability initiatives.
J. Layzer

International issues and perspectives also considered.
J. Carmin
11.377 Food Systems and the Environment
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Explores the evolution of food production in the US and globally. Considers the science, economics, and politics behind the transition from pre-industrial to an industrial food system. Debates the costs and benefits of genetically modified food, organic agriculture, and local/regional food production. Focuses on the environmental sustainability and human-health consequences of different approaches, for both the developed and developing world.
J. Layzer

11.378J Water Planning, Policy, and Design
(Same subject as 4.625J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.625J.
J. Wescoat

11.380 Urban Climate Adaptation
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the challenges cities face and strategies to prepare for the impacts of climate change. Particular attention to the needs of vulnerable populations and resource-constrained cities, global and national adaptation policies and funding mechanisms, and ways in which local government and community-based activities can promote climate-readiness.
J. Carmin

11.381 Urban Energy Systems and Policy
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
Examines how cities use energy; the institutional, market and regulatory environment in which policymakers operate; steps cities are taking to better manage their energy use; and the challenges entrepreneurs face in trying to make the system more sustainable. Guest speakers contribute real-world perspective.
Staff

11.382 Water Diplomacy: The Science, Policy, and Politics of Managing Shared Resources
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the history and dynamics of international environmental treaty-making, or what is called environmental diplomacy. Emphasizes climate change and other atmospheric, marine resource, global waste management and sustainability-related treaties and the problems of implementing them. Reviews the legal, economic, and political dynamics of managing shared resources, involving civil society on a global basis, and enforcing transboundary agreements. Focuses especially on principles from international relations, international law, environmental management, and negotiation theory as they relate to common-pool resource management.
L. Susskind

11.383J Managing Sustainable Businesses for People and Profits
(Same subject as 15.662J, ESD.278J)
Prereq: None
G (Spring)
3-0-3
See description under subject 15.662J.
T. Kochan

11.384 Preparation for Malaysia Sustainable Cities Fieldwork (New)
Prereq: Permission of instructor
G (Fall; partial term)
0-0-3 [P/D/F] H-LEVEL Grad Credit
Under faculty supervision, students conduct independent research to familiarize themselves with the culture, economy, politics, geography, ecology, and history of Malaysia. Selection by application.
L. Susskind

11.385 Malaysia Sustainable Cities Fieldwork (New)
Prereq: 11.384
G (IAP)
3-0-3 [P/D/F] H-LEVEL Grad Credit
Investigates sustainable development efforts of regional development agencies in Penang, Kuala Lumpur, or Johor Bahru. In addition to these sites, students visit the government city of Putrajaya, the World Heritage cities of George Town in Penang and Malacca, and Kuching in East Malaysia. Selection by application.
L. Susskind

11.386 Malaysia Sustainable Cities Practicum (New)
Prereq: 11.385
G (Spring; partial term)
2-0-1 H-LEVEL Grad Credit
Examines examples of city development that reflect a commitment to the principles of sustainability, including economic development that ensures ecological sustainability, strategies for addressing intercultural tensions, and environmental quality improvements catalyzed by city development.
L. Susskind

11.401 Introduction to Housing, Community, and Economic Development
Prereq: None
G (Fall)
3-0-9
Provides a critical introduction to the shape and determinants of political, social and economic inequality in America. Explores equitable development as a response framework for planners; social capital and community building as planning concepts; and the history, development, and current prospects of the fields of housing (with an emphasis on affordability and inclusion) and local economic development. Considers multiple scales but primarily the neighborhood, city/town, and metro region, centered on the interplay of policies, institutions and markets.
J. P. Thompson

11.402 Urban Politics: Race and Political Change
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Prereq: None
G (Spring)
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.

P. C. Clay

11.405 Political Economy and Society
Prereq: Permission of Instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit

Focuses on the connection (or not) between mind (theory) and matter (lived experience). Examines basic tenets of classical and recent political economic theories and their explication in ideas of market economies, centrally planned economies, social market economies, and cooperative economies. Assesses theories according to their relation to the lived experiences of people in communities and workplaces.

J. P. Thompson

11.406 Key Ideas in City Planning History and Theory
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

Staff

11.407 Economic Development Tools and Techniques
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Introduces a suite of tools representing the basic set of practices used in the development field. Presents a wealth creation framework that focuses on place, improving livelihoods, incentivizing collaboration, creating multiple forms of wealth, and promoting local ownership. Students work with web-based tools designed for use in a professional setting. Discussions are based on results from tools, their interpretation, and their meaning. Relevant to all students interested in the structure and function of local, state, national and international economic contexts. Students develop a series of memos as students they complete assignments.

A. Glasmeier

11.410 Urban and Regional Economics
(Same subject as 1.283J, 14.573J, ESD.191J)
(Same subject as 14.51)
Prereq: 14.04, 14.32
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 14.573J.

Consult W. Wheaton

11.427 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

11.430 Leadership in Real Estate
(Same subject as 15.941J)
Prereq: None
G (Fall; first half of term)
3-0-3

See description under subject 15.941J.

G. Schuck

11.431 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 commercial property development and investment. Topics include property income streams, urban economics, discounted cash flow, equity valuation, leverage and income tax considerations, development projects, and joint ventures.

D. Geltner

11.432 Real Estate Capital Markets
(Same subject as 15.427J)
Prereq: 11.431; 15.402 or 15.414
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

Introduces real estate capital markets for institutional investors. Topics include real estate investment trusts (REIT), commercial mortgage-backed securities (CMBS), and private equity.

D. Geltner

11.433 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

11.434 Tools for Analysis: Design for Real Estate and Infrastructure Development
(Same subject as 15.428J, ESD.712J)
Prereq: None
G (Spring; second half of term)
2-0-4

Introduction to analytical tools to support design and decision-making in real estate, infrastructure development, and investment. Particular focus on identifying and valuing sources of flexibility using "real options," Monte-Carlo simulation, and other techniques from the field of engineering systems. Integrates economic and engineering perspectives, and is suitable for students with various backgrounds. Provides useful preparation for thesis work in the area.

D. Geltner, R. de Neufville

11.435 Mixed-Income Housing Development
Prereq: None
G (Spring)
3-0-9

Provides an overview of affordable and mixed-income housing development for students who wish to understand the fundamental issues and requirements of urban scale housing development, and the process of planning, financing and developing such housing. Students gain practical experience assembling a mixed-income housing development proposal.

P. Roth
11.436 Housing Studio: Neighborhood Sustainability Plan
Prereq: 11.401, 11.301, or 11.601
G (Spring)
3-0-9 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.

11.437 Financing Economic Development
(Subject meets with 11.137)
Prereq: None
G (Fall)
3-0-9
Focuses on financing tools and program models to support local economic development. Provides an overview of private capital markets and financing sources to understand capital market imperfections that constrain economic development, business accounting, financial statement analysis, federal economic development programs, and public finance tools. Covers policies and program models, including revolving loan funds, guarantee programs, venture capital funds, bank holding companies, community development loan funds and credit unions, micro enterprise funds, and the Community Reinvestment Act. Students taking graduate version complete additional assignments.

11.438 Economic Development Planning
Prereq: 11.203, 11.220
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Focuses on the policy tools and planning techniques used to formulate and implement local economic development strategies. Includes an overview of economic development theory, discussion of major policy areas and practices employed to influence local economic development, a review of analytic tools to assess local economies and how to formulate strategy. Coursework includes formulation of a local economic development strategy for a client.

11.439 Revitalizing Urban Main Streets
Prereq: 11.401 or 11.301 or 11.328
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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.

11.441A The New Global Planning Practitioner
(Same subject as 4.232)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 4.232).

(Subject meets with 4.233)
Prereq: Permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
See description under subject 4.232).

11.463J Structuring Low-Income Housing Projects in Developing Countries
(Same subject as 4.236)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 4.236).

11.466J Technology, Globalization, and Sustainable Development
(Same subject as 1.813J, 15.657J, ESD.137J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.137J).

11.468J SIGUS Workshop
(Same subject as 4.230)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 4.230).

11.469 Urban Sociology in Theory and Practice
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Introduction to core writings in urban sociology. Examines key theoretical paradigms that have comprised the field since its founding. Explores the nature and changing character of the city and the urban experience in the US and abroad, providing context for development and application of planning skills and sensibilities as well as urban research. Topics include the changing nature of community, social inequality, culture, political power, socio-spatial change, technological change, and the relationship between the built environment and human behavior.

11.470 The Politics of Development Policy
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

11.471 Political Economy of Development Projects: Targeting the Poor
Prereq: 11.701 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Covers conditions under which public-sector policies, programs, and projects succeed in enhancing the 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.
11.472J D-Lab: Development
(Same subject as EC.781J)
(Subject meets with 11.025J, EC.701J)
Prereq: None
G (Fall)
3-2-7
See description under subject EC.781J.
A. B. Smith, B. Sanyal

11.474 D-Lab: Disseminating Water, Sanitation, and Hygiene Innovations for the Common Good
(Subject meets with EC.715)
Prereq: None
G (Spring)
3-0-6
Focuses on disseminating water, sanitation and hygiene (WASH) innovations in developing countries, especially among underserved communities. Structured around field-based learning, case studies, lectures and videos. Emphasis on core WASH principles, culture-specific solutions, appropriate and sustainable technologies, behavior change, social marketing and building partnerships. Term project entails implementing the “next steps” in a WASH innovation in a specific locale and/or a new proposal/plan/project. Long-term commitment to specific real-world WASH projects which have been disseminated by MIT faculty, students and alumni. Students taking graduate version complete additional assignments. Limited to 30.
S. E. Murcott

11.475 Navigating Power in Water and Sanitation Planning
Prereq: Open to undergraduates with permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Informs and prepares students to navigate the explicit and implicit power dynamics among stakeholders in decision-making processes that govern the planning and delivery of water and sanitation systems. Through investigations of organization, regulation, financing, physical delivery, and research designs, students examine the trajectory of decisions that shape and influence the accessibility, affordability, and adequacy of water and sanitation services, particularly in vulnerable neighborhoods in mostly urban and peri-urban areas. Emphasis is placed on the importance of moving beyond the limited dimensions of supply and demand studies and gaining fluency in the multiplicative political-economic and social factors driving choices in water and sanitation systems planning. In-depth, globally comparative readings inform the course, and expose basic services in water and sanitation as a misnomer.

G. Carolini

11.476 Urbanizing China (New)
(Subject meets with 11.146)
Prereq: Permission of Instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Discusses China’s daunting urban challenges: congestion and smog, housing affordability, land reform and urban financing, migrants and locals, and social and spatial inequality. Provides examples of laudable achievements and diverse and innovative responses across more than six hundred cities. Presents China’s urbanization as the joint result of natural socioeconomic processes and conscious actions by governments, markets, and the public. Presents multidisciplinary approaches and alternative narratives. Examines the intricate interaction between state and market in China’s context, yielding a variety of state-market ‘cocktails’ devised and experimented in different cities in response to local problems, each involving a multilayered projection onto urban space. Students taking graduate version complete additional assignments.
J. Zhao

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 efforts 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

11.478 Behavior and Policy: Connections in Transportation (New)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Examines the behavioral foundation for policy design, using urban transportation examples. Introduces multiple frameworks of understanding travel behavior (rational or irrational), contrasting the perspectives of classic economic theory with behavioral economics and social psychology, and suggests corresponding policy interventions. Presents a spectrum of ten instruments for positively influences behavior and improving welfare, including manipulating information and changing perceptions of time and space; pricing and framing; including emotions of pride and shame; exploiting peer pressure or enhancing self-control and motivation; and nudging and preference shaping. Challenges students to critique, design, implement and interpret experiments that nudge travel behavior. Brings behavioral insights to creative design of transport policies, making them efficient and equitable as well as simpler, consistent, transparent, acceptable, and adaptive to behavioral changes.
L. Susskind, D. Cunningham

11.479J Water, Sanitation, Hygiene, and Environmental Sanitation (WASH-ENV) in Low- and Middle-Income Countries
(Subject meets with 1.851J)
Prereq: None
G (Spring)
Units arranged
See description under subject 1.851J.
Staff

11.480 Urbanization and Development
(Subject meets with 11.140)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9
Examines developmental dynamics of rapidly urbanizing locales, with a special focus on the developing world. Case studies from India, China, Mexico, Brazil, and South Africa form the basis for discussion of social, spatial, political and economic changes in cities spurred by the decline of industry, the rise of services, and the proliferation of urban mega projects. Emphasizes the challenges of growing urban inequality, environmental risk, citizen displacement, insufficient housing, and the lack of effective institutions for metropolitan governance. Students taking graduate version complete additional assignments.
Staff
11.481J Analyzing and Accounting for Regional Economic Change
(Same subject as 1.284J, ESD.192J)
Prereq: 14.03, 14.04
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Surveys theories of regional growth, factor mobility, clustering, restructurings, learning regions, and global supply chains from a political-economy perspective. Examines criticalities 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

11.483J Housing and Land Use in Rapidly Urbanizing Regions
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Studies current urban controversies over affordable housing, land redevelopment, and public space, with special attention to property rights. Reviews how law, economics, sociology and planning theories frame these issues and interplay with them through spatial approaches of urban design and geography. Explores cases that use property rights strategies to increase economic growth and social justice, providing insights for future design and policymaking. Topics include land trusts for affordable housing, mixed-use public space, and critical cartography.
Y. Hong

11.484 Project Appraisal in Developing Countries
(Subject meets with 11.144)
Prereq: Permission of instructor
G (Spring)
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. Students taking graduate version complete additional assignments. Enrollment limited; preference to majors.
Staff

11.487 Innovative Budgeting and Finance for the Public Sector
(Subject meets with 11.147)
Prereq: None
G (Spring)
3-0-9
Examines globally relevant challenges of adequately and effectively attending public sector responsibilities for basic services with limited resources, particularly in the contexts of fiscal crises, rapid population growth, as well as shrinkage, through: an introduction to methods and processes of budgeting, accounting, and financial mobilization in the public sector; use of case studies and practice exercises to explore revenue strategies and to gain fiscal analytical competencies; study of pioneering examples of promising budget and accounting processes as well as innovative funding mobilization via taxation, capital markets, and experimental experiences with mechanisms such as land-value capture. Students taking graduate version are expected to explore the subject in greater depth.
G. Carolini

11.490 Law and Development
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
2-0-10 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, legitimacy of law, sequencing of legal reform, and international economic law aspects. Studies the role 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)
Not offered regularly; consult department
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.
Staff

11.493 Legal Aspects of Property and Land Use
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.
Foci 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

11.495 Governance and Law in Developing Countries
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

Studies the interaction between law, courts, and social movements in shaping domestic and global public policy. Examines how groups mobilize to use law to affect change and why they succeed and fail. Uses case studies to explore 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.

B. Rajagopal

11.497 Human Rights in Theory and Practice
(Subject meets with 11.164J, 17.391J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

11.520 Workshop on Geographic Information Systems
Prereq: 11.205 or permission of instructor
G (Fall; partial term)
2-2-2 H-LEVEL Grad Credit

An introduction to geographic information systems (GIS) as applied to urban and regional planning, community development, and local government. Emphasis on learning GIS technology and spatial analysis techniques through extensive hands-on exercises using real-world data sets such as the US census of population and housing. Includes a small project on an urban planning problem involving the selection of appropriate methods, the use of primary and secondary data, computer-based modeling, and spatial analysis. Enrollment limited; preference to MCP students.

S. Williams

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

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.

J. Ferreira

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
(Subject meets with 1.251J)
Prereq: Permission of Instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Focuses on the integration of land use and transportation planning, drawing from cases in
both industrialized and developing countries. Reviews underlying theories, analytical techniques, and the empirical evidence of the land use-transportation relationship at the metropolitan, intra-metropolitan, and micro-scales. Also covers the various ways of measuring urban structure, form, and the "built environment." Develops students’ skills to assess relevant policies, interventions and impacts. C. Zegras

11.527 Advanced Seminar in Transportation Finance
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. Staff

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. Staff

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.

11.543J Transportation Policy, the Environment, and Livable Communities
(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.

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.

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.

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 policymaking and the practice of environmental planning. Taught comparatively, with numerous references to examples from around the world. Four major areas of focus: National Environmental Policymaking, Environmental Ethics, Environmental Forecasting and Analysis Techniques, and Strategies for Collaborative Decision-making. L. Susskind

11.630J Environmental Law, Policy, and Economics: Pollution Prevention and Control
(Same subject as 1.811J, ESD.133J)
Prereq: Permission of instructor for undergraduates
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.811J.

11.631J Regulation of Chemicals, Radiation, and Biotechnology
(Same subject as 1.812J, ESD.134J)
Prereq: 1.802J, 11.022J, ESD.136J
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit
See description under subject 1.812J.

11.701 Introduction to International Development Planning
Prereq: None
G (Fall)
3-0-9
Studies interaction between planners and institutions at different scales, from local to global/transnational. Emphasizes a historical and institutional approaches to development planning. Includes an overview of theories of development, state, organizational arrangements, and implementation mechanisms. Covers current topics in development planning, such as decentralization, participatory planning, urban-rural linkages, corruption, legal institutions and post-conflict development. Analyzes various roles planners play in different institutional contexts. Restricted to first-year MCP and SPURS students. B. Rajagopal

TUTORIALS, RESEARCH, AND FIELDWORK SUBJECTS

11.800 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. 

**Staff**

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

11.904 Supervised Readings in Urban Studies
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged
Can be repeated for credit

Reading and discussion of topics in urban studies and planning. 

**Staff**

11.905 Research Seminar in Urban Studies and Planning
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

11.906 Research Seminar in Urban Studies and Planning
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Special research issues in urban planning. 

**Staff**

11.907 Urban Fieldwork
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

11.908 Urban Fieldwork
Prereq: None
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

Practical application of planning techniques to towns, cities, and regions, including problems of replanning, redevelopment, and renewal of existing communities. Includes internships, under staff supervision, in municipal and state agencies and departments. 

**Staff**

11.909 Graduate Tutorial
Prereq: None
G (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**

11.910 Doctoral Tutorial
Prereq: None
G (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**

11.962 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

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**

11.985 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

11.5940–11.5944 Special Subject: Urban Studies and Planning
Prereq: Permission of instructor
G (Fall)
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. 

M. Kothari

11.5945–11.5949 Special Subject: Urban Studies and Planning
Prereq: Permission of instructor
G (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 (Spring)
Units arranged [P/D/F]
Can be repeated for credit
For graduate students wishing to pursue further study in advanced areas of urban studies and city and regional planning not covered in regular subjects of instruction.
Staff

11.S958 Special Seminar: Urban Studies and Planning
Prereq: Permission of instructor
G (Spring)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Prereq: Permission of instructor
G (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.S965 Special Subject: 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
11.S966, 11.S967 Special Subject: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
11.S968, 11.S969 Special Seminar: Real Estate
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer; first half of term)
Units arranged [P/D/F]
Can be repeated for credit
Small group study of advanced subjects under staff supervision. For graduate students wishing to pursue further study in advanced areas of real estate not covered in regular subjects of instruction.
Staff

11.THG Graduate Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged 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>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement (four 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 (can be satisfied by 11.188 in the Departmental Program)</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
- 69 units
- 11.001J Introduction to Urban Design and Development, 12, HASS-H
- 11.002J Making Public Policy, 12, HASS-S, CI-H
- 11.011 The Art and Science of Negotiation, 12, HASS-S
- 11.123 Big Plans and Mega-Urban Landscapes, 9, HASS-S
- 14.01 Principles of Microeconomics, 12, HASS-S
- 11.188 Urban Planning and Social Science Laboratory, 12, LAB, CI-M

### Planned Electives
- 57–60 units
- 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.

#### Environmental Policy
- 11.003J Methods of Policy Analysis, 12, HASS-S; 11.002J; 14.01
- 11.016J The Once and Future City, 12, HASS-H, CI-H
- 11.021J Environmental Law, Policy, and Economics: Pollution Prevention and Control, 12, HASS-S
- 11.022J Regulation of Chemicals, Radiation, and Biotechnology, 12, permission of Instructor
- 11.161J Energy Decisions, Markets, and Policies, 12, HASS-S; 14.01*
- 11.162J Politics of Energy and the Environment, 12, HASS-S
- 11.165J Energy and Infrastructure Technologies, 12, HASS-S; 14.01*

#### Urban History and Society
- 11.073J American Urban History I, 9, HASS-H; CI-H
- 11.074J American Urban History II, 9, HASS-H; CI-H
- 11.075J Riots, Strikes, and Conspiracies in American History, 12, HASS-H, CI-H
- 11.079J Migration and Immigration in US History, 12, HASS-S
- 11.026J Downtown, 9, HASS-H
- 11.170J Metropolis: A Comparative History of New York City, 12, HASS-H
- 11.172J The Ghetto: From Venice to Harlem, 12, HASS-S

#### International Development
- 11.005J Introduction to International Development, 12, HASS-S
- 11.025J D-Lab: Development, 12, HASS-S
- 11.140J Urbanization and Development, 12
- 11.144J Project Appraisal in Developing Countries, 12
- 11.147J Innovative Budgeting and Finance for the Public Sector, 12, HASS-S; permission of Instructor
- 11.148J Human Rights in Theory and Practice, 12, HASS-S; permission of instructor
- 11.165J Energy and Infrastructure Technologies, 12, HASS-S; 14.01*
- 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.
- 11.027J 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.
- 24 units
- 11.ThT Thesis Research Design Seminar, 12, CI-M
<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>87–90</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 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.*

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).
UNDERGRADUATE SUBJECTS

Core and General Science Subjects

12.000 Solving Complex Problems
Prereq: None
U (Fall)
3-1-8 REST

Provides an opportunity for entering freshmen to gain firsthand experience in integrating the work of small teams to develop effective solutions to complex problems in Earth system science and engineering. Each year’s class explores a different problem in detail through the study of complementary case histories and 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. Bowring

12.001 Introduction to Geology
Prereq: None
U (Fall)
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. Sedimentary 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, T. Perron

12.002 Introduction to Geophysics and Planetary Science
Prereq: Physics II (GIR), Calculus II (GIR)
U (Spring)
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 Introduction to Atmosphere, Ocean, and Climate Dynamics
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.

P. O’Gorman

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

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


R. Lagrange

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, 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-3-6
J. Wisdom, G. J. Sussman

12.009J Theoretical Environmental Analysis
(Same subject as 18.352J)
Prereq: Physics I (GIR), Calculus II (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
See description under subject 3.985J.
H. N. Lechtman, J. Stubbe, F. A. Frey

12.012 MatLab, Statistics, Regression, Signal Processing
(Subject meets with 12.44A)
Prereq: None. Coreq: 18.06
U (Fall)
3-0-9
Introduces the basic tools needed for data analysis and interpretation in the Geosciences, as well as other sciences. Composed of four modules, targeted at introducing students to the basic concepts and applications in each module. MatLab: Principles and practice in its uses, script and function modules, basic approaches to solving problems. Statistics: Correlation, means, dispersion, precision, accuracy, distributions, central limit theorem, skewness, probability, Chi-Square, Gaussian and other common distributions used in hypothesis testing. Regression: Random and grid search methods, basic least squares and algorithms applicable to regression, inversion and parameter estimation. Signal Processing: Analog and digital signals, Z-transform, Fourier series, fast Fourier transforms, spectral analysis leakage and bias, digital filtering. Students taking the graduate version complete different assignments.
F. D. Morgan, T. A. Herring, S. Ravela

12.021 Earth Science, Energy, and the Environment
Prereq: 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

12.031A Fundamentals of Ecology I (New)
(Same subject as 1.018A, 7.30A)
Prereq: None
U (Fall; first half of term)
2-0-4
See description under subject 1.018A.
S. Chisholm, M. Follows

12.031B Fundamentals of Ecology II (New)
(Same subject as 1.018B, 7.30B)
Prereq: 1.018A
U (Fall; second half of term)
2-0-4
See description under subject 1.018B.
S. Chisholm, M. Follows

12.080 EAPS Undergraduate Seminar
Prereq: None
U (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

12.086 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 biochemical 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)
Not offered regularly; consult department
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
Laboratory or field work in earth, atmospheric, and planetary sciences. Consult with department Education Office.

EAPS Faculty

12.092 Current Topics in Geology and Geochemistry
Prereq: None
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
12.093 Current Topics in Geology and Geochemistry
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
Laboratory or field work in geology and geochemistry. To be arranged with department faculty. Consult with department Education Office.

EAPS Faculty

12.094 Current Topics in Geophysics
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
12.095 Current Topics in Geophysics
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
Laboratory or field work in geophysics. To be arranged with department faculty. Consult with department Education Office.

EAPS Faculty

12.096 Current Topics in Atmospheric Science and Oceanography
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
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
Laboratory or field work in atmospheric science and oceanography. To be arranged with department faculty. Consult with department Education Office.

EAPS Faculty

12.098 Current Topics in Planetary Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
12.099 Current Topics in Planetary Science
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
Laboratory or field work in planetary science. To be arranged with department faculty. Consult with department Education Office.

EAPS Faculty

Geology and Geochemistry

12.102 Environmental Earth Science
Prereq: None
U (Fall)
Not offered regularly; consult department
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 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-2-7
Focuses on low-temperature geochemistry and the Earth’s biogeochemical cycles, including the biologic and inorganic chemical processes that create chemical variability and element partitioning among lithosphere, hydrosphere and atmosphere. Covers basic thermodynamics, aqueous chemistry, major and trace element geochemistry, and stable isotopic geochemistry.

S. Ono, D. McGee

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

12.109 Petrology
Prereq: 12.108
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
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

12.113 Structural Geology
Prereq: 12.001
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 depar-
mations. 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, O. Jagoutz

12.114 Field Geology I
Prereq: 12.108 or permission of instructor; or Coreq: 12.113
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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)
0-12-0 Institute LAB
During January, students practice methods of modern geological field study off-campus during an intensive four-week experience. Exercises include geological and geomorphological mapping on topographic and photographic base maps of a wide variety of bedrock and surficial rocks. Where feasible, geochemical and geophysical field measurements are correlated with geology.

B. C. Burchfiel, O. Jagoutz

12.116 Analysis of Geologic Data
Prereq: 12.115
U (Spring)
0-2-4
Includes in-depth laboratory analysis of samples, interpretation of geologic data, and where possible, geophysical and geochemical data. Includes the preparation of reports based on the field studies conducted in 12.115 during January; report generally exceeds 30 pages in length and includes one major revision and rewrite. Instruction in writing techniques provided.

B. C. Burchfiel, O. Jagoutz

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, T. L. 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. L. 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, diagnostic 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 additional 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)
Not offered regularly; consult department
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 composition-al 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 experiments, expeditions, and studies from the past, along with their premises and results. Students taking graduate version complete additional assignments.

EAPS Staff
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.
G. Prieto

12.207J Nonlinear Dynamics: Continuum Systems
(Subject meets with 1.062J, 18.354J)
Prereq: 18.03 or 18.034; Physics II (GIR) G (Spring)
3-0-9 H-LEVEL Grad Credit H (except 18)
See description under subject 18.354J.
J. Dunkel

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.
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

12.221 Field Geophysics
Prereq: None
U (IAP)
1-4-1 [P/D/F]

Practical methods of modern geophysics including the Global Positioning System (GPS), gravity, and magnetics. Field work is conducted in western US and includes intensive 10-day field exercise. Focus is on measurement techniques and their interpretation. Introduction to the science of gravity, magnetics, and the GPS. Measurement of crustal structure, fault motions, tectonic deformations, and the local gravity and magnetic fields. Students perform high-precision measurements and participate in data analysis. Emphasis on the principles of geophysical data collection and the relevance of these data for tectonic faulting, crustal structure, and the dynamics of the earthquake cycle.
T. A. Herring, B. H. Hager, 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 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, F. D. Morgan

Atmospheres, Oceans, and Climate

12.301 Past and Present Climate
(Subject meets with 12.842)
Prereq: Chemistry (GIR), 18.03, or permission of instructor
U (Fall)
4-0-8

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: 5.60 or 5.61; 18.075; or permission of instructor
U (Spring)
3-0-9

Introduction to the physics and chemistry of the atmosphere including experience with computer codes. Aerosols and theories of their formation, evolution, and removal. Gas and aerosol transport from urban to continental scales. Coupled models of radiation, transport, and chemistry. Solution of inverse problems to deduce emissions and removal rates. Emissions control technology and costs. Applications to air pollution and climate. Students taking the graduate version complete different assignments.
R. G. Prinn

12.307 Weather and Climate Laboratory
Prereq: Calculus II (GIR), Physics I (GIR)
U (Spring)
1-4-10 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
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, K. Dryer

12.336J Air Pollution
(Same subject as 1.085J)
Prereq: 18.03 U (Fall) 3-0-9
See description under subject 1.085J.

C. Heald

12.338 Aerosol and Cloud Microphysics and Chemistry
(Subject meets with 12.814)
Prereq: 12.335, 12.336 or permission of instructor
U (Spring) 3-0-9
Focuses on understanding how aerosol particles form droplets or ice crystals during several atmospheric processes: determining Earth’s radiative balance; heterogeneous chemistry and acid rain; understanding where, when and how much precipitation occurs. Provides tools for understanding the physics of aerosol and cloud element motion; the interaction of particles with water vapor, including phase changes and droplet and ice nucleation; the chemical composition of particles and the effect on cloud formation processes; and the effect of cloud processing on aerosol chemistry. Discusses relevant topics of contemporary interest, e.g., geoengineering and weather modification and volcanic effects. Students taking the graduate version complete different assignments.

D. Cziczo

12.340 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

12.346J Global Environmental Science and Negotiations (New)
(Same subject as ESD.046J)
Prereq: Permission of instructor U (Fall) 3-0-6
See description under subject ESD.046J.

N. Selin

12.348J Global Climate Change: Economics, Science, and Policy
(Same subject as 15.026)
(Subject meets with 12.848J, 15.023J, ESD.128J)
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor
Acad Year 2014–2015: Not offered Acad Year 2015–2016: U (Spring) 3-0-6
See description under subject 15.026J.

R. G. Prinn

12.349 Mechanisms and Models of the Global Carbon Cycle (New)
(Subject meets with 12.849)
Prereq: Calculus II (GIR), Physics I (GIR) U (Spring) 3-0-9
Addresses changes in the ocean, terrestrial biosphere and rocks modulation of atmospheric carbon dioxide on timescales from months to millions of years. Includes feedbacks between carbon cycle and climate. Combines hands-on data analysis with the formulation of simple models rooted in basic physical, chemical and biological principles. Students create individual “toy” global
carbon cycle models. Students taking graduate version complete different assignments.

M. Follows

12.385 Science, Politics, and Environmental Policy
(Subject meets with 11.373J, 12.885J)
Prereq: 12.306 or permission of instructor
U (Fall)
3-0-6

Examines the role of science in US and international policymaking. Surveys the methods by which scientists learn about the natural world; the treatment of science by experts, advocates, the media, and the public and the way science is used in legislative, administrative, and judicial decision making. Through lectures, group discussion, and written essays, students develop a critical understanding of the role of endangered species. Students taking the graduate version complete different assignments.

S. Solomon, J. Layzer

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.

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 planetary science and astrophysics, involving supervised work at Lowell Observatory in Flagstaff, AZ. Projects may include observations made using Lowell’s telescope facilities. Project topics and objectives vary from year to year. Written and oral reports required. Limited enrollment. Limited to 6.

A. Bosh

12.420 Physics and Chemistry of the Solar System
(Subject meets with 12.601)
Prereq: 12.002 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9

Advanced applications of physical and chemical principles to the study of the solar system.

Topics include terrestrial and giant planets, meteorites, asteroids, comets, Kuiper belt objects, rings, impact craters, interiors, surfaces, atmospheres, geomagnetism, cosmochemistry, remote sensing, formation and evolution of the solar system.

B. P. Weiss

12.425 Extrasolar Planets: Physics and Detection Techniques
(Subject meets with 12.625)
Prereq: Physics I (GIR), Calculus I (GIR)
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
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 16.83J)
Prereq: Permission of instructor
U (Spring)
3-3-6

See description under subject 16.83J.

K. Cahoy

12.43J Space Systems Development
(Same subject as 16.83J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-10-6 Institute LAB

See description under subject 16.83J.

K. Cahoy
Independent Research Subjects

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

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

Undergraduate research opportunities in Earth, Atmospheric, and Planetary Sciences. To be arranged by student and an appropriate EAPS faculty member. A written report may be required at the discretion of the advisor. Units arranged should reflect the project requirements.

Consult Department UROP Coordinator

12. IND Independent Study
Prereq: 12.TIP
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

Independent reading, laboratory, or fieldwork in Earth, Atmospheric, and Planetary Sciences. To be arranged by student and an appropriate EAPS faculty member. A written report may be required at the discretion of the advisor. Units arranged should reflect the project requirements.

Consult EAPS Education Office

12. TIP Thesis Preparation
Prereq: None
U (Fall, Spring)
2-0-4

Definition of and early-stage work on the thesis project. Students develop a written research proposal and begin writing the supporting text of the thesis concurrent with conducting research for the thesis project. Supervision of the writing continues into the spring term which concludes with an oral presentation of the research results.

J. Connor

12. THU Undergraduate Thesis
Prereq: 12.TIP
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Program of research leading to the writing of a thesis; to be arranged by the student and an appropriate MIT faculty member.

EAPS Faculty

GRADUATE SUBJECTS

12. 440, 12.441 Collaborative Seminar in Geology and Geophysics
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

Focuses on current interest in geology and geophysics; subject matter varies from term to term. Includes guest speakers from outside of EAPS. 12.441 is graded P/D/F.

Geology and Geophysics Staff

12. 442, 12.443 Collaborative Seminar in Planetary Science
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Focuses on current interest in planetary science; subject matter varies from term to term. Includes guest speakers from outside of EAPS. 12.443 is graded P/D/F.

Planetary Science Staff

12. 444 MATLAB, Statistics, Regression, Signal Processing
(Subject meets with 12.012)
Prereq: 18.06
G (Fall)
3-0-9

Introduces the basic tools needed for data analysis and interpretation in the Geosciences, as well as other sciences. Composed of four modules, targeted at introducing students to the basic concepts and applications in each module. MATLAB: Principles and practice in its uses, script and function modules, basic approaches to solving problems. Statistics: Correlation, means, dispersion, precision, accuracy, distributions, central limit theorem, skewness, probability, Chi-Square, Gaussian and other common distributions used in hypothesis testing. Regression: Random and grid search methods, basic least squares and algorithms applicable to regression, inversion and parameter estimation. Signal Processing: Analog and digital signals, Z-transform, Fourier series, fast Fourier transforms, spectral analysis leakage and bias, digital filtering. Students taking the graduate version complete different assignments.

F. D. Morgan, T. A. Herring, S. Ravela

12. 445 Communication in the Earth, Atmospheric, and Planetary Sciences
Prereq: Permission of instructor
G (Fall)
3-0-3 [P/D/F] H-LEVEL Grad Credit

Concentrated instruction and practice in professional writing and presentation. Topics include review of various communication styles prevalent in the field; strategies for tailoring reports, technical papers, and presentations for specific audiences; and mechanics of organization and style. Weekly assignments in writing or speaking, with peer and instructor feedback. Limited to 6.

F. D. Morgan

12. 446 Teaching Experience in EAPS
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Recognizes the educational value derived from satisfactory performance of assigned duties as a Teaching Assistant. Laboratory, field, recitation, or classroom teaching under supervision of a faculty member. Credit for this subject may not be used for any degree granted by Course 12. Total enrollment limited by availability of suitable teaching assignments.

EAPS Staff

12. 447 Strategies for Writing Successful Fellowship Proposals
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-0 [P/D/F]

Addresses developing writing skills appropriate for preparing successful fellowship proposals. Includes writing practice, self-evaluation, and faculty feedback.

Staff

12. 448, 12.449 Collaborative Seminar in Atmospheres, Oceans and Climate
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Focuses on current interest in atmospheres, oceans, and climate; subject matter varies from term to term. Includes guest speakers from outside of EAPS. 12.449 is graded P/D/F.

PAOC 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 pre-doctoral 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)
Not offered regularly; consult department
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 Education Office

12.456 Seminar in Rock Mechanics
Prereq: Permission of instructor
G (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

12.458 Molecular Biogeochemistry
(Subject meets with 12.158)
Prereq: Permission of instructor
G (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

12.456–12.461 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
Original investigations on problems in geology, petrology, mineralogy, geochemistry, or geobiology. 12.460 is letter-graded.
EAPS Staff

12.463 Geomorphology
(Subject meets with 12.163)
Prereq: 12.001, Physics I (GIR), Calculus I (GIR); or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-3-6 H-LEVEL Grad Credit
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

12.467 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)
Not offered regularly; consult department
Acad Year 2014–2015: 3-0-4
Acad Year 2015–2016: 4-0-8
Geology of planetary interiors and surfaces, including plate tectonics, as a unifying theory of terrestrial geology, surface processes, and the Earth’s interior. Igneous, metamorphic, and sedimentary processes associated with tectonic settings and the typical rock suites created. Mineral and rock identification. Causes of compositional differences on many scales: mineral grains, rocks, regions of the Earth, different planets. Conditions required for melting and melting processes. Rock structure and field techniques. Earth history. Treatment of these topics includes discussions of the geochemical, petrologic, geochronological, experimental, or field techniques used to investigate them; the limitations of current geological techniques and geological controversies; and great geological expeditions, experiments, and studies from the past, their premises, and their results. Students taking graduate version complete additional assignments.
EAPS Staff

12.471 Essentials of Geobiology
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-4-5
Introduces basic concepts of microbial structure, growth, energetics, molecular biology, and biochemistry. Presents examples of microbial interactions with environments throughout Earth’s history as well as current topics in astrobiology. Includes lectures, discussions of literature, and a field trip. Lab focuses on student-designed
projects that involve cultivation, modeling, or sample analyses. Intended for students whose background is not in biology, but who want to learn more about the contribution of microbes to geochemistry and planetary evolution.

T. Bosak

**12.473 Paleomagnetism and Planetary Magnetism**

Prereq: 12.002, 18.03; or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
2-0-4

Introduces the study of natural remanent magnetization and the generation of planetary magnetic fields. Topics include paleomagnetism, rock magnetism, geomagnetism, magnetostratigraphy, paleomagnetic measurement techniques, polar wander and continental drift, biogenic magnetism, 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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, O. Jagoutz

**12.475 Plate Tectonics and Continental Deformation**

Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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.

L. H. Royden

**12.476 Radiogenic Isotope Geology**

Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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

**12.480 Thermodynamics for Geoscientists**

Prereq: 5.60 or 3.00
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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: 12.113, 12.114
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
2-2-2 [P/D/F]
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, O. Jagoutz

**12.482 Advanced Field Geology II**

Prereq: 12.481
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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 geoscientific 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
12.501 Essentials of Geophysics
(Subject meets with 12.201)
Prereq: Physics II (GIR), 18.03
G (Fall)
4-0-8 H-LEVEL Grad Credit
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.
G. Prieto

12.507 Environmental Geophysics
(Subject meets with 12.214)
Prereq: 18.03
G (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.
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
Survey 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 (Spring)
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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Introduces theory, design, and practical methods of computational modeling in geodynamics and geophysical fluid dynamics. Covers the most effective and widely used numerical modeling approaches (e.g., boundary element, finite difference, finite element) and emphasizes problem-solving skills through illustrative examples of heat and mass transfer in the mantle and the ocean. Students acquire experience with various numerical methods through regularly assigned computational exercises and a term-long modeling project of each student’s choice.
J. Lin, O. Marchal, M. Behn

12.522 Geological Fluid Mechanics
Prereq: 8.03; 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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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
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 processes that control the rheology of faults, including friction and fracture, (2) how these rheological processes are manifest in faulting and earthquakes in the earth from a geodynamics perspective, and (3) how the mechanics of faulting and earthquakes are constrained by seismological and geodetic observations. Both continental and oceanic examples of faulting and earthquakes will be featured.
J. Lin, J. McGuire, Y. Liu

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
EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

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
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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.
A. Malcolm

12.560–12.561 Advanced Seminar in Exploration Geophysics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
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. 12.560 is letter-graded.
Geophysics Staff

12.570 Topical Issues in Global Geophysics
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
Units arranged [P/D/F] 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

12.580–12.581 Current Research in Geophysics
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Original investigations, laboratory work, or fieldwork in geophysics. 12.580 is letter-graded.
Geophysics Staff

12.586 Modeling Environmental Complexity
(Subject meets with 12.086)
Prereq: 18.03 or Permission of instructor
G (Fall)
3-0-9
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

12.601 Essentials of Planetary Science
(Subject meets with 12.420)
Prereq: 8.03, 18.03
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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. P. Weiss

12.602 Asteroids and Small Bodies
Prereq: Physics II (GIR), 18.03
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. 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
G (Spring)
3-0-9 H-LEVEL Grad Credit
Studies the dynamics of the solar system and its major subsystems, and the dynamics of exoplanets, with a modern emphasis on the qualitative structure of phase space. Topics may include rotational dynamics, spin-orbit coupling, Cassini states, and orbital dynamics, resonances, and Kozai oscillations, tidal evolution and tidal heating.
J. Wisdom

12.611 Advanced Planetary Observations
Prereq: Permission of instructor
G (IAP)
0-6-3 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Individual research projects in planetary science and astrophysics involving supervised work at Lowell Observatory in Flagstaff, AZ. Projects may include observations made using Lowell’s telescope facilities. Project topics and objectives vary from year to year. Written and oral reports required. Enrollment limited.
A. Bash

12.620 Classical Mechanics: A Computational Approach
(Subject meets with 6.946J, 8.351J)
Prereq: Physics I (GIR), 18.03, permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-3-6 H-LEVEL Grad Credit
Classical mechanics in a computational framework, Lagrangian formulation, action, variational principles, and Hamilton’s principle. Conserved

J. Wisdom, G. J. Sussman

12.625 Extrasolar Planets: Physics and Detection Techniques
(Subject meets with 12.425)
Prereq: 8.03, 18.03
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 the graduate version complete additional assignments.

S. Seager

12.650 Current Topics in Planetary Science
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall, Spring)
Acad Year 2015–2016: Not offered
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 2014–2015: Not offered
Acad Year 2015–2016: 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

12.690–12.691 Current Research in Planetary Science
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

Original investigations, laboratory work, or fieldwork in planetary science. 12.690 is letter-graded.

Planetary Science Staff

Geological, Geophysical, and Chemical Oceanography

12.707 The History of Earth's Climate
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.

D. McGee

12.708 Advanced Seminar in Paleoclimatology
Prereq: Permission of instructor
G (Fall)
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. Marchal, O. Marchal (WHOI)

12.710 Marine Geology and Geophysics I
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

WHOI Staff

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 magnetism, 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 WKBJ approximations; the Sommerfeld/Weyl integrals, asymptotic analysis, and Lamb’s problem for a fluid/solid interface; reflectivity and related methods; finite difference and finite element methods; and special topics of interest to the class. Extensive readings of geophysical and seismological literature.

R. Stephen (WHOI)

12.714 Computational Data Analysis
Prereq: 18.03
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 2014–2015: G (Fall)  
Acad Year 2015–2016: Not offered  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  

Quantitative analysis of melting, melt transport, and igneous crustal accretion at ocean 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)  

12.717 Coastal Geomorphology (New)  
Prereq: Permission of instructor  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
3-0-9 H-LEVEL Grad Credit  

Explores mechanisms behind the formation and reshaping of coastal environments. Focuses on a process-based understanding of both the fluid dynamic and sediment transport aspects of coastal landforms, and, especially, the importance of feedbacks between the two. Investigates coastal evolution at various scales—from ripples to coastline formation—with an emphasis on the behavior of coastal environments over integrated timescales of days and years to centuries and millennia. Students investigate the effect of storms, sea-level rise, and interactions with biological and anthropogenic influences. Covers a broad array of coastal environments, including beaches, barrier islands, spits, inlets, tidal flats, deltas, rocky coasts, arctic shores, and carbonate atolls.  

A. Ashton  

12.721 Current Research 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  

Original investigations, laboratory work, or fieldwork in marine geology and geophysics.  

WHOI Staff  

12.722 Current Research in Chemical Oceanography at Woods Hole  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  

Original investigations, laboratory work, or fieldwork in chemical oceanography.  

WHOI Staff  

12.730–12.731 Current Research in Marine Geology and Geophysics at MIT  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  

Original investigations, laboratory work, or fieldwork in marine geology and geophysics under the supervision of a faculty member in residence at MIT. For students in the MIT/WHOI Joint Program. 12.730 is letter-graded.  

Marine Geology and Geophysics Staff  

12.735–12.736 Current Research 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  

Original investigations, laboratory work, or fieldwork in chemical oceanography under the supervision of a faculty member in residence at MIT. For students in the MIT/WHOI Joint Program. 12.735 is letter-graded.  

Chemical Oceanography Staff  

12.740 Paleoceanography  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
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 mechanisms. Micropaleontological, isotopic, geochemical, and mineralogical changes are used to infer changes in seawater composition, atmospheric chemistry, and climate. Observations are interpreted as consequences of changes in ocean temperature, circulation, and chemistry, and are used to evaluate theories proposed to account for glacial/interglacial cycles. Focuses on the past two million years, but major processes and events from the past 100 million years are also included.  

E. A. Boyle  

12.741 Marine Bioinorganic Chemistry  
Prereq: Permission of Instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  

Provides an overview of trace element biogeochemistry and marine biogeochemical processes. Topics include controls on oceanic trace metal distributions; co-evolution of biological metal requirements and metal availability during early Earth history; chemical speciation and its influence on microbial bioavailability; applications of metal isotopes; roles of metalloenzymes and metal proteins in biogeochemical cycles; and biogeochemical applications of metagenomics, metaproteomics, and bioinformatics.  

M. Saito  

12.742 Marine Chemistry  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  

An introduction to chemical oceanography. Reservoir models and residence time. Major ion composition of seawater. Inputs to and outputs from the ocean via rivers, the atmosphere, and the sea floor. Biogeochemical cycling within the oceanic water column and sediments, emphasizing the roles played by the formation, transport, and alteration of oceanic particles and the effects that these processes have on seawater composition. Cycles of carbon, nitrogen, phosphorus, oxygen, and sulfur. Uptake of anthropogenic carbon dioxide by the ocean. Material presented through lectures and student-led presentation and discussion of recent papers.  

B. Van Mooy (WHOI)  

12.743 Geochemistry of Marine Sediments  
Prereq: Chemistry (GIR), 5.60  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  

Focuses on processes that control the composition of sediments in coastal, shelf, and deep-sea environments and processes that define their roles in biogeochemical cycles. Topics include calculating chemical fluxes across the sediment-water interface; evaluating the sources and reactivity of carbonate, silicic, and detrital sediments; using pore water gradients to calculate diffusion, reaction, and flux rates; sediment dating; estimating accumulation rates; and using stable isotopes and natural-series radioisotopes. Covers evaluation of the links between sedimentary and water column processes; the effects of anthropogenic disturbances (e.g., eutrophication, acidification, warming) on sedimentary processes; and the role of sediments in global biogeochemical cycles. Introduces sam-
planning techniques and mathematical modeling of sedimentary processes.

D. McCorkle, W. Martin, A. Spivak (WHOI)

12.744 Marine Isotope Chemistry
Prereq: 12.748 or Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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.

WHOI 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 molecular-level perspective. Surveys the mineralization and preservation of OC in the water column and within anoxic and oxic marine sediments. Topics include: OC composition, reactivity, and budgets within, and fluxes through, major reservoirs; microbial recycling pathways for OC; models for OC degradation and preservation; role of anoxia in OC burial; relationships between dissolved and particulate (sinking and suspended) OC; methods for characterization of sedimentary organic matter; application of biological markers as tools in oceanography. Both structural and isotopic aspects are covered.

D. Repeta, T. Eglinton (WHOI)

12.747 Modeling, Data Analysis, and Numerical Techniques for Geochemistry
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

Emphasizes the basic skills needed for handling and assimilating data as well as the basic tools 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: 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)
Not offered regularly; consult department
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)
Not offered regularly; consult department
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)
Not offered regularly; consult department
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

Introduction to fluid dynamics. Students acquire an understanding of some of the basic concepts of fluid dynamics that are needed as a foundation for advanced courses in atmospheric science, physical oceanography, ocean engineering, climate science, etc. Emphasizes fluid fundamentals, with an atmosphere/ocean twist.

J. Marshall

12.801 Large-scale Ocean Dynamics
Prereq: 12.800
G (Spring)
3-0-9 H-LEVEL Grad Credit

Applies fundamental principles of geophysical fluid dynamics to understand the general patterns of the ocean circulation and stratification. Includes the mid-latitude wind-driven circulation, the Southern Ocean circulation, and the global overturning circulation. Uses a combination of theory, numerical simulations, and observations to illustrate the concepts.

R. Ferrari

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.
topics include: resonant interactions, potential
vorticity, wave-mean flow interactions, and
instability.
G. Flierl, 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. Basic concepts include mass
and momentum conservation, hydrostatic and
geostrophic balance, and pressure and other
vertical coordinates. Barotropic vorticity equa-
tion on the sphere and beta plane: potential
vorticity (PV) and invertibility; Greens functions/
point vortices. Shallow water equations; balance
in forced flow, waves, and vortices; geostrophic
adjustment. Stratified atmospheres and oceans:
thermodynamics. The quasi-geostrophic equa-
tions; Rossby waves and vortices; upward wave
radiation. Barotropic and baroclinic instabilities
and theorems concerning necessary conditions.
Superposition and the continuous spectrum.
Equilibration of instabilities. Frontogenesis and
semeigostrophy. Emphasizes numerical exper-
iments and analytical derivations.
G. Flierl

12.804 Large-scale Flow Dynamics Laboratory
Prereq: 12.800, Coreq: 12.803
G (Fall)
0-3-9 H-LEVEL Grad Credit
Analysis of observations of oceanic and atmo-
spheric quasi-balanced flows, 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. Presents
critical summaries of the results of each project
in written reports and oral presentations.
L. Illari, G. Flierl

12.805 Laboratory in Physical Oceanography
Prereq: 12.808
G (Fall)
3-0-6 H-LEVEL Grad Credit
Introduction to standard data analysis meth-
ods, including time series analysis, objective
mapping, and empirical orthogonal functions.
Focuses on working with data in a computer
laboratory setting. Emphasizes how statistical
information can be used to improve experimen-
tal design. Some attention given to the instru-
ments and algorithms used to acquire the data.
K. Brink

12.806 Atmospheric Physics and Chemistry
(Same subject as 10.571)
(Subject meets with 12.306)
Prereq: 5.60 or 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.
R. G. Prinn

12.807 Atmospheric Chemistry
(Same subject as 1.84J, 10.817)
Prereq: 5.60
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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)
3-0-9 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.
Y. Kwon, S. Jayne (WHOI)

12.809 Hydraulic Phenomena in Geophysical
Fluid Flows
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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 hydrau-
lcs, 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 rotat-
ing channel flow, nonlinear Kelvin and frontal
waves, rotating hydraulic jumps, geostrophic
adjustment in a rotating channel, and applica-
tions 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
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; bal-
anced 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 grad-
uate version complete different assignments.
R. A. Plumb

12.811 Tropical Meteorology
Prereq: 12.810 or Coreq: 12.803
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 Oscilla-
tion; easterly waves; and tropical cyclones.
K. A. Emanuel

12.812 The General Circulation of the
Atmosphere and Climate Change
Prereq: None. Coreq: 12.803, 12.810, or
permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Explains the main features of the general circula-
tion of the Earth’s atmosphere. Final part of the
course explores possible changes in the general
circulation associated with climate change.
R. O’Gorman
Aerosol and Cloud Microphysics and Chemistry
(Subject meets with 12.338)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Focuses on understanding how aerosol particles form droplets or ice crystals during several atmospheric processes: determining Earth’s radiative balance; heterogeneous chemistry and acid rain; understanding where, when and how much precipitation occurs. Provides tools for understanding the physics of aerosol and cloud element motion; the interaction of particles with water vapor, including phase changes and droplet and ice nucleation; the chemical composition of particles and the effect on cloud formation processes; and the effect of cloud processing on aerosol chemistry. Discusses relevant topics of contemporary interest, e.g., geoengineering and weather modification and volcanic effects. Students taking the graduate version complete different assignments.

D. Cziczo

Atmospheric Radiation
Prereq: 5.61, 12.800, 18.075, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
5-2-5 H-LEVEL Grad Credit

Introduction to the physics of atmospheric radiation, remote sensing, and convection, including use of computer codes. Radiative transfer equation including emission and scattering, spectroscopy, Mie theory, and numerical solutions. Physics of dry and moist convection, including moist thermodynamics. Radiative-convective equilibrium. Solution of inverse problems in remote sensing of atmospheric temperature and composition.

S. Seager, R. A. McClatchey, K. Emanuel

Atmospheric Composition in the Changing Earth System
(Same subject as 12.841)
Prereq: 1.84
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 12.841.

C. Heald

Introduction to Atmospheric Data and Synoptic Meteorology
Prereq: None. Coreq: 12.800
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

Turbulence in the Ocean and Atmosphere
Prereq: 12.803
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 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-gaussian turbulence, baroclinic turbulence, and macroturbulence in the ocean and atmosphere.

R. Ferrari, G. Flierl

Modeling the Biology and Physics of the Ocean
Prereq: 18.075 or 18.085
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit


G. Flierl, D. McGillicuddy

Stability Theory for Oceanic and Atmospheric Flows
Prereq: 12.802 or permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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 stability; 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

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.

EAPS Staff

Dynamics and Transport in the Stratosphere
Prereq: 12.803 or permission of instructor
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, K. Dryer

12.842 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

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

12.844J Modeling and Assessment for Policy  
(Subject meets with ESD.864J)  
Prereq: ESD.10 or permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit

See description under subject ESD.864J.  
Staff

12.845J Sustainability Science and Engineering  
(Subject meets as ESD.120J)  
Prereq: None. Coreq: ESD.83 or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-0-6 H-LEVEL Grad Credit

See description under subject ESD.120J.  
N. Selin

12.846J Global Environmental Science and Negotiations  
(Subject meets with 12.346J, ESD.046J)  
Prereq: None  
G (Fall)  
3-0-6

See description under subject ESD.110J.  
N. Selin

12.848J Global Climate Change: Economics, Science, and Policy  
(Subject meets as 15.023J)  
Prereq: Calculus II (GIR); 5.60; 14.01 or 15.010; or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
3-0-6

See description under subject 15.023J.  
R. G. Prinn

12.849 Mechanisms and Models of the Global Carbon Cycle (New)  
(Subject meets with 12.349)  
Prereq: Permission of instructor  
G (Spring)  
3-0-9

Addresses changes in the ocean, terrestrial biosphere and rocks modulation of atmospheric carbon dioxide on timescales from months to millions of years. Includes feedback between carbon cycle and climate. Combines hands-on data analysis with the formulation of simple models rooted in basic physical, chemical and biological principles. Students create individual "toy" global carbon cycle models. Students taking graduate version complete different assignments.  
M. Follows

12.860 Climate Variability and Diagnostics  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit

Practical insight into characteristics and mechanisms of climate variability from regional to global scale in the modern world with applications to past and future climates. Major emphasis is placed on the salient features of the mean climate system and their dominant modes of natural variability (e.g., El Nino-Southern Oscillation, North Atlantic Oscillation) as well as observed and projected manifestations of anthropogenic climate change. Learning is driven by exploration of data and supplemented by lectures and published literature. Through inter-active learning students gain experience accessing and analyzing a wide range of gridded data including instrumental, satellite, and re-analysis products as well as IPCC global climate models.  
K. Karnauskas

12.862 Coastal Physical Oceanography  
Prereq: 12.800  
Acad Year 2014–2015: G (Fall)  
Acad Year 2015–2016: Not offered  
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.  
WHOI Staff

12.863 Advanced Topics in Coastal Physical Oceanography  
Prereq: 12.862 or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
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.  
WHOI Staff

12.866 Theory of the General Circulation of the Ocean  
Prereq: 12.800, 12.801, 12.802  
G (Fall)  
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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 paleoclimatic 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)

12.885j Science, Politics, and Environmental Policy
(Same subject as 11.373j)
(Subject meets with 12.385)
Prereq: 12.806, 12.807, or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Examines the role of science in US and international environmental policymaking. Surveys the methods by which scientists learn about the natural world; the treatment of science by experts, advocates, the media, and the public and the way science is used in legislative, administrative and judicial decision making. Through lectures, group discussions, and written essays, students develop a critical understanding of the role of science in environmental policy. Potential case studies include fisheries management, ozone depletion, global warming, smog, and endangered species. Students taking the graduate version complete different assignments.
S. Solomon, J. Layzer

12.950, 12.951 Seminar in Physical Oceanography at MIT
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] 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 Research 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
Original investigations, laboratory work, or fieldwork in oceanography. 12.960 is letter-graded.
Physical Oceanography Staff

12.970, 12.971 Current Research in Physical Oceanography at Woods Hole
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Original investigations, laboratory work, or fieldwork in oceanographic problems. 12.970 is letter-graded.
WHOI Staff

12.980, 12.981 Current Research in Atmospheric Science
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Original investigations on problems in atmospheric science. 12.980 is letter-graded.
EAPS Staff

12.982, 12.983 Current Research in Climate Physics and Chemistry
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Original investigations, laboratory work, or fieldwork in problems related to climate. 12.982 is letter-graded
PAOC faculty

12.5488, 12.5489 Special Seminar in Structural Geology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject on an aspect of structural geology not normally covered in regularly scheduled subjects. 12.488 is letter-graded.
Geology and Geochemistry Staff

12.5490, 12.5491 Special Seminar in Geology and Geochemistry
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject on an aspect of geology or geochemistry not normally covered in regularly scheduled subjects. 12.490 is letter-graded.
Geology and Geochemistry Staff

12.5492, 12.5493 Special Seminar in Geobiology
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject on an aspect of geobiology not normally covered in regularly scheduled subjects. 12.492 is letter-graded.
Geobiology Staff

12.5590, 12.5591 Special Seminar in Geophysics
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject on an aspect of geophysics not normally covered in regularly scheduled subjects. 12.5590 is letter-graded.
Consult EAPS Education Office

s u b j e c t s 1 2 . 8 3 5 t o 1 2 . 5 5 9 1
12.5592, 12.5593 Special Seminar in Earth, Atmospheric and Planetary Sciences
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject on an aspect of the earth sciences, planetary sciences, or astronomy not normally covered in regularly scheduled subjects. 12.5592 is letter-graded.
EAPS Staff

12.5680, 12.5681 Special Seminar in Planetary Science
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject on an aspect of planetary science not normally covered in regularly scheduled subjects. 12.5680 is letter-graded.
Planetary Science Staff

12.5990, 12.5991 Special Subject in Atmospheric Science
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject on an aspect of atmospheric science not normally covered in regularly scheduled subjects. 12.5990 is letter-graded.
PAOC Staff

12.5992, 12.5993 Special Subject in Climate Physics and Chemistry
Prereq: Permission of instructor
G (Fall)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Organized lecture or laboratory subject on an aspect of climate not normally covered in the regularly scheduled subjects. 12.5992 is letter-graded.
PAOC Staff

### Bachelor of Science in Earth, Atmospheric, and Planetary Sciences

<table>
<thead>
<tr>
<th>Course 12</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Institute Requirements (GIRs)</td>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Restricted Electives in Science and Technology (REST) Requirement (can be satisfied from among 12.001, 18.03, and 18.034 in the Departmental Program)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Laboratory Requirement</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
<td></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
  - **12.002** Introduction to Geophysics and Planetary Science, 12, REST; Physics II (GIR), Calculus II (GIR)
  - **12.003** Introduction to Atmospheric, Ocean, and Climate Dynamics, 12, REST; Physics I (GIR), Calculus II (GIR)
  - **12.005** Theoretical Environmental Analysis, 12; Physics I (GIR), Calculus II (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 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, 12, LAB; 12.113, 12.114
  - **12.116** Field Geology Analysis, 6, CI-M; 12.115
  - **12.221** Field Geophysics, 6
  - **12.222** Field Geophysics Analysis, 6, CI-M; 12.221
  - **12.307** Weather and Climate Laboratory, 15, LAB, CI-M; Calculus II (GIR), Physics I (GIR)
  - **12.335** Experimental Atmospheric Chemistry, 12, LAB, CI-M; Chemistry (GIR)
  - **12.410** Observational Techniques of Optical Astronomy, 15, LAB, CI-M; 8.282*; 8.03

The remainder of the program consists of 60 units from either the Discipline or Supporting Science subjects; no more than 36 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
- **12.005** Applications of Continuum Mechanics to Earth, Atmospheric, and Planetary Sciences, 12; Physics II (GIR), Calculus II (GIR) 18.03
- **12.006** Nonlinear Dynamics: Chaos, 12; Physics II (GIR), 18.03*
- **12.007** Geobiology: History of Life on Earth, 12
- **12.008** Classical Mechanics: A Computational Approach, 12; Physics I (GIR), 18.03, permission of instructor
- **12.021** Earth Science, Energy, and the Environment, 12; Physics I (GIR), Calculus I (GIR), Chemistry (GIR)
- **12.086** Modeling Environmental Complexity, 12; 18.03
- **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
- **12.113** Structural Geology, 12; 12.001
- **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
- **12.165** Geomorphology, 12; 12.005, 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
- **12.201** Essentials of Geophysics, 12; Physics II (GIR), Calculus II (GIR), 18.03
- **12.207** Nonlinear Dynamics: Continuum Systems, 12; 12.006*
- **12.213** Alternate Energy Sources, 6
- **12.214** Environmental Geophysics, 12; 18.03
- **12.301** Past and Present Climate, 12; Chemistry (GIR)*
- **12.306** Atmospheric Physics and Chemistry, 12; 5.6*
- **12.310** An Introduction to Weather Forecasting, 6; Physics I (GIR), Calculus I (GIR)
- **12.333** Atmospheric and Ocean Circulations, 12; 12.003
- **12.335** Air Pollution, 12; 18.03
- **12.336** Aerosol and Cloud Microphysics, 12; 12.335*
- **12.385** Environmental Science and Society, 12; 12.306
12.340 Global Warming Science, 12; Physics I (GIR)*, 5.60
12.348J Global Climate Change: Economics, Science, and Policy, 9; Calculus II (GIR), 5.60, 14.01*; or permission of instructor
12.420 Physics and Chemistry of the Solar System, 12; 12.002*
12.425 Extrasolar Planets: Physics and Detection Techniques, 12, REST; Physics I (GIR), Calculus I (GIR)
12.43J Space Systems Engineering, 12; permission of department
12.431J Space Systems Development I, 12, LAB; 16.83J

Supporting Science Subjects
1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)
1.060A Fluid Mechanics I, 6; 18.03*
1.060B Fluid Mechanics II, 6, 1.060A*
1.061A Transport Processes in the Environment I, 6; 1.060A
1.061B Transport Processes in the Environment II, 6; 1.061B
1.080A Environmental Chemistry I, 6; Chemistry (GIR)
1.080B Environmental Chemistry II, 6; 1.080A
3.012 Fundamentals of Materials Science and Engineering, 15, REST; 18.03*
5.02 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)
6.0001 Introduction to Computer Science Programming in Python, 12
6.0002 Introduction to Computational Thinking and Data Science, 12; 6.0001*
7.01 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)
12.012 Matlab, Statistics, Regression, Signal Processing, 12; 18.06
12.320J Introduction to Hydrology, 12; 1.060, 2.061, 1.106
18.09 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*

Students with appropriate interests may substitute two subjects in urban planning, economics, policy, or management for subjects in the Supporting Science category.

Departmental Program Units That Also Satisfy the GIRs

36

Unrestricted Electives

66–72

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) The combination of 6.0001 and 6.0002 counts as a REST subject.

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.
GENERAL ECONOMICS AND THEORY

14.003 Microeconomic Theory and Public Policy (Subject meets with 14.03)  
Prereq: 14.01  
U (Fall, Spring)  
3-0-9 HASS-S  
Applies microeconomic theory to analysis of public policy. Builds from microeconomic model of consumer behavior; extends to operation of single and multiple markets and analysis of why markets sometimes fail. Empirical examples to evaluate theory, focusing on the casual effects of policy interventions on economic outcomes. Topics include minimum wages and employment, food stamps and consumer welfare, economics of risk and safety regulation, the value of education, and gains from international trade. Graduate students are expected to complete additional assignments.  
Fall: D. Autor  
Spring: N. Agarwal

14.01 Principles of Microeconomics  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-S  
Introduces microeconomic concepts and analysis, supply and demand analysis, theories of the firm and individual behavior, competition and monopoly, and welfare economics. Applications to problems of current economic policy. Taught in two formats—lecture/recitation and recitation only—each with 3 sessions per week. Same content and exams.  
Fall: J. Gruber  
Spring: J. Harris

14.02 Principles of Macroeconomics  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-S  
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. Taught in two formats—lecture/recitation and recitation only—each with 3 sessions per week. Same content and exams.  
Fall: P. Willen  
Spring: J. Poterba

14.03 Microeconomic Theory and Public Policy (Subject meets with 14.003)  
Prereq: 14.01  
U (Fall, Spring)  
4-0-8 HASS-S  
Applies microeconomic theory to analysis of public policy. Builds from microeconomic model of consumer behavior; extends to operation of single and multiple markets and analysis of why markets sometimes fail. Empirical examples to evaluate theory, focusing on the casual effects of policy interventions on economic outcomes. Topics include minimum wages and employment, food stamps and consumer welfare, economics of risk and safety regulation, the value of education, and gains from international trade.  
Fall: D. Autor  
Spring: N. Agarwal

14.04 Intermediate Microeconomic Theory  
Prereq: 14.01, Calculus II (GIR)  
U (Fall)  
4-0-8 HASS-S  
Analysis of consumer and producer decisions including analysis of competitive and monopolistic markets. Price-based partial and general equilibrium analysis. Introduction to game theory as a foundation for the strategic analysis of economic situations. Imperfect competition, dynamic games among firms. Failures of general equilibrium theory and their resolutions: externalities, public goods, incomplete information settings, signaling, screening, insurance, alternative market mechanisms, auctions, design of markets.  
J. Toikka

14.05 Intermediate Macroeconomics  
Prereq: 14.01, 14.02  
U (Fall)  
4-0-8 HASS-S  
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 substantial research paper on the economics of long-run economic growth.  
A. Simsek

14.08 Technical Topics in Economics  
Prereq: 14.01  
U (Fall, Spring)  
4-0-8  
Can be repeated for credit  
Considers technical issues of current research interest in economics.  
Consult Department Headquarters

14.09 Reading Seminar in Economics  
Prereq: 14.04, 14.06  
U (Fall, IAP, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit

14.10 Reading Seminar in Economics  
Prereq: 14.04, 14.06  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit  
Reading and discussion of particular topics in economics. Open to undergraduate students by arrangement with individual faculty members.  
Consult Department Headquarters.  
A. Mikushera

14.11 Topics in Economics  
Prereq: 14.01  
U (Fall)  
4-0-8 HASS-S  
Can be repeated for credit  
Considers issues of current research interest in economics.  
M. Hoffman, E. Yoeli

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  
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. Covers the tools of identification in price and general equilibrium theory, the fundamental welfare theorems, aggregation, and applications. Enrollment limited; preference to PhD students.

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.

B. Holmstrom

14.125 Market Design
Prereq: 14.124
G (Spring)
4-0-8 H-LEVEL Grad Credit
Theory and practice of market design, building on ideas from microeconomics, game theory and mechanism design. Prominent case studies include auctions, labor markets, school choice, prediction markets, financial markets, and organ exchange clearinghouses.

P. Pathak

14.126 Game Theory
Prereq: 14.122
G (Spring)
3-0-9 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring; second half of term)
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.

Consult R. Townsend

14.137J Psychology and Economics
(Same subject as 9.822J)
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 (Spring)
4-0-8 H-LEVEL Grad Credit
Advanced subject on topics of current research interest.

M. Manea, A. Wolitzky

14.15J Networks
(Same subject as 6.207J)
Prereq: 6.041 or 14.30
U (Spring)
4-0-8 HASS-S
Highlights common principles that permeate the functioning of diverse technological, economic and social networks. Utilizes three sets of tools for analyzing networks—random graph models, optimization, and game theory—to study informational and learning cascades; economic and financial networks; social influence networks; formation of social groups; communication networks and the Internet; consensus and gossiping; spread and control of epidemics; control and use of energy networks; and biological networks.

Consult D. Acemoglu, M. Dahleh

14.16 Strategy and Information
Prereq: 14.12 or permission of instructor
U (Spring)
4-0-8 HASS-S
Begins with a rigorous overview of the main equilibrium concepts for non-cooperative games in normal and extensive form, with complete or incomplete information. Defines and explores properties of iterated dominance, rationalizability, Nash equilibrium, subgame perfection, perfect Bayesian equilibrium, and sequential, perfect and proper equilibria. 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.

M. Manea

14.19 Market Design
Prereq: 14.04
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S
Covers the design and operation of organized markets, building on ideas from microeconomic and game theory. Topics may include mechanism design, auctions, matching markets, and other resource allocation problems.

Consult 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.
N. Rose

14.193 Advanced Seminar in Economics
Prereq: 14.121, 14.451
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Reading and discussion of current topics in economics. Open to advanced graduate students by arrangement with individual members of the staff.
M. Piore

14.195 Reading Seminar in Economics
Prereq: 14.121
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Reading and discussion of current topics in economics. Open to advanced graduate students by arrangement with individual members of the staff.
Staff

14.197 Independent Research
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Under supervision of a faculty member approved by Graduate Registration Officer, student conducts independent research.
N. Rose

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: P. Willen, J. Poterba

INDUSTRIAL ORGANIZATION

14.20 Industrial Organization and Competitive Strategy
Prereq: 14.01
U (Spring)
4-0-8 HASS-S
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.
N. Rose

14.21 Health Economics
Prereq: 14.01
U (Spring)
3-0-9 HASS-S
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 (Fall)
4-0-8 HASS-S
Rigorous 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 impact of incentives on risk-taking and innovation; the analysis of venture capital and other forms of financing; and the implications of informational asymmetries among participants for the functioning of markets.
B. Holmstrom, H. Rantakari

14.27 Economics and E-Commerce
Prereq: 14.01; 6.041 or 14.30
U (Fall)
4-0-8 HASS-S
Uses theoretical economic models and empirical evidence to help understand the growth and future of e-commerce. Economic models help frame class discussions of, among other topics, content provision, privacy, piracy, sales taxation, group purchasing, price search, and advertising on the internet. Empirical project and paper required.
J. Toikka

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.
N. Rose, M. Whinston

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.
N. Agarwal

14.281 Contract Economics
Prereq: 14.124
G (Fall)
4-0-8 H-LEVEL Grad Credit
Covers theoretical research on contracts in static as well as dynamic settings. Emphasis is on canonical models in contracting (agency theory, mechanism design, incomplete contracting) illustrated by major areas of application (e.g. compensation, labor and capital markets, property rights, organizational design, corporate finance).
J. Toikka
14.282 Introduction to Organizational Economics
Prereq: 14.124
G (Fall)
5-0-7 H-LEVEL Grad Credit

Starts 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.
M. Whinston

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.
B. Holmstrom

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.
Consult Department Headquarters

STATISTICS AND ECONOMETRICS

14.30 Introduction to Statistical Methods in Economics (New)
(Subject meets with 14.30)
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. Students taking graduate version complete additional assignments. May not count toward HASS requirement.
Consult Department Headquarters

14.300 Introduction to Statistical Methods in Economics (New)
(Subject meets with 14.30)
Prereq: Calculus II (GIR)
G (Fall)
4-0-8

Self-contained introduction to probability and statistics with some economic applications. Elements of probability theory, sampling theory, statistical estimation, and hypothesis testing. Graduate students are expected to complete additional assignments.
Consult Department Headquarters

14.32 Econometrics
Prereq: 14.30
U (Fall, Spring)
4-0-8

Introduction to econometric models and techniques, emphasizing regression. Advanced topics include instrumental variables, measurement error, and limited dependent variable models. Includes problem sets. May not count toward HASS requirement.
Fall: A. Mikusheva
Spring: J. Angrist

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
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.
A. Galichon

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.
A. Galichon, 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.
V. Chernozhukov

14.384 Time Series Analysis
Prereq: 14.382 or permission of instructor
G (Fall)
5-0-7 H-LEVEL Grad Credit

Studies theory and application of time series methods in econometrics, including spectral analysis, estimation with stationary and non-stationary processes, VARs, factor models, unit roots, cointegration, estimation of DSGE models, and Bayesian methods. Enrollment limited.
A. Mikusheva

14.385 Nonlinear Econometric Analysis
Prereq: 14.382 or permission of instructor
G (Fall)
5-0-7 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.
For additional related subjects in statistics, see:
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, 15.061, 15.065, 15.070, 15.075, 15.076, 15.098, and 15.306
Mathematics: 18.05, 18.175, 18.177, 18.440, 18.441, 18.443, 18.445, 18.458, and 18.465
See also: 2.061, 2.830, 5.70, 5.72, 7.02, 8.044, 8.08, 10.816, 11.220, 11.221, 16.322, 17.872, 17.874, 22.38, HST.191, and MAS.622J.

NATIONAL INCOME AND FINANCE

14.41 Public Finance and Public Policy
Prereq: 14.01
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S
Explores the role of government in the economy, applying tools of basic microeconomics to answer important policy questions such as government response to global warming, school choice by K-12 students, Social Security versus private retirement savings accounts, government versus private health insurance, setting income tax rates for individuals and corporations.
Consult J. Gruber

14.41J Introduction to Financial Economics
(Same subject as 15.416J)
Prereq: 14.121, 14.122
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 15.416J.
S. A. Ross

14.42 Environmental Policy and Economics
(Subject meets with 14.420)
Prereq: 14.01
U (Spring)
4-0-8 HASS-S
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 Department Headquarters

14.43 Energy Decisions, Markets, and Policies
(Same subject as 11.161J, 15.031J, 17.397J, 21A.415J)
Prereq: 14.01, 15.016, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S
See description under subject 15.031J.
D. Lessard, R. Schmalensee, S. Silbey, C. Warshaw

14.44 Energy Economics and Policy
(Same subject as 15.037J)
Prereq: 14.01
U (Spring)
4-0-8 HASS-S
Credit cannot also be received for 14.444, 15.038
Analyzes business and public policy issues in energy markets and in the environmental markets to which they are closely tied. Examines the economic determinants of industry structure and evolution of competition among firms in these industries. Investigates successful and unsuccessful strategies for entering new markets and competing in existing markets. Industries studied include oil, natural gas, coal, electricity, and transportation. Topics include climate change and environmental policy, the role of speculation in energy markets, the political economy of energy policies, and market power and antitrust. Two team-based simulation games, representing the world oil market and a deregulated electricity market, act to cement the concepts covered in lecture. Students taking graduate version complete additional assignments. Limited to 60.
C. Knittel

(Same subject as 15.440J)
Prereq: 15.416
G (Fall)
5-0-7 H-LEVEL Grad Credit
See description under subject 15.440J.
H. Chen, L. Kogan


14.441J Advanced Financial Economics II
(Same subject as 15.441J)
Prereq: 14.121, 14.122, or 15.416J
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 15.441J.

(Same subject as 15.442J)
Prereq: 14.382, 15.416J, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 15.442J.

(Same subject as 15.038J)
Prereq: 14.01
G (Spring)
4-0-8
Credit cannot also be received for 14.44, 15.037

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. Limited to 60.

C. Knittel

14.45 Financial Economics
Prereq: 14.03 or 14.04; 14.32
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S

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.

Consult 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 programming in non-stochastic and stochastic environments, and continuous time methods including the Pontryagin maximum principle. Applications may include the Ramsey model, irreversible investment models, and consumption choices under uncertainty. Enrollment limited.

A. Simsek

14.452 Economic Growth
Prereq: 14.451, permission of instructor
G (Fall; second half of term)
3-0-3 H-LEVEL Grad Credit

Introduces the sources and modeling of economic growth and income differences across nations. Topics include an introduction to dynamic general equilibrium theory, the neoclassical growth model, overlapping generations, determinants of technological progress, endogenous growth models, measurement of technological progress, the role of human capital in economic growth, and growth in a global economy. Enrollment limited.

D. Acemoglu

14.453 Economic Fluctuations
Prereq: 14.452, permission of instructor
G (Spring; first half of term)
3-0-3 H-LEVEL Grad Credit

Investigation of why aggregate economic activity fluctuates, and the role of policy in affecting fluctuations. Topics include the link between monetary policy and output, the economic cost of aggregate fluctuations, the costs and benefits of price stability, and the role of central banks. Introduction to real business cycle and new Keynesian models. Enrollment limited.

I. Werning

14.454 Economic Crises
Prereq: 14.453, permission of instructor
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit

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.

R. Caballero

14.461 Advanced Macroeconomics I
Prereq: 14.122, 14.452
G (Fall)
5-0-7 H-LEVEL Grad Credit

Advanced subject in macroeconomics that seeks to bring students to the research frontier. Topics vary from year to year, covering a wide spectrum of classical and recent research. Topics may include business cycles, optimal monetary and tax policy, monetary economics, banking, and financial constraints on investment and incomplete markets.

D. Acemoglu, A. Burstein

14.462 Advanced Macroeconomics II
Prereq: 14.461
G (Spring)
5-0-7 H-LEVEL Grad Credit

Advanced topics on business cycles and crises; informational frictions; coordination problems; global games; DSGE models; financial frictions.

I. Werning

14.471 Public Economics I
Prereq: 14.04
G (Fall)
4-0-8 H-LEVEL Grad Credit

Theory and evidence on government taxation policy. Topics include tax incidence; optimal tax theory; the effect of taxation on labor supply and savings; taxation and corporate behavior; and tax expenditure policy.

J. Poterba, I. Werning

14.472 Public Economics II
Prereq: 14.471
G (Spring)
3-0-9 H-LEVEL Grad Credit

Theory and evidence on government expenditure policy and on regulatory and tax responses to problems of market failure. Topics include social insurance programs such as social security and unemployment insurance; health care policy; cost-benefit analysis in the context of climate change; externalities, public goods, measurement of willingness to pay for non-market goods; environmental policy, including climate policies; redistribution and the welfare state.

A. Finkelstein
14.473 Public Policy in Health Economics  
Prereq: 14.122  
G (Spring)  
4-0-8 H-LEVEL Grad Credit  
Theory and evidence on the economics of the health care sector. Particular focus on the causes and consequences of rising health expenditures; technological change and productivity in the health care sector; and the impact of health insurance.  
H. Williams

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  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Spring)  
3-0-9 HASS-S  
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.  
Consult W. Wheaton

14.54 International Trade  
Prereq: 14.01, 14.02  
U (Fall)  
4-0-8 HASS-S  
Introduction to the theory of international trade and finance with applications to current policy issues.  
P. Antras

14.573 Urban and Regional Economics  
(Same subject as 1.283J, 11.410J, ESD.191J)  
(Subject meets with 14.51)  
Prereq: 14.04, 14.32  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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

14.581 International Economics I  
Prereq: 14.04  
G (Spring)  
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 (Fall)  
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. Burstein, I. Werning

LABOR ECONOMICS AND INDUSTRIAL RELATIONS

14.64 Labor Economics and Public Policy  
Prereq: 14.30 or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Spring)  
4-0-8 HASS-S  
Provides an introduction to the labor market, how it functions, and the important role it plays in people's lives world-wide. 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  
Theory and evidence on the determinants of earnings levels, inequality, intergenerational mobility, skill demands, and employment structure. Particular focus on the determinants of worker- and firm-level productivity; and the roles played by supply, demand, institutions, technology and trade in the evolving distribution of income.  
D. Autor, H. Williams

ECONOMIC HISTORY

14.70J Medieval Economic History in Comparative Perspective  
(Subject meets with 21H.134J)  
Prereq: None  
U (Spring)  
3-0-9 HASS-S; CI-H  
See description under subject 21H.134J.  
A. McCants, S. Ostrow

14.73 The Challenge of World Poverty  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Spring)  
4-0-8 HASS-S  
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.  
Consult E. Duflo

ECONOMIC DEVELOPMENT

14.74 Foundations of Development Policy  
(Subject meets with 14.740)  
Prereq: 14.01, 14.30  
U (Spring)  
4-0-8 HASS-S  
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, B. Olken

14.75 Political Economy and Economic Development
Prereq: 14.01, 14.30
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S

Explores the relationship between political institutions and economic development, covering key theoretical issues as well as recent empirical evidence. Topics include corruption, democracy, dictatorship, and war. Discusses not just what we know on these topics, but how we know it, covering how to craft a good empirical study or field experiment and how to discriminate between reliable and unreliable evidence.

Consult B. Olken

14.770 Introduction to Collective Choice and Political Economy
Prereq: None
G (Fall)
4-0-8

Broad introduction to political economy. Covers topics from social choice theory to political agency models, including theories of voter turnout and comparison of political institutions.

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.

S. Jayachandran, 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.

A. Banerjee, E. Duflo

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, A. Banerjee

14.781J Political Economy I: Theories of the State and the Economy
(Same subject as 15.678J, 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

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 [P/D/F]
Can be repeated for credit

14.URG Undergraduate Research
Prereq: 14.02
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Participation in research with an individual faculty member or research group, independent research or study under the guidance of a faculty member. Admission by arrangement with individual faculty member.

Consult A. Mikusheva
### 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</td>
<td>8</td>
</tr>
<tr>
<td><a href="1">three subjects can be satisfied by subjects in the Departmental Program</a></td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>[one subject can be satisfied by 14.30 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 14.33 in the Departmental Program]</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>14.01 Principles of Microeconomics, 12, HASS-S</td>
<td>96–99</td>
</tr>
<tr>
<td>14.02 Principles of Macroeconomics, 12, HASS-S</td>
<td></td>
</tr>
<tr>
<td>14.04 Intermediate Microeconomic Theory, 12, HASS-S; 14.01, Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>14.05 Intermediate Macroeconomics, 12, HASS-S, CI-M; 14.02, 14.02</td>
<td></td>
</tr>
<tr>
<td>14.30 Introduction to Statistical Method in Economics,(2) 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>14.32 Econometrics, 12, 14.30</td>
<td></td>
</tr>
<tr>
<td>14.33 Research and Communication in Economics, 12, LAB, CI-M; 14.04, 14.05, 14.32</td>
<td></td>
</tr>
<tr>
<td>14.33 Thesis (15 units), 14.33(3)</td>
<td></td>
</tr>
</tbody>
</table>

| Restricted Electives | 60 |
| Elective subjects in economics | |

| Departmental Program Units That Also Satisfy the GIRs | (60) |
| Unrestricted Electives | 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: None
G (Fall)
4-0-5

15.011 Economic Analysis for Business Decisions
(Subject meets with 15.016)
Prereq: None
G (Fall)
4-0-5

Introduces principles of microeconomic analysis as a framework for making more informed managerial decisions. Includes the analysis of competitive markets with supply and demand, sources of market power, pricing, anti-trust policy, as well as an overview of game theory and its application to competitive strategy. Students use the tools presented to analyze business and public policies. Students taking graduate version complete additional assignments. Intended primarily for non-MBA students.

J. Doyle

15.012 Applied Macro- and International Economics
Prereq: None
G (Spring)
3-0-6

Uses case studies to investigate the macroeconomic environment in which firms operate. First half of subject 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.

Staff

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 (Fall)
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 its application to competitive strategy. Students use the tools presented to analyze business and public policies. Students taking graduate version complete additional assignments.

J. Doyle

15.016 Economic Analysis for Business Decisions
(Subject meets with 15.011)
Prereq: None
U (Fall)
4-0-5

Introduces principles of microeconomic analysis as a framework for making more informed managerial decisions. Includes the analysis of competitive markets with supply and demand, sources of market power, pricing, anti-trust policy, as well as an overview of game theory and its application to competitive strategy. Students use the tools presented to analyze business and public policies. Students taking graduate version complete additional assignments.

R. Rigobon, A. Cavallo

15.021J Real Estate Economics
(Subject meets with 12.348J)
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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
MANAGEMENT

15.024 Applied Economics for Managers
Prereq: Permission of instructor
G (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. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.
T. Stoker

15.025 Game Theory for Strategic Advantage
Prereq: 15.010, 15.011, 15.015, or 14.01
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 and opponents; strategic commitment, reputation, and "irrational" actions; brinkmanship and negotiation; auctions; and the design of markets and contests. Applications to a variety of business decisions that arise in different industries, both within and outside the firm.
A. Bonatti

15.026j Global Climate Change: Economics, Science, and Policy
(Subject meets with 11.161J, 14.43J, 17.397J, 21A.415J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S

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.
Lessard, R. Schmalensee, S. Silbey, C. Warshow

15.031j Energy Decisions, Markets, and Policies
(Non-overlapping courses 11.161J, 14.43J, 17.397J, 21A.415J)
Prereq: 14.01, 15.016, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S

15.032j Engineering, Economics and Regulation of the Electric Power Sector
Prereq: Permission of instructor
G (Spring)
3-2-7 H-LEVEL Grad Credit
See description under subject ESD.162J.

15.034 Metrics for Managers: Big Data and Better Answers
Prereq: None
G (Fall)
3-0-6

15.037j Energy Economics and Policy
(Non-overlapping courses 14.44J)
Prereq: 14.01
U (Spring)
4-0-8 HASS-S
Credit cannot also be received for 14.444, 15.038
See description under subject 14.44J.

15.040 Seminar in Managerial Economics
Prereq: 15.010, 15.012
G (Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.054 Optimization Methods in Management Science
(Subject meets with 15.058)
Prereq: None
G (Spring)
4-0-8

15.053 Optimization Methods in Management Science
(Subject meets with 15.058)
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. Includes a team project in which students select and solve a problem in practice.
J. B. Orlin

15.054j The Airline Industry
(Subject meets with 1.232J, 16.71J, ESD.217J)
Prereq: None
G (Fall)
3-0-9

See description under subject 16.71J.
15.058 Optimization Methods in Operations Research
(Subject meets with 15.053)
Prereq: None
G (Spring)
4-0-8
Introduces students to the theory, algorithms, and applications of optimization. Methodologies include linear programming, network optimization, integer programming, and decision trees. Applications to logistics, manufacturing, transportation, marketing, project management, and finance. Includes a team project in which students select and solve a problem in practice. Students taking graduate version complete additional assignments.
J. Ortin

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) or second half of term
2-0-4 H-LEVEL Grad Credit
Provides an introduction to data mining and machine learning, a class of methods that assist in recognizing patterns and making intelligent use of massive amounts of data collected via the internet, e-commerce, electronic banking, point-of-sale devices, bar-code readers, medical databases, 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. Term project required.
R. E. Welsch

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, R. E. Welsch

15.066J System Optimization and Analysis for Operations
(Same subject as 2.851J, 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

15.068 Statistical Consulting
Prereq: 15.060
G (Fall)
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 2014–2015: Not offered
Acad Year 2015–2016: 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 Analytics Edge
Prereq: 15.053 or 15.060
G (Spring)
4-0-8 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 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 their impact. Uses R programming language. Includes team projects.
D. Bertsimas

15.072J Queues: Theory and Applications
(Same subject as 6.264J)
Prereq: 6.262
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Modeling and analysis of queueing systems, with applications in communications, manufacturing, computers, 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

15.073J Logistical and Transportation Planning Methods
(Same subject as 1.203J, 6.281J, 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

15.074J Predictive Data Analytics and Statistical 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 broader range of topics and examples. Begins with a brief review of statistics.
and regression by addressing advanced topics, such as bootstrap resampling, variable selection, data and regression diagnostics, visualization, and Bayesian and robust methods. Goes on to cover data-mining and machine learning, including classification, logistic regression, and clustering. Culminates with time series analysis and forecasting, design of experiments, analysis of variance, and process control. Students use statistical computing systems based on Excel add-ins and stand-alone packages. Includes case studies involving finance, management science, consulting, risk management, and engineering systems. Term project required.

R. E. Welsch

15.07J Statistical Thinking and Data Analysis
(Same subject as ESD.07J)
Prereq: 6.041
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

15.07J 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, data-mining, and machine learning, concentrating on techniques used in management science, marketing, 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 and MATLAB for data analysis and data mining. Term project required.

R. E. Welsch

15.07J 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

15.081J 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. S. Schulz

15.082J Network Optimization
(Same subject as ESD.78J)
Prereq: 15.081 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Doctoral seminar on network models and algorithms. Emphasis on the design and analysis of efficient algorithms for network flow models. Topics may vary from year to year.
J. Orlin

15.083J Integer Programming and Combinatorial Optimization
(Same subject as 6.859J)
Prereq: 15.081 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
4-0-8 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

15.084J Nonlinear Optimization
(Same subject as 6.252J)
Prereq: 18.06, 18.100
G (Spring)
4-0-8 H-LEVEL Grad Credit
See description under subject 6.252J.
R. M. Freund, D. P. Bertsekas, G. Perakis

15.085J 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

15.093J 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, robust, nonlinear, dynamic optimization and optimal control. Emphasizes methodology and the underlying mathematical structures. Topics include the simplex method, network flow methods, branch and bound and cutting plane methods for discrete optimization, optimality conditions for nonlinear optimization, interior point methods for convex optimization, Newton’s method, heuristic methods, and dynamic programming and optimal control methods.
D. Bertsimas, P. Parrilo

15.094J Robust Modeling, Optimization, and Computation
(Same subject as 1.142J)
Prereq: 18.06 or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Introduces modern robust optimization, including theory, applications, and computation. Presents formulations and their connection to probability, information and risk theory for conic optimization (linear, second-order, and semidefinite cones) and integer optimization. Application domains include analysis and optimization of stochastic networks, optimal mechanism design, network information theory, transportation, pattern classification, structural and engineering design, and financial engineering. Students formulate and solve a problem aligned with their interests in a final project.
D. Bertsimas
15.096 Prediction: Machine Learning and Statistics
Prereq: None
G (Spring)
3-0-9

Gives a practical background and theoretical foundation to machine learning algorithms and Bayesian analysis. Includes an overview of the top ten algorithms in data mining. Covers frameworks for knowledge discovery, a unified view of support vector machines, AdaBoost and regression based on regularized risk minimization; generalization bounds from statistical learning theory based on covering numbers, VC dimension, and the margin theory; as well as basic Bayesian analysis and notes on the history of machine learning and statistics.

C. Rudin

15.097 Seminar in Operations Research and Statistics
Prereq: Permission of instructor
G (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 (Fall)
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 (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, and 1.205

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, 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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, J. Karp

15.124j Evaluating a Biomedical Business Concept
(Same subject as HST.973j)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-6

See description under subject HST.973j.

C. Berke, R. Anders, R. J. Cohen

15.127j Designing and Sustaining Technology Innovation for Global Health Practice
(Same subject as HST.939j)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject HST.939j.

T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

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, S. N. Finkelstein, 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; personalized/stratified medicines and diagnostic biomarkers; and formation and management of various alliances. Visiting speakers from academia, government, NGOs, and industry. Assignments include 4 to 6 essays.

E. R. Berndt
GLOBAL ECONOMICS AND
MANAGEMENT

15.218 Global Economic Challenges and Opportunities
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-6
Analyze the causes, effects and policy responses to major global economic issues. Focuses on financial crises, beginning with historical examples in emerging markets and building up to recent crises. Also focuses on current economic debates and challenges facing countries around the world. Possible topics include unsustainable debt, European union, aging populations, global warming, inequality and poverty, oil and commodity markets, 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 (Fall; second half of 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.
V. Karplus

15.221 Global Strategy and Organization
Prereq: None
G (Spring; first half of 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. Restricted to Sloan Fellows in Innovation and Global Leadership.
Staff

15.223 Global Markets, National Policies, and the Competitive Advantages of Firms
Prereq: None
G (Fall; second half of term)
3-0-3
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. Restricted to Sloan Fellows in Innovation and Global Leadership.
S. Johnson

15.225 Economy and Business in Modern China and India: China Lab and India Lab
Prereq: None
G (Spring)
3-0-9
Provides an integrated approach to analyze the economies of China and India through action learning. The classroom portion covers macro issues of China and India, project-related issues and personal and learning reflections. The onsite portion involves working with a host company in China or India. Students work in teams to tackle a real world business problem with an entrepreneurial Chinese or Indian company and produce a final deliverable for the host company. Students are required to take a mid semester trip during SIP and Spring Break to China or India to work onsite with the host company. Past lab projects have included creating a business plan for fundraising, developing a new market strategy, and crafting financial models; the projects have included both for-profit and NGO projects. Limited to graduate students who participate in China Lab or India Lab.
J. Grant, Y. Huang, M. Jester

15.227–15.229 Seminar in International Management
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, Spring)
Units arranged
Can be repeated for credit
Group study of current topics related to international business.
Staff

15.229 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

HISTORY, ENVIRONMENT, AND ETHICS

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 Leadership Stories: 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 nature of ethical standards, social enterprise, and questions of gender, cultural and individual identity, and work/life balance. Materials vary from year to year, but past readings have included work by Robert Bolt, Michael Frayn, Timothy Mo, Wole Soyinka, H.D. Thoreau, and others; films have included Crouching Tiger Hidden Dragon, Hotel Rwanda, The Descendants, Motorcycle Diaries, Three Kings, and others. Draws on various professions and national cultures, and is run as a series of moderated discussions, with students centrally engaged in the teaching process. Limited to 20; priority to Sloan students.

J. Yates

15.277 Seminar in Communications
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, Spring)
Units arranged
Can be repeated for credit
15.278 Seminar in Communications
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Develops writing, speaking, teamwork, interpersonal, and cross-cultural communication skills necessary for management professionals. Assignments include creating persuasive memos, writing in response to cases, and giving presentations. Major project involves the production of a team report and presentation on a topic of interest to a professional audience. Instruction in written and oral communication provided.

L. Breslow

15.280 Communication for Leaders
Prereq: Permission of instructor
G (Fall)
3-1-5 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.

N. Hartman, C. Kelly, R. Pittore, V. Healy-Tangney, K. Blackburn, M. Kazakoff, J. Yates

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

15.282 EnActing Leadership: Shakespeare and Performance (New)
Prereq: None
G (Fall, Spring)
3-0-6
Uses Shakespeare to challenge students’ views of leadership and provide them with a deeper understanding of their performance as a leader. While performing shortened versions of Shakespeare’s plays, students consider the serious questions they raise about the nature of leadership, power, and ambition, and explore their own leadership presence. Uses acting to strengthen speaking ability and personal presence.

C. Kelly

15.289 Doctoral Seminar: Communication Skills for Academics
Prereq: Permission of instructor
G (Spring; partial term)
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

COMMUNICATION

15.270 Ethical Practice: Leading Through Professionalism, Social Responsibility, and System Design
Prereq: None
G (Spring; partial term)
3-0-3
Introduction to ethics in business, with a focus on business management. Students explore theoretical concepts in business ethics, and cases representing the challenges they will likely face as managers. Opportunity to work with guest faculty as well as business and other professional practitioners. Individual sessions take the form of moderated discussion with occasional short lectures from instructor.

L. Hafrey

15.282 EnActing Leadership: Shakespeare and Performance (New)
Prereq: None
G (Fall, Spring)
3-0-6
Uses Shakespeare to challenge students’ views of leadership and provide them with a deeper understanding of their performance as a leader. While performing shortened versions of Shakespeare’s plays, students consider the serious questions they raise about the nature of leadership, power, and ambition, and explore their own leadership presence. Uses acting to strengthen speaking ability and personal presence.

C. Kelly

15.289 Doctoral Seminar: Communication Skills for Academics
Prereq: Permission of instructor
G (Spring; partial term)
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
**WORK AND ORGANIZATIONAL STUDIES**

**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. Shares lectures with 15.310.

*Fall: A. Yap  
Spring: J. Carroll*

**15.305 Leadership and Management**
Prereq: Permission of instructor
U (Fall, Spring)
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. Cranin, D. Ancona*

**15.310 Managerial Psychology**
Prereq: None
G (Fall, Spring)
2-1-6

Surveys social psychology and organization theory as interpreted in the context of the managerial environment. Covers a number of diverse topics, including motivation and reward systems, social influence, groups and teams, leadership, power, organizational design and culture, and networks and communication patterns. Similar in content to 15.311; shares lectures with 15.301. Preference to non-Course 15 students.

*Fall: A. Yap  
Spring: 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, K. Kellogg, D. Apfelbaum*

**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 Leadership and Organizational 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 (LGO) program, with a focus on leadership that blends theory and practice. During their first summer in the program, students reflect on exemplary leaders’ stories in cases, the arts, journalism, philosophy, and social science, and evaluate their own previous leadership experience. During the succeeding four terms, they apply the lessons they have learned in class to their off-campus internship and other activities at Sloan, and intensively review that experience as they reach the end of the program. Classes take the form of moderated discussion, with the expectation that students will participate fully in each session; students also submit short, written deliverables throughout the program.

*L. Hafrey*

**15.318 Discovering Your Leadership Signature**
Prereq: 15.311, 15.322, or permission of instructor
G (Spring; first half of term)
3-0-6 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. Ancona*

**15.320 Strategic Organizational Design**
Prereq: None
G (Spring)
3-0-6

Focusses on effective organizational design in both traditional and innovative organizations, with special emphasis on innovative organizational forms that can provide strategic advantage. Topics include when to use functional, divisional, or matrix organizations; how IT creates new organizational possibilities; examples of innovative organizational possibilities, such as democratic decision-making, crowd-based organizations, internal resource markets, and other forms of collective intelligence. Team projects include inventing new possibilities for real organizations.

*T. Malone*

**15.321 Improvisational Leadership: In-the-Moment Leadership Skills (New)**
Prereq: None
G (Fall, Spring; second half of term)
3-0-3

Designed to provide a practical understanding of the skills of improvisation and their application to leadership. Examines the essential elements of successful leadership, including creativity, emotional intelligence, adaptability, and the capacity to develop effective influence strategies and build strong teams. Cultivates students’ ability to respond to the unexpected with confidence and agility. Each class offers a highly experiential learning laboratory where students practice a wide variety of improvised business scenarios, interactive exercises, and simulations.

*D. Giardella*
15.322 Leading Organizations
Prereq: None
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

15.324 Practical leadership (New)
Prereq: None
G (Fall, Spring; first half of term)
3-0-3 [P/D/F]
Strengthens leadership capacities through feedback, reflection, and of their own videos, as well as focused coaching and feedback, to optimize their own leadership capabilities. Focuses on individual leadership growth. Culminates with submission of a written summary of students' reflections and experiences around leadership from throughout the term. P. Bentley

15.325 Seminar in Leadership I
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

15.339 Distributed Leadership Workshop (New)
Prereq: None
G (IAP)
2-0-4 [P/D/F]
Focuses on the key leadership capabilities needed in today's increasingly decentralized organizations: sense-making, relating, visioning, and inventing. Through conceptual discussions, small group exercises, and self-reflection helps students understand leadership capabilities, evaluate their leadership strengths and weaknesses, articulate their values and aspirations, and practice developing leadership skills in interaction with class members. D. G. Ancona, T. Malone, W. Orlukowski

15.341 Individuals, Groups, and Organizations
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers classic and contemporary theories and research related to individuals, groups, and organizations. Designed primarily for doctoral students in the Sloan School of Management who wish to familiarize themselves with research by psychologists, sociologists, and management scholars in the area commonly known as micro organizational behavior. Topics may include motivation, decision making, negotiation, power, influence, group dynamics, and leadership. J. Curhan

15.342 Organizations and Environments
Prereq: Permission of instructor
G (Fall)
3-0-9 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

15.345 Doctoral Proseminar in Behavioral and Policy Sciences
Prereq: Permission of instructor
G (Spring)
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. Staff

15.347 Doctoral Seminar in Research Methods I
(Subject meets with 21A.809)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. S. Silbey

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, models for ordinal and nominal outcomes, count models, event history models). E. J. Castilla
15.349J Qualitative Research Methods  
(Same subject as 21A.819J)  
Prereq: Permission of instructor  
G (Spring)  
3-0-6  
See description under subject 21A.819J.  
S. Silbey, E. James

15.350 Managing Technological Innovation and Entrepreneurship  
Prereq: None  
G (Spring)  
3-0-6  
Focuses on the challenges inherent in attempting to take advantage of both incremental innovation and more radical or breakthrough changes in products, processes and services. Highlights the importance of innovation to both new ventures and to large established firms and explores the organizational, economic and strategic problems that must be tackled to ensure innovation is a long term source of competitive advantage. Discussions and class presentations cover non-technical as well as technology-based innovation. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.  
Staff

15.355 Building Entrepreneurial Advantage  
Prereq: Permission of instructor  
G (Summer)  
3-0-3 H-LEVEL Grad Credit  
Analyzes in depth the challenges in identifying, funding and managing innovation-based entrepreneurial ventures in firms of varying size, from standalone start-ups to large corporations. Examines different developmental patterns adopted by start-ups, many of which involve linkages between new and established firms. Explores the ways that entrepreneurial ecosystems—such as those around MIT and Kendall Square—help to expand innovation and entrepreneurial capacity beyond traditional firm boundaries. Includes an intensive project in which students define and present the strategic advantage of a new innovation-based start-up to its founders and an established firm partner. Restricted to Sloan Fellows Program in Innovation and Global Leadership  
F. Murray

15.356 Product and Service Development in the Internet Age  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring; second half of term)  
3-0-3  
Traditional “in-house” innovation processes must be changed to benefit from emerging open-source innovation practices. Users are now increasingly developing their own b-to-b and b-to-c products. Course explains proven open innovation development methods such as crowdsourcing, innovation toolkits, tournaments and more. Includes visits from industry experts who present cases that illustrate the art required to implement each method.  
E. A. von Hippel

15.357 Economics of Ideas, Innovation, and Entrepreneurship  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
3-0-6  
Advanced subject in the economics of technological change. Covers the micro-foundations of the knowledge production function (including the role of creativity and the impact of Science), the impact of institutions and strategic interaction on the commercialization of new technology, and the diffusion and welfare impact of ideas and technology. Includes a mixture and explicit comparisons of both theoretical and empirical research. Students should have adequate preparation in microeconomic theory and econometrics. Primarily for PhD students.  
P. Azoulay, S. Stern

15.358 Software and Internet Entrepreneurship  
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, I. Sayeed

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 MIT entrepreneurship activities, e.g., Trust Center for MIT Entrepreneurship, 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 ES.580, Silicon Valley Study Tour, for the following spring term required. No listeners; restricted to students in Sloan Entrepreneurship and Innovation (E&I) MBA track.  
E. Roberts

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
15.366 Energy Ventures
Prereq: 15.910; 15.390 or 15.371; 10.391 or 10.579
G (Fall)
3-0-9 H-LEVEL Grad Credit
Project-based approach to innovation and venture creation in the energy sector. Explores how innovation and entrepreneurial concepts apply (or do not apply) to the significant opportunities in the industry. Working in teams, students create new ventures specifically for the energy sector. Lectures guide teams through key elements of their projects. Concurrent enrollment in 15.933 recommended.
W. Aulet, T. Hynes, F. O’Sullivan

15.369 Corporate Entrepreneurship: Strategies for Technology-Based New Business Development
Prereq: 15.310 or 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.
V. Livada, A. Kacperczyk

15.370 Building an Entrepreneurial Venture: Advanced Tools and Techniques (New)
(Subject meets with 15.378)
Prereq: 10.808, 15.379, or permission of instructor
U (Fall, Spring)
3-1-8
Project-based class in which students use entrepreneurial techniques to build innovation-driven ventures in a time-compressed but robust setting. Applies the fundamental concepts provided in other foundational entrepreneurship courses in greater depth and presents additional tools and techniques. Students apply these concepts to specific venture-development projects. Designed to help students who want to prototype their potential new venture. Includes design, developing, and testing the underlying product/service for the new venture. Students taking graduate version complete additional assignments. Application required; consult instructor.
W. Aulet, J. Baum, E. Chen

15.371 Innovation Teams
(Same subject as 10.807)
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

15.373J Venture Engineering (New)
(Same subject as 2.912J)
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9
Develops the capability to move from testing ideas to assembling a venture as a system comprised of technological, human, social, regulatory, managerial, and financial processes and flows that affect costs, revenues, and value. Begins with a focus on leadership, addressing key issues involved in recruiting and building a founder team and its early employees. Fosters understanding of financial resource needs for the new enterprise an methods for raising funds. Students engage in a venture planning activity in which they must demonstrate their understanding of the concepts covered in class.
F. Murray

15.375 Development Ventures
(Same subject as EC.731J, MAS.665J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.665J.
A. Pentland, J. Bonsen

15.376J Media Ventures
(Same subject as MAS.664J)
Prereq: None
G (Spring)
3-0-6
Can be repeated for credit
See description under subject MAS.664J.
A. Pentland, J. Bonsen

15.377J Linked Data Ventures
(Same subject as 6.932J)
Prereq: 6.005, 6.033, or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.932J.
T. Berners-Lee, L. Kagai, K. Rae, R. Sturdevant

15.378 Building an Entrepreneurial Venture: Advanced Tools and Techniques (New)
(Subject meets with 15.370)
Prereq: Permission of instructor
G (Fall, Spring)
3-1-8 H-LEVEL Grad Credit
Project-based class in which students use entrepreneurial techniques to build innovation-driven ventures in a time-compressed but robust setting. Applies fundamental concepts in greater depth and introduces tools and techniques. Students apply these concepts to specific venture-development projects. Designed to help students who want to prototype their potential new venture. Includes designing, developing, and testing the underlying product/service for the new venture. Students taking graduate version complete additional assignments. Application required; consult instructor.
W. Aulet, J. Baum, E. Chen

15.379 New Enterprises (New)
(Subject meets with 15.390)
Prereq: None
U (Fall, Spring)
2-1-6
Covers the process of identifying and quantifying market opportunities, then conceptualizing, planning, and starting a new, technology-based enterprise. Topics include opportunity assessment, the value proposition, the entrepreneur, legal issues, entrepreneurial ethics, the business plan, the founding team, seeking customers, and raising funds. Students develop detailed business plans for a start-up. Intended for students who want to start their own business, further develop an existing business, be a member of a management team in a new enterprise, or better understand the entrepreneur and
the entrepreneurial process. Meets with 15.390 when offered concurrently.

W. Aulet, C. Catalini

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

15.385 Social Innovation and Entrepreneurship
Prereq: 15.911
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-6 H-LEVEL Grad Credit

Students work individually or in teams to develop a business plan for an enterprise (for- or nonprofit) to solve a social problem. They also have the opportunity to develop their skills by working on an existing social venture. Examines the theory and practice of social entrepreneurship and innovation within various social issues and topics, including social impact markets, performance measurement, and theory of change. Students gain practical knowledge on how to identify potential social venture opportunities; develop skills and competencies for creating, developing and implementing ideas; and measure the success and value of a young enterprise.

Staff

15.386 Managing in Adversity
Prereq: None
G (Fall, Spring; second half of term)
3-0-3

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, determine and evaluate the options, and then take critical and precipitous actions to address the situation. No listeners.

P. Kurzina, N. Thompson

15.387 Entrepreneurial Sales
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. Half term course.

L. Shipley

15.389 Global Entrepreneurship II: Global Entrepreneurship Lab
Prereq: None. Coreq: 15.395
G (Fall, IAP; second half of term)
2-0-7

Building upon 15.395, discusses the issues and policies that affect the climate for innovation and start-up success around the world. 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 US. Focuses on start-ups operating in emerging markets throughout the world. Restricted to graduate students.

Y. Huang, S. Johnson

15.390 New Enterprises
(Subject meets with 15.379)
Prereq: None
G (Fall, Spring)
2-1-6

Covers the process of identifying and quantifying market opportunities, then conceptualizing, planning, and starting a new, technology-based enterprise. Topics include opportunity assessment, the value proposition, the entrepreneur, legal issues, entrepreneurial ethics, the business plan, the founding team, seeking customers and raising funds. Students develop detailed business plans for a start-up. Intended for students who want to start their own business, further develop an existing business, be a member of a management team in a new enterprise, or better understand the entrepreneur and the entrepreneurial process. Meets with 15.379 when offered concurrently.

W. Aulet, C. Catalini

15.392 Designing, Developing and Launching Successful Products in an Entrepreneurial Environment: Tools and Techniques (New)
Prereq: 15.371 or 15.390
G (Spring; first half of term)
3-0-3 H-LEVEL Grad Credit

Students develop and help market an innovation-driven product that may form the basis of an entrepreneurial start-up, but also could be part of a larger entity. Students use tools and techniques to effectively and efficiently drive product development (hardware or software) in a fast-paced environment, including how to iterate their way to product/market fit, how to generate interest in their start-up through the internet, and how to select the right business model for their market. Application required.

B. Halligan, P. English

15.394 Dilemmas in Founding New Ventures
Prereq: None
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

15.395 Global Entrepreneurship I: Entrepreneurship Without Borders
Prereq: None
G (Fall; first half of term)
3-0-3

Examines opportunities and problems for entrepreneurs outside the US, including in Europe, Latin America, and Asia. Covers the linkages between the business environment, the institutional framework, and new venture creation. Students apply analytics of finance for start-ups in emerging markets. In addition to discussing a range of global entrepreneurial situations, student groups pick one particular cluster on which to focus and to understand what further development would entail. Classroom interactions are based primarily on case studies.

S. Johnson, V. Karplus
15.396 Seminar in Entrepreneurship
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.
P. Kurzina

15.399 Entrepreneurship Lab
Prereq: None
G (Fall, Spring)
2-9-1
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.
C. Catalini, J. Dougherty

FINANCE

15.401 Finance Theory I
(Subject meets with 15.411)
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. Students taking graduate version complete additional assignments.
Consult K. Nixon

15.402 Finance Theory II
(Subject meets with 15.412, 15.S418)
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. Students taking graduate version complete additional assignments.
P. Asquith, R. Iyer, A. Malenko

15.403 Introduction to the Practice of Finance
Prereq: None
G (Fall)
2-0-1
Seminar 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. Restricted to first-year Finance track MBA students.
J. Parsons

15.411 Finance Theory I
(Subject meets with 15.401)
Prereq: None
U (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. Students taking graduate version complete additional assignments.
Consult K. Nixon

15.412 Finance Theory II
(Subject meets with 15.402, 15.S418)
Prereq: 15.411
U (Fall, Spring)
4-0-5
Continuation of 15.411, 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. Students taking graduate version complete additional assignments.
P. Asquith, R. Iyer, A. Malenko

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 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.
D. Lucas

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
15.427J Real Estate Capital Markets
(Same subject as 11.432J)
Prereq: 11.431; 15.402 or 15.414
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
See description under subject 11.432J.
D. Geltner

15.429J Securitization of Mortgages and Other Assets
(Same subject as 11.353J)
Prereq: 15.426, 15.401, or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Investigates the economics and finance of securitization, a practice that allows illiquid assets to be transformed into more liquid securities. Considers the basic mechanics of structuring deals for various asset-backed securities. Investigates the pricing of pooled assets, using Monte Carlo and other option pricing techniques, as well as various trading strategies used in these markets.
W. Torous

15.431 Entrepreneurial Finance
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)
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.
Staff

15.434 Advanced Corporate Finance
Prereq: 15.402, 15.412, 15.414, or 15.415
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Covers advanced topics in corporate finance, including complex valuations, static and dynamic capital structure, risk management, and real options. Also considers security design, restructing, bankruptcy, corporate control and governance, and international finance issues.
N. Bergman, N. Gregory

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.
J. C. Cox, H. Chen

15.438 Fixed Income Securities and Derivatives
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 credit derivatives; mortgages; and securitization. 15.437 strongly recommended.
D. Lucas
15.439 Investment Management  
Prereq: 15.401, 15.414, or 15.415  
G (Spring)  
3-0-6 H-LEVEL Grad Credit

Studies financial markets, principally equity markets, from an investment decision-making perspective. Develops a set of conceptual frameworks and tools, and applies them to particular investments and investment strategies chosen from a broad array of companies, securities, and institutional contexts. Focuses strongly on case studies; students are expected to prepare each case before class and participate extensively in discussions.  
R. Cohen

15.440J Advanced Financial Economics I  
(Same subject as 14.440J)  
Prereq: 15.416  
G (Fall)  
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 finance, economics, and accounting.  
H. Chen, L. Kogan

15.441J Advanced Financial Economics II  
(Same subject as 14.441J)  
Prereq: 14.121, 14.122, or 15.416J  
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.  
Staff

15.442J Advanced Financial Economics III  
(Same subject as 14.442J)  
Prereq: 14.382, 15.416J, or permission of instructor  
G (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.  
Staff

15.444 International Finance: Corporate Finance  
Prereq: 15.402, 15.414, or 15.415  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
3-0-6 H-LEVEL Grad Credit

Addresses issues relating to valuation, risk management, financing and contractual design for firms operating in international markets, providing exposure to emerging markets. Students analyze how risk and cash flows should be evaluated in environments with varying levels of risk, such as currency fluctuation, sovereign default, weak property rights, etc. Discusses how certain types of risk can be eliminated or managed through the appropriate design of financial contracts, and how institutional differences across countries shape the structure and efficacy of private equity contracts. Other topics include firm policy and international tax regimes, microfinance, and valuing social return. Concludes with a discussion on the impact of global financial crises on firm financial policy.  
Staff

15.445 Mergers and Acquisitions: The Market for Corporate Control  
Prereq: 15.402, 15.414, 15.515, or 15.516  
G (Spring; partial term)  
2-0-4 H-LEVEL Grad Credit

Examines a corporation’s decision to acquire another firm or the decision to oppose being acquired. 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. Sessions alternate between discussions of academic readings and applied cases.  
N. Gregory

15.447 International Finance: Capital Markets  
Prereq: 15.401, 15.414, or 15.415  
G (Spring)  
3-0-6 H-LEVEL Grad Credit

Students analyze international financial markets and instruments. Covers topics such as currency markets, exchange rate determination, statistical properties of exchange rates; currency futures and options; hedging foreign exchange risk and managing foreign exchange exposure; international portfolio management; international asset market implications of bubbles, crashes, and crises.  
J. Parker

15.448–15.449 Seminar in Finance  
Prereq: 15.402 or 15.414  
G (Fall, Spring)  
Units arranged H-LEVEL Grad Credit

Can be repeated for credit  
Group study of current topics related to finance.  
J. C. Cox

15.450 Analytics of Finance  
Prereq: 15.401, 15.414, or 15.415  
G (Spring)  
5-0-7 H-LEVEL Grad Credit

Provides a rigorous foundation for the main analytical techniques and quantitative methods necessary to succeed in the financial services industry. Topics include discrete and continuous asset pricing models, financial econometrics, machine learning methods, and dynamic optimization. Examples of applications include portfolio management, risk management, derivative pricing, and algorithmic trading.  
A. Kirilenko

15.451 Proseminar in Capital Markets/Investment Management  
Prereq: 15.401, 15.414, or 15.415  
G (Fall)  
2-0-4 H-LEVEL Grad Credit

Group study of current topics related to finance. Students are assigned to teams, and each team is assigned one such problem. Teams present their solutions at a seminar which is attended by representatives of the sponsoring organization and open to the entire MIT community. Not open to students from other institutions.  
M. Kritzman

15.452 Proseminar in Corporate Finance/Investment Banking  
Prereq: 15.402, 15.414, or 15.415  
G (Fall)  
3-0-3 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. Not open to students from other institutions.

**J. Parsons**

**15.460 Applied Quantitative Finance**  
Prereq: 15.401, 15.414, or 15.415  
G (Spring)  
4-0-5 H-LEVEL Grad Credit

Covers practical aspects of the analytics of finance from the perspective of a quantitative investment manager. Develops an understanding of stochastic processes, option pricing, investment strategies, backtest simulation, data and computational architecture, portfolio construction, trading implementation, and risk management within the context of specific quantitative trading strategies. 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 and the use of real-world market data.

**P. Mende**

**15.466 Valuation**  
Prereq: 15.141, 15.402, 15.414, 15.415, 15.515, or 15.516  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
4-0-5 H-LEVEL Grad Credit

Project-based subject in which students work in teams to prepare comprehensive and detailed valuations of several major investments. Develops a deeper and more detailed understanding of valuation methods and concepts, including estimation of industry betas and costs of capital, discounting the after-tax WACC vs. the adjusted present value (APV) method, using forward and futures prices, R&D and CAPEX leverage and the two-discount-rate method, and valuing debt-equivalent cash flows and certainty equivalents. Guest speakers brief the class on some of the in-depth aspects of valuation methods and concepts and new product ideas. Students should be familiar with basic portfolio-selection theory, CAPM, options, futures, swaps and other derivative securities. Preference to MBA and MFin students.

**R. Merton**

**15.467 Retirement Finance, Lifecycle Investing, and Asset Management**  
Prereq: 15.433  
G (Spring)  
3-0-6 H-LEVEL Grad Credit

Organized around applying finance science and financial engineering in three related financial activities: retirement finance, lifecycle investing, and asset management. Develops the necessary tools of derivative pricing and risk measurement, portfolio analysis and risk accounting, and performance measurement to analyze and implement concepts and new product ideas. Students should be familiar with basic portfolio-selection theory, CAPM, options, futures, swaps and other derivative securities. Preference to MBA and MFin students.

**R. Merton**

**15.481J Financial Market Dynamics and Human Behavior**  
(Same subject as 6.935J)  
Prereq: 15.401, 15.414, or 15.415  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
4-0-5 H-LEVEL Grad Credit

Develops a new perspective on the dynamics of financial markets and the roles that human behavior and the business environment play in determining the evolution of behavior and institutions. Draws on a variety of disciplines to develop a more complete understanding of human behavior in the specific context of markets and other economic institutions. Incorporates practical applications from financial markets, the hedge fund industry, private equity, government regulation, and political economy. Students use ideas from this new perspective to formulate several new hypotheses regarding recent challenges to traditional economic thinking.

**A. Lo**

**15.490 Practice of Finance: Private Equity and Hedge Funds**  
Prereq: 15.402, 15.414, or 15.415  
G (Spring; second half of term)  
2-0-1 [P/D/F] H-LEVEL Grad Credit

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**

**15.491 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**

**15.493 Practice of Finance: Perspectives on Investment Management**  
Prereq: 15.402, 15.414, or 15.415  
G (Fall, Spring; second half of term)  
3-0-3 [P/D/F] H-LEVEL Grad Credit

Provides an overview of the investment management industry and an introduction to business fundamentals and valuation. Students read company analyst reports, write papers analyzing various companies, and complete an in-depth company analysis as a final paper. Includes presentations by outside speakers in the investment management industry. Class attendance is mandatory.

**J. Shames**
15.495 Practice of Finance: Quantitative Investment Management  
Prereq: 15.402, 15.414, or 15.415  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-0-3 H-LEVEL Grad Credit  
Explores facets of quantitative investment management, such as alpha models and data analysis, risk management, portfolio construction and trading, and limitations of a quantitative approach. Focuses primarily on foreign exchange and fixed income markets; may also address examples from equity and commodity markets. Alpha models organized as case studies employing value/mean-reversion, momentum, and carry strategies. Students use market and economic data to challenge theoretical formulations. Problem sets and team projects involve MATLAB programming to solve practical problems faced in building and running a quantitative hedge fund.  
M. Mueller

15.496 Practice of Finance: Data Technologies for Quantitative Finance  
Prereq: 15.401, 15.414, or 15.415  
G (Fall)  
4-0-5 H-LEVEL Grad Credit  
Introduces financial market data architecture and design, with applications to asset pricing, quantitative investment strategies, portfolio management, risk management, and high-frequency trading. Studies how data relationships are structured and how to use modern tools and technologies to manipulate, manage, and analyze financial data sets. Uses real-world data, applications, and cases to illustrate principles and provide practical experience.  
P. Mende

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.  
N. Shroff

15.511 Financial Accounting  
Prereq: Permission of instructor  
G (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  
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. Core, R. Verdi

15.516 Corporate Financial Accounting  
(Subject meets with 15.501)  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
3-0-9  
See description under subject 15.501. If subject is oversubscribed, priority is given to Course 15 students.  
N. Shroff

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 through 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  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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.

T. W. Malone

15.535 Business Analysis Using Financial Statements
Prereq: 15.501, 15.511, 15.515, or 15.516; 15.401, 15.411, or 15.414
3-0-6 H-LEVEL Grad Credit
Primary learning objective is the strategic, financial, and accounting analysis of a company’s profitability and riskiness by means of financial statement data. A second, and related, learning objective is the valuation of a company using financial statement data. Concepts are applied to a number of decision making contexts, including securities analysis, credit analysis, merger analysis, and company performance assessment.

C. Weber

15.539 Doctoral Seminar in Accounting
Prereq: 15.515
G (Fall, Spring)
Can be repeated for credit
Designed primarily for doctoral students in accounting and related fields. The reading list consists of accounting research papers. Objective is to introduce research topics, methodologies, and developments in accounting, and train students to do independent research.

J. Weber

INFORMATION TECHNOLOGIES

15.561 Information Technology Essentials
Prereq: None
G (Spring)
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, and for managing innovative IT-dependent projects. Overall emphasis on business process automation and e-services.

S. Madnick

15.565J Digital Evolution: Managing Web 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; first half of term)
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, guest speakers, and action learning projects that enable teams of students to work with organizations on systemic change initiatives.

P. Senge, W. Orlikowski

15.570 Digital Marketing and Social Media Analytics (New)
Prereq: None
G (Fall; second half of term)
3-0-3
Provides a detailed, applied perspective on the theory and practice of digital marketing and social media analytics in the age of big data. Covers concepts such as the difference between earned and paid media, predictive modeling for ad targeting and customer relationship management, measuring and managing product virality, viral product design, native advertising, and engaging the multichannel experience. Stresses the theory and practice of randomized experimentation, AB testing and the importance of causal inference for marketing strategy. Combines lectures, case studies, and guest speakers with relevant industry experience that speak directly to the topics at hand.

S. Aral

15.571 Enterprise Transformations in the Digital Economy
Prereq: None
G (Spring)
3-0-6
Designed to help students understand how the digital economy forces companies to rethink their business strategies—and architect their processes, products, and information. Explores how firms use technology to simplify unnecessary complexity while capitalizing on the value-adding complexity inherent to more global, more integrated, more connected enterprises. Includes case studies about large enterprises using IT to transform how they do business, with guest executives from those enterprises responding to student discussions. Student
teams work on consulting projects for major corporations.

**J. W. Ross**

**15.575 Economics of Information and Technology in Markets and Organizations**

Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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, search and choice, auctions and mechanism design, transactions cost economics and incomplete contracts theory, and design of empirical studies. 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.

**E. Brynjolfsson**

**15.576 Research Seminar in Information Technology and Organizations: Social Perspectives**

Prereq: Permission of instructor
G (Fall, 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 micro, group, and macro level social phenomena surrounding the development, implementation, use and implications of information technology in organizations. Primarily for doctoral students.

**W. Orlikowski**

**15.578 Global Information Systems: Strategic, Technical, and Organizational Perspectives**

Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-6 H-LEVEL Grad Credit


**S. E. Madnick**

**15.579–15.580 Seminar in Information Technology**

Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

Broad-gauged introduction to business law designed to prepare managers to exercise judgment and leadership when confronting key law-sensitive issues of importance to their organizations and their own careers. Topics include contracts, liability, employment, changing jobs, intellectual property, business disputes, bankruptcy and reorganization, acquisitions, regulatory compliance, and corporate crime. The distinctive feature of 15.615 is an additional focus on the issues faced by entrepreneurs in organizing and financing a new venture.

**J. Akula**

**15.616 Basic Business Law, Tilted Towards Key Emerging Issues**

Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-6

Broad-gauged introduction to business law designed to prepare managers to exercise judgment and leadership when confronting key law-sensitive issues of importance to their organizations and their own careers. Topics include contracts, liability, employment, changing jobs, intellectual property, business disputes, bankruptcy and reorganization, acquisitions, regulatory compliance, and corporate crime. The distinctive feature of 15.616 is an additional focus on newly-emerging, law-sensitive issues of key significance to business. Those topics vary from year to year; some recent examples include doing business in the BRIC nations, and the legal framework of social media.

**J. Akula**

**15.617 Deals, Finance, and the Law**

Prereq: None
G (Spring)
3-0-6

Provide managers with the skills needed to confront key law-sensitive issues of importance to their organizations and their own careers. Focuses on two overlapping contexts: complex deals, and financial services and products. Examines the structure of investment funds (including private equity, hedge funds, venture capital, and mutual funds); complex transactions, such as mergers and acquisitions, commercial finance, securitization, and corporate reorganizations in bankruptcy; financial services regulation; financial instruments and structured products; and civil and criminal accountability.

**J. Akula**

**15.618 Law and Cutting-Edge Technologies**

Prereq: None
G (Spring)
3-0-6

Designed for students with an interest in the law-sensitive issues raised by cutting-edge technologies, including those who are involved in research relating to a new technology or are planning to work in a setting where cutting-edge technology will be an important asset. Examines the legal framework of intellectual property (especially patents, but also trade secrets and copyright) and intellectual property licensing.
Consider the key legal issues that arise in the organization of a hi-tech start-up and in the commercialization of technology-based products in entrepreneurial and established companies. Also looks at issues specific to certain key sectors and technologies, such as software and life sciences.

J. Akula

(Same subject as 6.903J)
Prereq: None
U (Spring)
3-0-6

Intensive introduction to the US law of intellectual property with major emphasis on patents, including the process of patent application and the remedies for patent infringement. Also focuses on copyrights and provides a brief look at trademarks and trade secrets. Presents comparisons of what can and cannot be protected, and what rights the owner does and does not obtain. Highlights issues relating to information technology, biogenetic materials, and business methods. Readings include judicial opinions and statutory material. No listeners.

J. A. Meldman, S. M. Bauer

15.647–15.649 Seminar in Law
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

15.657J Technology, Globalization, and Sustainable Development
(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. 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

15.662J Managing Sustainable Businesses for People and Profits
(Same subject as 11.383J, ESD.278J)
Prereq: None
G (Spring)
3-6-3

Examines opportunities and challenges involved in building and growing businesses that achieve high financial performance and returns to society. An anchor course for the social dimensions of sustainability and serves as an elective Sloan Sustainability Certificate program. Through readings, cases, simulations and class visits from industry leaders, students explore the underlying principles and business practices that help to secure that alignment between business health and societal wellbeing. Students participate in a team project with a firm that is addressing a sustainability challenge.

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 experientially 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 a grad H-level subject.

J. Curhan

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 problems to develop critical skills in negotiations, teamwork, and leadership.

T. Kochan, J. Carroll, P. Osterman

15.676 Work, Employment, and Industrial Relations Theory
Prereq: Permission of instructor
G (Spring)
2-0-7 H-LEVEL Grad 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, P. Osterman, E. Castilla, O. Sharone, M. Amengual

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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 Seminar in Industrial Relations and Human Resource Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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)
3-0-6 H-LEVEL Grad Credit
Investigates the different perspectives a general manager must take, how to integrate those perspectives, and the role of leadership in setting and realizing goals. Students work intensively in teams and with multiple faculty, using a deep dive into the challenges faced by a major global firm operating in complex global markets. Restricted to Executive MBA students. Consult J. Hising DiFabio

15.703 Leading Complex Organizations
Prereq: Permission of instructor
G (IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Strengthens students’ skills in recognizing, developing, and taking advantage of opportunities created by organizational complexity. Focusses on key topics in corporate strategy, organizational design, organizational economics, and strategic human resource management, as well as 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. Includes two projects where students create a plan for implementing a change initiative within their organization, and develop a career plan. Restricted to Executive MBA students. Consult J. Hising DiFabio

15.704 Innovation-Driven Entrepreneurial Advantage
Prereq: 15.714 or permission of instructor
G (Spring, Summer)
6-0-6 H-LEVEL Grad Credit
Exposes students to the content, context, and contacts that enable entrepreneurs to design and launch successful stand-alone ventures, ventures inside established corporations, and ventures in partnership with established corporations based on new innovations. Students examine the critical entrepreneurial and innovation challenges facing entrepreneurs inside new and established firms, and develop frameworks that allow them to identify, evaluate, iterate, and integrate their ideas effectively. Case-based discussions complemented by visits to key actors in MIT labs, as well as live case studies with successful entrepreneurs. Specially designed team projects provide practical experience in entrepreneurial strategy, innovation management, and the workings of the MIT entrepreneurial ecosystem. Restricted to Executive MBA students. Consult J. Hising DiFabio

15.705 Organizations Lab
Prereq: Permission of instructor or Coreq: 15.716
G (IAP, Spring, Summer)
3-0-9 H-LEVEL Grad 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. Each student leads a change project in his or her own organization, focusing on fixing a broken or ineffective process. Examples of possible initiatives include a strategic reorientation, organizational restructuring, introduction of a new technology, a worker participation program, etc. Restricted to Executive MBA students. Consult J. Hising DiFabio

15.706 Global Strategy
Prereq: Permission of instructor; Coreq: 15.708
G (Fall, IAP, Spring)
3-0-3 H-LEVEL Grad Credit
Provides students with the evidence, concepts and models for understanding company performance in a global world and the issues facing executives in the early 21st century. Prepares students to manage effectively in today’s interconnected world by understanding this changing environment, principles of global strategy, and the relation between global strategy and organization. Focusses on the specificities of strategy and organization of the multinational company. Restricted to Executive MBA students. Consult J. Hising DiFabio

15.707 Global Organizations Lab
Prereq: Permission of instructor; Coreq: 15.708
G (IAP, Spring, Summer)
6-0-6 H-LEVEL Grad Credit
Helps students discover and develop new and effective ways of managing and working together across national borders; also helps accelerate development of the context awareness and integrative management skills needed to lead in a globalized world. Involves intensive team engagement with a firm where students integrate their understanding of the relevant global and national economic and institutional contexts, industry dynamics, the firm’s strategic position and capabilities, and its management organization and processes to provide the management sponsor with insight and effective recommendations. Includes a week-long site visit for research. Restricted to Executive MBA students. Consult J. 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 experimentally and to understand negotiation in useful analytical frameworks. Emphasizes simulations, exercises, role playing, and cases. Restricted to Executive MBA students.
Consult J. Lehrich

15.714 Competitive Strategy
Prereq: Permission of instructor
G (IAP, Spring, Summer)
3-0-3 H-LEVEL Grad Credit
Credit cannot also be received for 15.902
Introduces a variety of modern strategy frameworks and methodologies to develop the skills needed to be a successful manager. Cases and readings explore a range of strategic problems, focusing particularly on the sources of competitive advantage and the interaction between industry structure and organizational capabilities. Emphasizes the perspective of the general manager in ensuring the firm’s success. Encourages awareness of both the external (market) and internal (organizational) forces that shape firm performance. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.716 Leading Organizations
Prereq: None
G (Summer)
3-0-6 [P/D/F]
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. Hising DiFabio

15.717 Organizational Processes
Prereq: Permission of instructor
G (Fall, Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Designed to enhance students’ ability to take effective action in complex organizational set-
tings by providing the analytic tools needed to analyze, manage, and lead the organizations of the future. Emphasizes the importance of the organizational context in influencing which individual styles and skills are effective. Employs a wide variety of learning tools, from experiential learning to the more conventional discussion of written cases. Centers on three complementary perspectives on organizations: the strategic design, political, and cultural “lenses” on organizations. Restricted to Executive MBA students. R. Fernandez, R. Reagans

15.720 Financial Accounting
Prereq: Permission of instructor
G (Spring)
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 users of accounting information (especially senior managers), rather than the preparer (the accountant). Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.722 Applied Economics for Managers
Prereq: Permission of instructor
G (Fall)
3-0-6 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. Hising DiFabio

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. N. Gregory, S. Myers

15.726 Pricing (New)
Prereq: None
G (IAP)
3-0-0
Credit cannot also be received for 15.818
Focuses on practical pricing tactics. Presents a framework for the steps firms should take when thinking about pricing a new product or improving the pricing performance of an old product. Tools covered include monadic pricing surveys, empirical price elasticity calculations, and conjoint. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.727 The Analytics Edge (New)
Prereq: 15.730 or permission of instructor
G (Spring)
3-0-3 H-LEVEL Grad Credit
Introduces modern analytics methods (data mining and optimization), starting with real-world problems where analytics have made a material difference. Modern data mining methods include clustering, classification, logistic regression, CART, random forest methods, and association rules. Modern optimization methods include robust, adaptive and dynamic finance, energy, security, internet, and demand modeling. Uses R programming language for data mining and ROME for robust optimization. Restricted to Executive MBA students.
Consult J. Hising DiFabio

15.730 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. Hising DiFabio
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, 15.812

Studies the application of a reasoned framework to the selection of target markets and the optimization of marketing decisions. Subject is divided into two parts: a tactical portion that reviews how firms optimize profits in their chosen markets, and a strategic portion that focuses on identifying target markets. Tactical topics include pricing, promotion, channel and product issues. Restricted to Executive MBA students. Consult J. Lehrich MBA students.

15.734 Introduction to Operations Management
Prereq: Permission of instructor
G (Spring, Summer)
3-0-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.761, 15.766

Provides concepts, techniques and tools to design, analyze and improve core strategic operational capabilities. Covers a broad range of application domains and industries, such as high-tech, financial services, insurance, automotive, health care, retail, fashion, and manufacturing. Emphasizes the effects of uncertainty in business decision making and the interplay between strategic and financial objectives and operational capabilities. Students play simulation games that demonstrate some of the central concepts. Restricted to Executive MBA students. Consult J. Hising DiFabio MBA students.

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 MBA students.

OPERATIONS MANAGEMENT

15.761 Introduction to Operations Management
Prereq: 15.060, 6.041, or permission of instructor
G (Fall, Spring, Summer)
4-0-5 H-LEVEL Grad Credit
Credit cannot also be received for 15.734, 15.766

Provides students with concepts, techniques and tools to design, analyze, and improve core operational capabilities, and apply them to a broad range of application domains and industries. Emphasizes the effect of uncertainty in decision-making, as well as the interplay between high-level financial objectives and operational capabilities. Covers topics in production control, risk pooling, quality management, process design, and revenue management. Underscores how these topics are integrated with the different functions of the firm (finance, marketing, R&D, etc.). Includes case studies and guest lectures. Simulation games demonstrate central concepts. Students taking graduate version complete additional assignments. Meets with 15.766 when offered concurrently. Summer section is primarily for Leaders for Global Operations students. R. Levi, K. Zheng

15.762 Supply Chain Planning
Prereq: 1.260J, 15.760, or 15.761
G (Spring)
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. First half-term subject. Staff

15.763 Manufacturing System and Supply Chain Design
Prereq: 1.260J, 15.761, or 15.778
G (Spring)
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. Second half-term subject. S. C. Graves, D. Simchi-Levi

15.764 The Theory of Operations Management
Prereq: 15.081J or 6.251J, 6.436J; or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Provides mathematical foundations underlying the theory of operations management. Covers application domains, including inventory management, supply chain management and logistics, behavioral operations, healthcare management, service industries, pricing and revenue management, and auctions. Studies a wide range of mathematical and analytical techniques, such as dynamic programming, stochastic orders, behavioral and experimental economics, algorithms and approximations, data-driven and learning models, and mechanism design. Also provides hands-on experience in how to apply the theoretical models to solve OM problems in concrete business settings. Specific topics vary from year to year. I. Ashlagi, D. Simchi-Levi, K. Zheng

15.765 Global Supply Chain Management
Prereq: 1.260J, 15.761, 15.778, or permission of instructor
G (Spring)
2-0-4 H-LEVEL Grad Credit

See description under subject 2.965J. B. Arntzen
15.766 Introduction to Operations Management
Prereq: 6.041 or permission of instructor
U (Spring)
4-0-5
Credit cannot also be received for 15.734, 15.761
Provides students with concepts, techniques and tools to design, analyze, and improve core operational capabilities, and apply them to a broad range of application domains and industries. Emphasizes the effect of uncertainty in decision-making, as well as the interplay between high-level financial objectives and operational capabilities. Covers topics in production control, risk pooling, quality management, process design, and revenue management. Underscores how these topics are integrated with the different functions of the firm (finance, marketing, R&D, etc.). Includes case studies and guest lectures. Simulation games demonstrate central concepts. Students taking graduate version complete additional assignments. Meets with 15.761 when offered concurrently.
R. Levi, K. Zheng

15.767 Healthcare Lab: Introduction to Healthcare Delivery in the United States
Prereq: 15.060, 15.761; or permission of instructor
G (Fall)
3-0-6 H-LEVEL Grad Credit
Focuses on the current business challenges and opportunities of the US healthcare delivery industry, providing a broad perspective of their effects on various career paths, such as consulting, entrepreneurship, hospital management, pharmaceutical, biomedical and IT innovation. Provides students the opportunity to interact with outside speakers, including many top-level executives. Discussions based on practical examples from the ongoing healthcare-related work of Sloan faculty, particularly, projects with local hospitals. Students form teams and work directly with a US-based organization on an applied project, which includes an onsite visit during SIP week. Students can continue their onsite project under a different subject number during IAP with permission of the instructor and guest instructors. Simulation games demonstrate central concepts. Students taking graduate version complete additional assignments. Meets with 15.761 when offered concurrently.
R. Levi, J. Wilkinson

15.768 Management of Services: Concepts, Design, and Delivery
Prereq: 15.761, 15.778, or permission of instructor
G (Spring)
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. H. Fine, Z. Ton

15.769 Operations Strategy
Prereq: 15.761, 15.778, or permission of instructor
G (Fall, Spring)
3-0-6 H-LEVEL Grad Credit
Provides unified framework for analyzing strategic issues in manufacturing and service operations. Covers decisions in technology, facilities, vertical integration, human resources and other strategic areas. Explores means of competition, such as cost, quality, speed, innovativeness, and how operations companies address growth. Presents students with an approach to make operations decisions in the era of outsourcing and globalization.
C. H. Fine, D. B. Rosenfield. Z. Ton

15.770J Logistics Systems
(Same subject as 1.260J, ESD.260J)
Prereq: 15.060, 15.761, 15.778, 15.810, or (Same subject as 2.739J, ESD.32J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Provides an introduction to supply chain management from both analytical and practical perspectives. Taking a unified approach, students develop a framework for making intelligent decisions within the supply chain. Covers key logistics functions, such as demand planning, procurement, inventory theory and control, transportation planning and execution, reverse logistics, and flexible contracting. Explores case studies that cover forecasting and planning, portfolio management, and dual sourcing. Emphasizes skills necessary 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

15.772J D-Lab: Supply Chains
(Same subject as EC.733J)
Prereq: None
U (Fall)
2-2-5
Introduces concepts of supply chain design and operations with a focus on supply chains for products destined to improve quality of life in developing countries. Topics include demand estimation, facility location and operations planning, inventory management, and supply chain coordination and performance. Also covers issues specific to emerging markets, such as sustainable supply chains, how to couple product design with supply chain design and operation, and how to account for the value-adding role of a supply chain. Students conduct projects on supply chain design or improvement.
S. C. Graves

15.778 Introduction to Operations Management
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 C. H. Fine

15.783J Product Design and Development
(Same subject as 2.739J, ESD.32J)
Prereq: 2.009, 15.761, 15.778, 15.810, or permission of instructor
G (Spring)
3-3-6 H-LEVEL Grad Credit
Credit cannot also be received for 15.735, ESD.40
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 and/or service. Class sessions employ cases to reinforce the key ideas. Topics include design thinking, product planning, identifying customer needs, concept generation, product architecture, industrial design, concept design, robust design, and green design practice. Enrollment limited; preference to students who register via Sloan Course Bidding.

S. Eppinger, W. P. Seering

15.784 Operations Laboratory
Prereq: None. Coreq: 15.761
G (Spring)
2-3-4 H-LEVEL Grad Credit

Provides an interactive learning experience in implementing operations improvement. Teams of 3-5 students act as consultants on operations engagements in small- to medium-sized Boston-area organizations. Class time focuses on project management, implementation issues for and examples from company settings (particularly small ones), and team report-outs and discussions. Organizations include small manufacturing companies as well as service organizations, such as hospitals and non-profits, providing a wide range of real operational problems in various environments.

D. B. Rosenfield, Z. Ton

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

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 (Fall)
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, such as how to deliver benefits to customers. Presents a framework for marketing analysis and enhances problem solving and decision-making abilities in these areas. Material relevant to understanding, managing, and integrating marketing concepts in managerial situations, from entrepreneurial ventures to large multinational firms and to consulting.

J. R. Hauser

15.812 Marketing Management
Prereq: None
U (Spring)
3-0-6
Credit cannot also be received for 15.732, 15.809, 15.810

Develops skills in marketing analysis and planning, and introduces key ideas and phenomena, such as how to deliver benefits to customers. Presents a framework for analysis and enhances problem solving and decision-making abilities in these areas. Material relevant to understanding, managing, and integrating marketing concepts in managerial situations, from entrepreneurial ventures to large multinational firms and to consulting. Primarily for undergraduate and non-MBA graduate students.

J. Zhang

15.818 Pricing
Prereq: None
G (Fall)
3-0-6
Credit cannot also be received for 15.726

Framework for understanding pricing strategies and analytics. Topics include economic value analysis, elasticities, customization, complementary products, pricing in platform markets, and anticipating competitive responses.

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 analyses suitable for qualitative data. Introduces new information-gathering methods in development at MIT.

**D. Prelec**

**15.822 Strategic Market Measurement**
Prereq: None
G (Fall; second half of term)
3-0-3
Project subject teaches students how to create, carry out, interpret, and analyze a market research questionnaire. Emphasis on discovering market structure and segmentation, but students can pursue other project applications. Includes a user-oriented treatment of multivariate analysis (factor analysis, multidimensional scaling, conjoint and cluster analysis).

**D. Prelec**

**15.828 Design and Marketing New Products**
Prereq: 15.809, 15.810 or 15.812
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

**Staff**

**15.830 Enterprise Management Lab**
Prereq: None. Coreq: 15.810, 15.761, or 15.900
G (Fall; IAP)
3-0-3
Lays the foundation for the Enterprise Management (EM Lab)Track by developing students’ ability to apply integrated management perspectives and practices in their roles within large organizations. Lectures, faculty mentors and cross-functional teams equip students with tools and knowledge to implement this track vision through classroom and project-based activities. Small teams of students deliver high quality deliverables working on live integrative projects focused on marketing, operations, and/or Strategy sourced from large organizations, both for-profit and not-for-profit. Management guest speakers from Marketing, Operations and Strategy discuss their interrelated activities. The overall goal is to promote an integrated mindset towards viewing and addressing business issues. Students must register for both the fall term and IAP. Restricted to MBA students in EM Track.

**S. Chatterjee**

**15.833 Business-to-Business Marketing**
Prereq: 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; first half of term)
3-0-6
Uses case studies to introduce economic tools to look systematically at marketing strategy. Topics include how to identify and leverage customer-based competitive advantages and how to use them to develop new ones.

**B. Wernerfelt**

**15.835 Entrepreneurial Marketing**
Prereq: None
G (Spring; second half of term)
3-0-3
Introduces economic tools to look systematically at entrepreneurial marketing. Topics include how to design products and marketing plans to maximize value for the customer-firm-supplier triad, how to evaluate innovative business models, and when to switch from investing in to monetizing of the customer base. Includes cases, guest speakers, and a project.

**B. Wernerfelt**

**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**

**15.840–15.843 Seminar in Marketing**
Prereq: 15.809, 15.810, or 15.812
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 life cycle. Introduces the fundamentals of brand architecture and management relevant for B2C and B2B Marketing. Examples from a variety of industries cover topics that include brand co-creation, diffusion, imitation, and authenticity. Explores theory and practice using cases and academic research. Also looks at the development of leadership branding.

**R. Gosline**
**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.  
Consult J. D. Sterman

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, H. Rahmandad, D. Keith

15.875 Applications of System Dynamics  
Prereq: 15.872  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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.  
J. D. Sterman

15.877 Professional Seminar in Sustainability  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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

15.878 Capstone Seminar in Sustainability  
Prereq: 15.913  
G (Spring; second half of term)  
3-0-3 H-LEVEL Grad Credit

Provides an opportunity for students to synthesize their coursework and experiences in sustainability. Involves deep intellectual exploration of fundamental debates in sustainability through classic and current readings that are essential for working in the field. Students link ideas to practice through an analysis of the industry they plan to enter after graduation.  
Staff

15.879 Research Seminar in System Dynamics  
Prereq: 15.872 and permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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 (Fall, Spring)  
3-0-6

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.  
D. Sull

15.902 Competitive Strategy  
Prereq: Permission of instructor  
G (Fall; second half of term)  
2-0-4 H-LEVEL Grad Credit  
Credit cannot also be received for 15.714

Focuses on developing skills and applying frameworks for the conduct of competitive and corporate strategy. Develops tools from earlier core courses, especially those from Strategic Marketing and Organizational Processes, and Economics. Emphasis is placed on the role of strategic commitments, social networks, strategic coherence, and adapting to environmental and technological change. Restricted to MIT Sloan Fellows in Innovation and Global Leadership.  
E. Zuckerman
15.903 Managing the Modern Organization: Organizational Economics and Corporate Strategy
Prereq: 15.010 or 15.311
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (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 and 15.311. Applies these frameworks to corporate strategy (i.e., the design and management of the multi-business firm) and extended enterprises (i.e., the design and management of multi-firm structures such as supply chains, alliances, joint ventures, and networks).
R. Gibbons

15.904 Advanced Strategic Management
Prereq: 15.900, or permission of instructor
G (Fall, Spring; second half of term)
3-0-3 H-LEVEL Grad Credit

Builds on 15.900 and 15.902 to explore key concepts that have shaped the field of strategic management and strategy consulting over the past several decades. Uses lectures, readings, case studies, and videos to review the evolution of strategy teaching, research, and practice; the role of randomness in strategic outcomes; the difference between strategic thinking versus planning; and 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)
3-0-9

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.
J. Utterback

15.910 Technology Strategy
Prereq: None
G (Spring; first half of term)
3-0-3

Establishes a solid foundation for students interested in formulating and executing a strategy for a technology-intensive business. Clarifies the interactions among competition, patterns of technological and market change, and the development of internal firm capabilities. Topics include appropriating the returns from innovation, the role of intellectual property, cooperative and open innovation, organization of R&D activities inside the firm, and multi-sided platform strategy. Key conceptual frameworks are linked to applications in a variety of industry and case settings.
P. Azoulay

15.911 Entrepreneurial Strategy
Prereq: None
G (Spring; second half of term)
6-0-3

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 entrepreneurship and entrepreneurs in economic growth.
S. Stern

15.912 Strategic Management of Innovation and Entrepreneurship
Prereq: 15.910, 15.911, or permission of instructor
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit

Provides a series of strategic frameworks for managing high-technology businesses with a particular focus on innovation and entrepreneurship, especially as it builds upon patterns of technological and market change, prior research on product development and new ventures, and the structure and development of organizational capabilities. Includes case analyses and simulations, as well as independent readings drawn from research in technological innovation, entrepreneurial management, and organizational theory.
Staff

15.913 Strategies for Sustainable Business
Prereq: None
G (Spring; first half of term)
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. In-class simulations and role-playing provide a robust foundation for understanding sustainability challenges. Cases analyze innovative strategies for sustainable businesses and organizations. Class discussions explore how sustainability is changing existing business models and market structures, how to develop sustainable management practices, and how firms can implement those practices successfully.
J. Jay, J. D. Sterman

15.914 Competitive Dynamics and Strategy: Winning in Technology Markets
Prereq: 15.872; 15.369, 15.567, 15.900, or 15.902
G (Spring)
2-0-7 H-LEVEL Grad Credit

Focuses on competitive strategy in technology-driven markets. Students acquire a portfolio of models of the signature dynamics in these markets and use the models in projects with participating companies to analyze technology markets, formulate competitive strategies, and illuminate the challenges of execution. Addresses issues critical for both established incumbents and new market entrants. Restricted to graduate students.
H. B. Weil

15.915 Laboratory for Sustainable Business
Prereq: 15.913
G (Spring)
4-0-2 H-LEVEL Grad Credit

Provides students with the opportunity to apply the concepts, theories, and tools of sustainability by working with a host organization on a real management project during the term. Classroom lectures and simulations complement project work to give greater depth in techniques for managing sustainability. Topics include start-up dynamics, certification programs, evaluating the environmental impact of products and services, and leveraging consumers to advance sustainability.
J. Jay, J. D. Sterman
15.928 The Sociology of Strategy (New)
Prereq: 15.342
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

Doctoral seminar in theory building for social scientists interested in economic sociology, organization theory, strategic management, and related fields. Builds skills for developing social scientific theory. Focuses on assessing and developing the relevance of sociological research for key questions in strategy research: what explains the relative performance of firms and the variety of their strategies for achieving performance. Students also develop skills in evaluating academic research in this area. Restricted to doctoral students.
E. Zuckerman

15.929 Identity and Action (New)
Prereq: 15.342
G (Spring)
3-0-9 H-LEVEL Grad Credit

Doctoral seminar in theory building for social scientists. Primary goal is to build skills for developing social scientific theory. Secondary goals are to review and integrate a broad array of ideas concerning the foundations of identity and its relation to action, and to suggest how such issues relate to a broader set of questions in the social sciences. Students learn that any account of action is based on ascribing desires, beliefs, and opportunities to specific actors, but such actors cannot be easily explained except as a result of action by prior actors. The focus of this course is around developing this paradox and providing a foundation for resolving it. Restricted to doctoral students.
E. Zuckerman

15.933 Strategic Opportunities in Energy
Prereq: 15.900 or permission of instructor
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)
3-0-3

Designed to help students deepen their understanding of leadership and increase self-awareness. They examine authentic leadership styles and create goals and a learning plan to develop their capabilities. They also participate in activities to strengthen their “leadership presence”—the ability to authentically connect with people’s hearts and minds. Students converse with leaders to learn from their insights, experiences, and advice. Limited to 15.
G. Schuck

15.949 Seminar in Strategy
Prereq: 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, 15.502 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.503 Special Seminar in Management
Prereq: Permission of instructor
G (IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.504 Special Seminar in Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.505–15.508 Special Seminar in Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.509–15.512 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer; second half of term)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.513, 15.514 Special Seminar in Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, IAP, Summer; first half of term)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.515–15.517 Special Seminar in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.518, 15.519 Special Seminar in Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

15.520–15.526 Special Seminar in Management
Prereq: Permission of instructor
G (IAP, Spring)
Units arranged
Can be repeated for credit

Group study of current topics related to management not otherwise included in curriculum. Coursework may continue into the following term.
Consult Sloan Educational Services
15.S30–15.S33 Special Distance Learning Seminar in Management
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, IAP, Spring, Summer)
Units arranged Can be repeated for credit

15.S35–15.S38 Special Distance Learning Seminar in Management
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.S40, 15.S41 Special Seminar in Management
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, Spring)
Units arranged [P/D/F] Can be repeated for credit

Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, IAP, Spring)
Units arranged Can be repeated for credit

15.S50–15.S54 Special Seminar in Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (IAP)
Units arranged [P/D/F] H-LEVEL Grad Credit Can be repeated for credit

Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (IAP)
Units arranged [P/D/F] H-LEVEL Grad Credit Can be repeated for credit

15.S60–15.S65 Special Seminar in Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit Can be repeated for credit

Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit Can be repeated for credit

15.S70–15.S75 Special Seminar in Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 Sloan Educational Services

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

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

Advanced work, special investigation or application of a management topic, on an individual basis, under faculty supervision. May include readings, conferences, laboratory and fieldwork, and reports. Projects require prior approval, as well as a written proposal and a final report.

M. Hanlon

15.952 Curricular Practical Training
Prereq: None
U (Fall, IAP, Spring)
0-1-0 [P/D/F] Can be repeated for credit

For Course 15 undergraduate students participating in management curriculum-related off-campus work experiences. Students must have an employment offer from a company or organization and must find a Sloan faculty supervisor before enrolling. Consult Sloan Undergraduate Education Office

M. Hanlon
15.960 Independent Study in Management
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] 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

Advanced work, special investigation or application of a management topic, on an individual basis, under faculty supervision. May include readings, conferences, laboratory and fieldwork, and reports. Projects require prior approval, as well as a written proposal and a final report. Consult Sloan Educational Services

15.962 Pre-Thesis Research
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Pre-thesis research conducted under faculty supervision; advance approval of project proposal required. Restricted to PhD students. Consult H. Ross

15.999 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 written deliverable. 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. Additional restrictions may apply. Consult Sloan Educational Services

15.THG Graduate Thesis
Prereq: Permission of instructor
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**

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td>6 subjects can be satisfied by 14.01 and 14.02 in the Departmental Program</td>
<td>6</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>can be satisfied by 6.041 and 18.06 in the Departmental Program</td>
<td>8</td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>can be satisfied by 15.301 in the Departmental Program</td>
<td>2</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).

<table>
<thead>
<tr>
<th>PLUS Departmental Program</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><strong>Required Subjects</strong></td>
<td>123</td>
</tr>
<tr>
<td>1.00 Introduction to Computers and Engineering Problem Solving, 12, REST; Calculus I (GIR)</td>
<td></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; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td>27–45</td>
</tr>
<tr>
<td>One of the following 4 subjects:</td>
<td></td>
</tr>
<tr>
<td>15.411 Finance Theory I, 9</td>
<td></td>
</tr>
<tr>
<td>15.812 Marketing Management, 9</td>
<td></td>
</tr>
<tr>
<td>15.766 Introduction to Operations Management, 9; 6.041*</td>
<td></td>
</tr>
<tr>
<td><strong>Concentration Subjects:</strong></td>
<td></td>
</tr>
<tr>
<td>Two to three additional subjects as specified in one of the following four concentrations:</td>
<td></td>
</tr>
</tbody>
</table>

| Departmental Program Units That Also Satisfy the GIRs | (60) |
| Unrestricted Electives | 72–90 |

| 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.
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
16.003 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

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.

D. L. Darmofal, H. Balakrishnan, O. de Weck, E.M. Greitzer, R. Radovitzky

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.

D. L. Darmofal, H. Balakrishnan, O. de Weck, R. Radovitzky, Z. S. Spakovszky

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

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.

H. Balakrishnan, O. de Weck, R. Radovitzky

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, D. Newman

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, D. Newman
CORE UNDERGRADUATE SUBJECTS

16.06 Principles of Automatic Control
Prereq: 16.004
U (Fall)
3-1-8
Introduction to design of feedback control systems. Properties and advantages of feedback systems. Time-domain and frequency-domain performance measures. Stability and degree of stability. Root locus method, Nyquist criterion, frequency-domain design, and some state space methods. Strong emphasis on the synthesis of classical controllers. Application to a variety of aerospace systems. Hands-on experiments using simple robotic systems.
J. P. How

16.07 Dynamics
Prereq: 16.004
U (Fall)
4-0-8
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.
W. W. Hoburg, S. E. Widnall

16.09 Statistics and Probability
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

MECHANICS AND PHYSICS OF FLUIDS

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 airflow 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)
Not offered regularly; consult department
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.
K. E. Willcox

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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Internal compressible flow and fundamentals of acoustics and aeroacoustic measurement 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, E.M. Greitzer, Q. Wang

16.13 Aerodynamics of Viscous Fluids
Prereq: 16.100, 16.110, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
M. Drela

MATERIALS AND STRUCTURES

16.20 Structural Mechanics
Prereq: 16.004
U (Spring)
5-0-7
P. A. Lagace

16.201 Topics in Materials and Structures
Prereq: Permission of department
U (Fall, IAP, Spring)
Not offered regularly; consult department
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.
K. E. Willcox
16.202 Manufacturing with Advanced Composite Materials
Prereq: None
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. Logace

16.221j Structural Dynamics and Vibrations
(Same subject as 1.581J, 2.060J)
Subject (Meets with 1.058)
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
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 linear algebra. Students taking graduate version complete additional assignments.

E. Kausel, J. K. Vandiver

16.223J Mechanics of Heterogeneous Materials
(Same subject as 2.076J)
Prereq: 2.002, 3.032, 16.20, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Mechanical behavior of heterogeneous materials such as thin-film microelectro-mechanical systems (MEMS) materials and advanced filamentary composites, with particular emphasis on laminated structural configurations. Anisotropic and crystallographic elasticity formulations. Structure, properties and mechanics of constituents such as films, substrates, active materials, fibers, and matrices including nano- and micro-scale constituents. Effective properties from constituent properties. Classical laminated plate theory for modeling structural behavior including extrinsic and intrinsic strains and stresses such as environmental effects. Introduction to buckling of plates and nonlinear (deformations) plate theory. Other issues in modeling heterogeneous materials such as fracture/failure of laminated structures.

B. L. Wardle, S.-G. Kim

16.225J Computational Mechanics of Materials
(Same subject as 2.099J)
Prereq: Permission of instructor, programming in either C++, C, or Fortran
G (Fall)
3-0-9 H-LEVEL Grad Credit
Formulation of numerical (finite element) methods for the analysis of the nonlinear continuum response of materials. The range of material behavior considered includes finite deformation elasticity and inelasticity. Numerical formulation and algorithms include variational formulation and variational constitutive updates; finite element discretization; constrained problems; time discretization and convergence analysis. Strong emphasis on the (parallel) computer implementation of algorithms in programming assignments. The application to real engineering applications and problems in engineering science are stressed throughout.

R. Radovitzky

16.230J Plates and Shells: Static and Dynamic Analysis
(Same subject as 2.081J)
Prereq: 2.071, 2.080J, or Permission of Instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 2.081J.

T. Sapsis

INFORMATION AND CONTROL ENGINEERING

16.30 Feedback Control Systems
(Subject meets with 16.30)
Prereq: 16.06 or 6.302
G (Fall)
3-1-8 H-LEVEL Grad Credit
Graduate-level version of 16.30; see description under 16.30. Includes additional homework questions, laboratory experiments, and a term project beyond 16.30 with a particular focus on the material associated with state-space realizations of MIMO transfer functions (matrices); MIMO zeros, controllability, and observability; stochastic processes and estimation; limitations on performance; design and analysis of dynamic output feedback controllers; and robustness of multivariable control systems.

S. Karaman

16.31 Topics in Control, Dynamics, and Automation
Prereq: Permission of department
U (Fall, IAP, Spring)
Not offered regularly; consult 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.

K. E. Willcox

16.322 Stochastic Estimation and Control
Prereq: 16.30; 6.041, 6.431, or 16.09
G (Fall)
3-0-9 H-LEVEL Grad Credit

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

16.333 Aircraft Stability and Control
Prereq: 16.31 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
E. Frazzoli

16.338J Dynamic Systems and Control
(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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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.
K. Cahoy, R. J. Hansman

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, 6.002, or 6.005
U (Spring)
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.
J. A. Shah

(Same subject as ESD.355J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Reading and discussion on issues in the engineering of software systems and software development project design. Includes the present state of software engineering, what has been tried in the past, what worked, what did not, and why. Topics may differ in each offering, but are chosen from the software process and life cycle; requirements and specifications; design principles; testing, formal analysis, and reviews; quality management and assessment; product and process metrics; COTS and reuse; evolution and maintenance; team organization and people management; and software engineering aspects of programming languages.
E. Modiano, D. Shah

16.36 Communication Systems and Networks
(Subject meets with 16.363)
Prereq: 16.004 or 6.003; 16.09 or 6.041
G (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. Students taking graduate version complete additional assignments.
E. H. Modiano

16.363 Communication Systems and Networks
(Subject meets with 16.36)
Prereq: 16.004 or 6.003; 16.09 or 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduces the fundamentals of digital communications and networking, focusing on the study of networks, including protocols, performance analysis, and queuing theory. Topics include elements of information theory, sampling and quantization, coding, modulation, signal detection and system performance in the presence of noise. Study of data networking includes multiple access, reliable packet transmission, routing and protocols of the internet. Concepts discussed in the context of aerospace communication systems: aircraft communications, satellite communications, and deep space communications. Students taking graduate version complete additional assignments.
E. H. Modiano

16.37J Data-Communication Networks
(Same subject as 6.263J)
Prereq: 6.041 or 18.313
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 6.263J.
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 2014–2015: G (Fall)
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: 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 Systems Engineering
(Subject meets with 16.453, ESD.773])
Prereq: None
U (Fall)
3-3-6
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.
L. A. Stirling

16.401 Topics in Communication and Software
Prereq: Permission of department
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Provides credit for student work on undergraduate-level material in communications and/or software outside of regularly scheduled subjects. Intended for 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.
K. E. Willcox

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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 6.0002
U (Fall)
4-0-8
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. Students taking graduate version complete additional assignments.
J. A. Shah

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 Engineering Design Points.
B. C. Williams

16.413 Principles of Autonomy and Decision Making
(Subject meets with 16.410)
Prereq: 1.00, 6.0002, 6.01, or permission of instructor
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.
J. A. Shah

16.420 Planning Under Uncertainty
Prereq: 16.413
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.
Staff
16.422J Human Supervisory Control of Automated Systems  
(Same subject as ESD.774J)  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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 underwater vehicles, robotics, and industrial systems.  

J. A. Shah

16.423J Aerospace Biomedical and Life Support Engineering  
(Same subject as ESD.65J, HST.515J)  
Prereq: 16.400, 16.06, 16.060, or permission of instructor  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
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

16.430J 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  
G (Spring)  
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.  

L. Young, C. Oman

(Same subject as STS.470J)  
Prereq: 16.400, 16.453, or permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  

Examines relationships between human-occupied, remotely operated, and autonomous systems in the extreme environments of the deep ocean, air, and spaceflight. Uses a mix of historical, sociological, and engineering perspectives, examines different forms of human presence in each type of system and how they relate to each other in time and space, including: physical hand-on-the stick flying, supervisory control, remote operation, systems design, programming autonomous systems, management. Emphasis on networks of people interacting in networks of organizations through networks of machines.  

D. A. Mindell

16.453J Human Factors Engineering  
(Same subject as ESD.773J)  
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.  

L. A. Stirling

16.456J Biomedical Signal and Image Processing  
(Same subject as 6.555J, HST.582J)  
Prereq: 6.003, 2.004, 16.004, or 18.085  
G (Spring)  
3-4-5 H-LEVEL Grad Credit  

See description under subject HST.582J. J. Greenberg, E. Adalsteinsson, W. Wells

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.  

Staff

16.470J Statistical Methods in Experimental Design  
(Same subject as ESD.756J)  
Prereq: 6.041, 16.09, or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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.  

L. A. Stirling

16.475J Human-Computer Interface Design Colloquium  
(Same subject as ESD.775J)  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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.

**Staff**

**PROPULSION AND ENERGY CONVERSION**

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

Presents aerospace propulsive devices as systems, with functional requirements and engineering and environmental limitations. Requirements and limitations that constrain design choices. Both air-breathing and rocket engines covered, at a level which enables rational integration of the propulsive system into an overall vehicle design. Mission analysis, fundamental performance relations, and exemplary design solutions presented.

*Z. Barrett*

16.511 Aircraft Engines and Gas Turbines
Prereq: 16.50 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Covers fundamentals of jet propulsion with a focus on understanding and mitigating environmental impacts. Examines performance and characteristics of aircraft engines as determined by thermodynamic and fluid mechanic behavior of components: inlets, compressors, combustors, turbines, and nozzles. Discusses various engine types and suitability for different missions. Significant attention to environmental issues in engine design, including combustion, emissions, air quality, climate change, and noise. Also covers environmental trade spaces in engine design.

*A. Spokovszky*

16.512 Rocket Propulsion
Prereq: 16.50 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit


*P. C. Lozano*

16.522 Space Propulsion
Prereq: 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.

*E. M. Greitzer, Q. Wang*

16.55 Ionized Gases
Prereq: 8.03
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit


*P. A. Lozano*

**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 Marie Stuppard, UROP staff coordinator.

*Staff*

16.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject
(Offered 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)
0-0-1 [P/D/F]
See description under subject 2.EPE.

*Staff*

16.EPW UPOP Engineering Practice Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (Fall, IAP)
1-0-0 [P/D/F]
See description under subject 2.EPW.

*Staff*

16.S685 Special Subject in Aeronautics and Astronautics
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
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. Prior approval required.

*M. A. Stuppard*
16.67A Project in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Opportunity to work on projects related to aerospace engineering outside the department.
Requires prior approval.
Consult M. A. Stuppard

16.68 Topics in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Opportunity for study or laboratory project work not available elsewhere in the curriculum. Topics selected in consultation with the instructor.
Consult M. A. Stuppard

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

16.683 Seminar in Aeronautics and Astronautics
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Speakers from campus and industry discuss current activities and advances in aeronautics and astronautics. Restricted to Course 16 students.
Consult M. A. Stuppard

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

16.69 Aeronautics Seminar
Prereq: None
U (Fall, IAP, Spring)
Can be repeated for credit
Speakers from campus and industry discuss current activities and advances in aeronautics and astronautics. Restricted to Course 16 students.
Consult M. A. Stuppard

16.707J The History of Aviation
(Same subject as STS.467J)
Prereq: Permission of Instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject STS.467J.
D. Mindell
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.

16.75j Transportation and the Environment
Prereq: Chemistry (GIR); 1.060, 2.006, 10.301, 16.004, or permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Addresses environmental challenges facing transportation in the 21st century, focusing on climate change and air quality. Covers air, sea, road and rail transportation and associated impacts. Introduces the fundamentals of combustion and emissions. Considers in depth the impacts of transportation emissions on atmospheric composition (from local to global scale) relevant to both climate change and human health. Environmental impact metrics and cost-benefit analysis techniques are discussed and illustrated with policy examples. Students assess alternative transportation fuels and analyze the impacts of electric vehicles.
S. Barrett

16.77j Air Traffic Control
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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

16.76j 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

16.76j Air Transportation Operations Research
(Same subject as 1.233J)
Prereq: 16.71, 6.431, 15.093, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Presents a unified view of advanced quantitative analysis and optimization techniques applied to the air transportation sector. Considers the problem of operating and managing the aviation sector from the perspectives of the system operators (e.g., the FAA), the airlines, and the resultant impacts on the end-users (the passengers). Explores models and optimization approaches to system-level problems, airline schedule planning problems, and airline management challenges. Term paper required.
H. Balakrishnan, C. Barnhart, P. P. Belobaba

16.767 Introduction to Airline Transport Aircraft Systems and Automation
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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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

16.82j Flight Vehicle Engineering
Prereq: Permission of instructor
U (Fall)
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
comprises 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.
M. Drela, R. J. Hansman

16.821 Flight Vehicle Development
Prereq: Permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
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.
M. Drela, R. J. Hansman

16.83J Space Systems Engineering
(Same subject as 12.43J)
Prereq: Permission of instructor
U (Spring)
3-3-6
Design of a complete space system, including systems analysis, trajectory analysis, entry dynamics, propulsion and power systems, structural design, avionics, thermal and environmental control, human factors, support systems, and weight and cost estimates. Students participate in teams, each responsible for an integrated vehicle design, providing experience in project organization and interaction between disciplines. Includes several aspects of team communication including three formal presentations, informal progress reports, colleague assessments, and written reports. Offered alternate Fall and Spring terms.
K. Cahoy

16.831J Space Systems Development
(Same subject as 12.431J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-10-6 Institute LAB
Students build a space system, focusing on refinement of sub-system designs and fabrica-
tion 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.
K. Cahoy

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, life-cycle 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.
N. G. Leveson

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.
J. A. Hoffman, K. Cahoy

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
Prereq: None
G (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.
E. M. Murman

16.855J Systems Architecting Applied to Enterprises
(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, 16.861, ESD.71)
(Subject meets with ESD.710)
Prereq: 1.145 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject ESD.71.
R. de Neufville

16.863J System Safety Concepts
(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**

**16.885 Aircraft Systems Engineering**
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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 Architecting**
(Same subject as ESD.351J)
Prereq: Permission of instructor
G (Fall)
3-2-7 H-LEVEL Grad Credit

Addresses the architecting of air transportation systems. Focuses on the conceptual phase of product definition including technical, economic, market, environmental, regulatory, legal, manufacturing, and societal factors. Centers on a realistic system case study and includes a number of lectures from industry and government. Past examples include the Very Large Transport Aircraft, a Supersonic Business Jet and a Next Generation Cargo System. Identifies the critical system level issues and analyzes them in depth via student team projects and individual assignments. Overall goal is to produce a business plan and a system specifications document that can be used to assess candidate systems.

**R. J. Hansman**

**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 2014–2015: Not offered
Acad Year 2015–2016: 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.

**J. A. Hoffman**

**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.

**Staff**

**16.895J Engineering Apollo: The Moon Project as a Complex System**
(Same subject as ESD.30J, STS.471J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
4-0-8 H-LEVEL Grad Credit

See description under subject STS.471J.

**D. Mindell**

**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.

**Q. Wang, K. E. Willcox**

**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.

**Q. Wang, J. K. White**

**16.930 Advanced Topics in Numerical Methods for Partial Differential Equations**
Prereq: 16.920
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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.

Staff

16.940 Numerical Methods for Stochastic Modeling and Inference
Prereq: 16.920, 6.431; or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit


Y. M. Marzouk

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.

P. C. Lozano

16.980 Advanced Project
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.981 Advanced Project
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Not offered regularly; consult department
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Study, original investigation, or lab project work by qualified students. Topics selected in consultation with instructor. Prior approval required.

Consult M. A. Stuppard

16.984 Seminar
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
2-0-0 [P/D/F]
Can be repeated for credit

Discussion of current interest topics by staff and guest speakers. Prior approval required. Restricted to Course 16 students.

Consult M. A. Stuppard

16.985J 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 15.792J.

D. B. Rosenfield

16.99 MATLAB Skills for Aeronautics and Astronautics (New)
Prereq: None
U (Fall; first half of term)
1-0-2 [P/D/F]

Introduction to basic MATLAB skills in programming, analysis, and plotting. Recommended for sophomores without previous MATLAB experience. Preference to Course 16 majors.

K. E. Willcox

16.999 Teaching in Aeronautics and Astronautics
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit

For qualified students interested in gaining teaching experience. Classroom, tutorial, or laboratory teaching under the supervision of a faculty member. Enrollment limited by availability of suitable teaching assignments. Consult department.

P. C. Lozano

16.5198 Advanced Special Subject in Mechanics and Physics of Fluids
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.5199 Advanced Special Subject in Mechanics and Physics of Fluids
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required.

Consult P. C. Lozano

16.5298 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.5299 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required.

Consult P. C. Lozano

16.980 Advanced Project
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.981 Advanced Project
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Not offered regularly; consult department
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Study, original investigation, or lab project work by qualified students. Topics selected in consultation with instructor. Prior approval required.

Consult M. A. Stuppard

16.984 Seminar
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
2-0-0 [P/D/F]
Can be repeated for credit

Discussion of current interest topics by staff and guest speakers. Prior approval required. Restricted to Course 16 students.

Consult M. A. Stuppard

16.985J 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 15.792J.

D. B. Rosenfield

16.99 MATLAB Skills for Aeronautics and Astronautics (New)
Prereq: None
U (Fall; first half of term)
1-0-2 [P/D/F]

Introduction to basic MATLAB skills in programming, analysis, and plotting. Recommended for sophomores without previous MATLAB experience. Preference to Course 16 majors.

K. E. Willcox

16.999 Teaching in Aeronautics and Astronautics
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit

For qualified students interested in gaining teaching experience. Classroom, tutorial, or laboratory teaching under the supervision of a faculty member. Enrollment limited by availability of suitable teaching assignments. Consult department.

P. C. Lozano

16.5198 Advanced Special Subject in Mechanics and Physics of Fluids
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.5199 Advanced Special Subject in Mechanics and Physics of Fluids
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required.

Consult P. C. Lozano

16.5298 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.5299 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required.

Consult P. C. Lozano

16.980 Advanced Project
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.981 Advanced Project
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Not offered regularly; consult department
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Study, original investigation, or lab project work by qualified students. Topics selected in consultation with instructor. Prior approval required.

Consult M. A. Stuppard

16.984 Seminar
Prereq: None
G (Fall, Spring)
Not offered regularly; consult department
2-0-0 [P/D/F]
Can be repeated for credit

Discussion of current interest topics by staff and guest speakers. Prior approval required. Restricted to Course 16 students.

Consult M. A. Stuppard

16.985J 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 15.792J.

D. B. Rosenfield

16.99 MATLAB Skills for Aeronautics and Astronautics (New)
Prereq: None
U (Fall; first half of term)
1-0-2 [P/D/F]

Introduction to basic MATLAB skills in programming, analysis, and plotting. Recommended for sophomores without previous MATLAB experience. Preference to Course 16 majors.

K. E. Willcox

16.999 Teaching in Aeronautics and Astronautics
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit

For qualified students interested in gaining teaching experience. Classroom, tutorial, or laboratory teaching under the supervision of a faculty member. Enrollment limited by availability of suitable teaching assignments. Consult department.

P. C. Lozano

16.5198 Advanced Special Subject in Mechanics and Physics of Fluids
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.5199 Advanced Special Subject in Mechanics and Physics of Fluids
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required.

Consult P. C. Lozano

16.5298 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

16.5299 Advanced Special Subject in Materials and Structures
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required.

Consult P. C. Lozano
16.S398 Advanced Special Subject in Information and Control
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
16.S399 Advanced Special Subject in Information and Control
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required. Consult P. C. Lozano

16.S498 Advanced Special Subject in Humans and Automation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
16.S499 Advanced Special Subject in Humans and Automation
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required. Consult P. C. Lozano

16.S598 Advanced Special Subject in Propulsion and Energy Conversion
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
16.S599 Advanced Special Subject in Propulsion and Energy Conversion
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required. Consult P. C. Lozano

16.S798 Advanced Special Subject in Flight Transportation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
16.S799 Advanced Special Subject in Flight Transportation
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required. Consult P. C. Lozano

16.S898 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
16.S899 Advanced Special Subject in Aerospace Systems
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required. Consult P. C. Lozano

16.S948 Advanced Special Subject in Computation
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
16.S949 Advanced Special Subject in Computation
Prereq: Permission of instructor
G (Fall, Spring)
Not offered regularly; consult department
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. Prior approval required. Consult P. C. Lozano

16.S982 Advanced Special Subject
Prereq: Permission of department
G (Fall, Spring, Summer)
Not offered regularly; consult department
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
16.S983 Advanced Special Subject
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
Organized lecture or laboratory subject consisting of material not available in regularly scheduled subjects. Prior approval required. Consult P. C. Lozano
### Bachelor of Science in Aerospace Engineering/Course 16

#### 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 from among 6.0001/6.0002; 6.041; 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 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). 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) |
|--------------------------------------------------|----------|
| **Units**                                        |          |
| Departmental Core                                | 108      |
| 16.001 Unified Engineering I, 12, REST; Physics II (GIR), 18.03*, Chemistry (GIR) |          |
| 16.002 Unified Engineering II, 12; Physics II (GIR), 18.03*, Chemistry (GIR) |          |
| 16.003 Unified Engineering III, 12; 16.001, 16.002 |          |
| 16.004 Unified Engineering IV, 12; 16.001, 16.002 |          |
| 6.0001 Introduction to Computer Science Programming in Python |          |
| 6.0002 Introduction to Computational Thinking and Data Science, 6; 6.0001* |          |
| 16.06 Principles of Automatic Control, 12; 16.004 |          |
| 16.07 Dynamics, 12; 16.004 |          |
| 16.09 Statistics and Probability, 12; Calculus II (GIR) or 6.041 Probabilistic Systems Analysis, 12, REST; Calculus II (GIR) |          |
| 18.03 Differential Equations, 12, REST; Calculus II (GIR) or 18.034 Differential Equations, 12, REST; Calculus II (GIR) |          |

#### Professional Area Subjects

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. For students who wish to complete an option in aerospace information technology, 36 of the 48 units must come from subjects other than 16.100, 16.20, 16.50, or 16.90.

- **Fluid Mechanics**: 16.100 Aerodynamics, 12; 16.004
- **Materials and Structures**: 16.20 Structural Mechanics, 12; 16.004
- **Propulsion**: 16.50 Aerospace Propulsion, 12; 16.004*
- **Computational Tools**: 16.90 Computational Methods in Aerospace Engineering, 12; 16.004*; 16.09*
- **Estimation and Control**: 16.30 Feedback Control Systems, 12; 16.06*
- **Computer Systems**: 6.111 Introductory Digital Systems Laboratory, 12, LAB; 16.004*
- **Communications Systems**: 16.36 Communication Systems and Networks, 12; 16.004*, 16.09*
- **Humans and Automation**: 16.400 Human Systems Engineering, 12
- **Laboratory and Capstone Subjects**: 16.410 Principles of Autonomy and Decision Making, 12; 6.0002*
- **Flights**
  - 16.821 Flight Vehicle Development, 18, LAB, CI-M; permission of instructor
  - 16.831J Space Systems Development, 18, LAB, CI-M; permission of instructor

One of the following two subjects:
- 16.82 Flight Vehicle Engineering, 12, CI-M; permission of instructor
- 16.831 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
  - Flight Vehicle Development
- 16.821 Flight Vehicle Development, 18, LAB, CI-M; permission of instructor
- 16.831J Space Systems Development, 18, LAB, CI-M; permission of instructor
<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
</tbody>
</table>

**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.

(1) The combination of 6.0001 and 6.0002 counts as a REST subject.

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 as Recommended by the Department of Aeronautics and Astronautics/Course 16-ENG

General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</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 from among 6.0001/6.0002; 16.001 and 18.03 or 18.034 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

<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>Departmental Core</td>
</tr>
<tr>
<td>16.001 Unified Engineering I, 12, REST; Physics II (GIR), 18.03*; Chemistry (GIR)</td>
</tr>
<tr>
<td>16.002 Unified Engineering II, 12; Physics II (GIR); 18.03*; Chemistry (GIR)</td>
</tr>
<tr>
<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>
</tr>
<tr>
<td>6.0001 Introduction to Computer Science Programming in Python, 6</td>
</tr>
<tr>
<td>6.0002 Introduction to Computational Thinking and Data Science, 6; 6.0001**</td>
</tr>
<tr>
<td>18.03 Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>or 18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
</tr>
<tr>
<td>16.06 Principles of Automatic Control, 12; 16.004</td>
</tr>
<tr>
<td>or 16.07 Dynamics, 12; 16.004</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 4.2 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:
- 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* | 6     |
- 16.622 Experimental Projects II, 12, LAB, CI‑M; 16.621 | 12     |
| or Flight Vehicle Development |  | |
- 16.821 Flight Vehicle Development, 18, LAB, CI‑M; 16.82 | 18     |
| or Space Systems Development |  | |
- 16.831J Space Systems Development, 18, LAB, CI‑M; permission of instructor | 18     |

Departmental Program Units That Also Satisfy the GIRs | (36) |

Unrestricted Electives | 48 |

Total Units Beyond the GIRs Required for SB Degree | 198 |

Notes

* Alternate prerequisites and corequisites are listed in the subject description.
** The combination of 6.0001 and 6.0002 counts as a REST subject.

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
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Systematic examination of selected issues in political philosophy. Topic changes each year and subject may be taken repeatedly with permission of instructor.
L. Stanczyk

17.006 Feminist Thought
(Subject meets with 17.007, 24.237J, WGS.301J)
Prereq: Permission of instructor, based on previous coursework
G (Fall)
3-0-9 H-LEVEL Grad Credit
17.007J Feminist Thought
(Same subject as 24.237J, WGS.301J)
(Subject meets with 17.006)
Prereq: None
U (Fall)
3-0-9 HASS-H
Analyzes theories of gender and politics, especially ideologies of gender and their construction; definitions of public and private spheres; gender issues in citizenship, the development of the welfare state, experiences of war and revolution, class formation, and the politics of sexuality. Graduate students are expected to pursue the subject in greater depth through reading and individual research.
S. Haslanger

17.01J Justice
(Same subject as 24.04J)
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H
See description under subject 24.04J.
K. Gallagher

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
See description under subject 24.235J.
J. Markovits

17.03 Introduction to Political Thought
Prereq: None
U (Fall)
3-0-9 HASS-S
Examines major texts in the history of political thought and considers how they contribute to a broader conversation about freedom, equality, democracy, rights, and the role of politics in human life. Philosophers include Plato, Aristotle, Machiavelli, Hobbes, Locke, Rousseau, Marx, Tocqueville, and Mill.
K. Gallagher

17.035J Libertarianism in History (New)
(Same subject as 21H.181J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
See description under subject 21H.181J.
M. Ghachem

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
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-S
Provides an introduction to the politics of international economic relations, including a range of analytical “lenses” to view the global economy. Examines the politics of trade policy, international monetary and financial relations, financial crises, foreign direct investment, third-world development and transition economies, the debate over “globalization,” and international financial crime.
D. Singer

17.145 Political Economy of Technology and Development in Latin America
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S; CI-H
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 2014–2015: G (Spring)
Acad Year 2015–2016: 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
17.150 The American Political Economy in Comparative Perspective
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

Examines the origins and impact of key features of the American political economy in comparative perspective. Considers a range of political-economic topics, including labor markets, finance, taxation, social policy, and the role of money and organized interests. Highlights the distinctive aspects of American political economy in terms of both institutional structure and substantive outcomes (such as poverty and inequality) by comparing the US with other nations, particularly other rich democracies.

K. Thelen, D. Caughey

17.154 Varieties of Capitalism and Social Inequality
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

Focuses on the advanced democracies of Europe, the United States, and Japan. Explores trajectories of change that bear on issues of economic and social inequality. Examines whether contemporary trends (globalization, deindustrialization) undermine institutional arrangements that once reconciled economic efficiency with high levels of social equality. Considers the extent to which existing theoretical frameworks capture cross-national variation in the dynamics of redistribution in these societies.

K. Thelen, P. Hall

17.156 Welfare and Capitalism in Western Europe
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 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

17.172 Institutionalism and Institutional Change
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

Examines several strands of theorizing on the role of institutions in politics and on the dynamics through which institutions evolve and change over time. Explores the core theoretical assumptions that underpin various approaches, assesses their relative strengths and weaknesses, and considers whether distinct lines of theorizing should be considered complementary or competing.

K. Thelen

17.176J Economic Development and Policy Analysis
(Same subject as 11.491J)
Prereq: 11.701
G (Fall)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

See description under subject 11.491J.

Staff

17.178 Political Economy of Institutions and Development
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 (Fall)
3-0-9 HASS-S

17.182 Sustainability: Political Economy, Science, and Policy
(Subject meets with 17.181)
Prereq: None
G (Fall)
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. Choucri

17.195 Globalization
(Subject meets with 17.196)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S

17.196 Globalization
(Subject meets with 17.195)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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
17.198 Current Topics in Comparative Political Economy (New)
Prereq: Permission of Instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Analyzes and compares approaches in current political economy literature. Weekly topics are selected by instructor and participants. Examples include the organization of interests, industrial policy, growth and inequality, resource "curse", late development. Topics vary each year depending on the research interests of the seminar participants. The subject is for graduate students in social sciences with previous coursework in political economy.
S. Berger

AMERICAN POLITICS

17.20 Introduction to the American Political Process
Prereq: None
U (Spring)
3-0-9 HASS-S; CI-H
Provides a substantive overview of US politics and an introduction to the discipline of political science. Surveys the institutional foundations of US politics as well as the activities of political elites, organizations, and ordinary citizens. Explores the application of general political science concepts and analytic frameworks to specific episodes and phenomena in US politics. Enrollment limited
D. Caughey

17.200 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. Warshaw

17.245 Constitutional Law: Structures of Power and Individual Rights
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S
Examines American constitutional law in historical and modern context. Focuses closely on the constitutional text and Supreme Court case law. Explores the allocation of decision-making authority among government institutions, including the distribution of power across the branches of the federal government and between the federal and state governments. Examines the guarantees of individual rights and liberties stemming from the due process, equal protection, and other clauses in the Bill of Rights and post Civil War amendments.
C. Warshaw

17.249J Law and Society
(Same subject as 11.163J, 21A.455J)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-S
See description under subject 21A.455J.
S. Silbey

17.251 Congress and the American Political System I
Prereq: 17.251 or permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 HASS-S

17.262 Congress and the American Political System II
(Subject meets with 17.261)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 through reading and individual research.
C. Stewart

17.263 Electoral Politics, Public Opinion, and Democracy
Prereq: Permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S
Considers the role of elections in American politics. Issues explored include empirical and theoretical models of electoral competition, the effect of elections on public policy, and proposals to improve elections. Special emphasis is given to mass voting behavior, political parties, the media, and campaign finance. Subject focuses on US elections, but provides some contrasts with other countries, especially the United Kingdom. One subject in American Politics or relevant background required.
A. Berinsky

17.264 Electoral Politics
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

D. Caughey

17.265 Public Opinion and American Democracy
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-S
Introduces students to public opinion in politics and public policymaking. Surveys theories of political psychology and political behavior. Examines empirical research on public understanding of and attitudes toward important issues, including war, economic and social policies, and moral questions.

A. Berinsky

17.266 Public Opinion
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit
Provides an introduction to the scholarly literature devoted to public opinion. Surveys the major theoretical approaches and empirical research in the field of political behavior. Topics include mass-elite relations, racial politics, political ideology, public opinion and war, public opinion and public policy and media effects. Primarily focuses on American public opinion, though research on comparative public opinion is also covered.

A. Berinsky

17.267 Democracy in America
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S
Examines the functioning of democracy in the US beginning with the theoretical foundations of democratic representation. Explores how the views of the public influence policy making. Examines factors, such as malapportionment, that lead to non-majoritarian outcomes. Reviews evidence on how well policy outcomes reflect public opinion, and whether certain groups are over or under-represented in the policy process. Discusses reforms that might make our democracy more responsive to the American public.

C. Warshaw

17.270 American Political Development
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Examines the evolution of American national political processes over time: how political culture, governing institutions, and structures of political linkage (parties and organized interests) shape political conflict and public policy. Topics include the evolution of electoral politics and the party system, eras of political reform and state expansion (Populist, Progressive, New Deal, and Great Society), major wars and their effects, and the adaptation of government institutions to crisis and complexity in society and in the economy. Open to undergraduates with permission of instructor.

D. Caughey

17.275 Public Opinion Research Design and Training Seminar (New)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S
Studies the basic skills required to design, use, and interpret opinion surveys and survey experiments. Acts as both a reading subject on survey analysis and a practicum on collecting and analyzing observational and experimental survey data. Culminates in a group project involving a survey experiment on a particular topic chosen by the class and the instructor.

A. Berinsky

17.276 Public Opinion Research Training Lab
Prereq: 17.800, 17.266; or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Follows 17.266. Offers practical training in public opinion research and provides students with an opportunity to conduct their own survey research. As a group, students design a national sample survey and field the survey. Students analyze the survey results and examine literatures related to the content of the survey. Ideal for second and third year PhD students and advanced undergraduates, though others are welcome.

A. Berinsky, A. Campbell

17.28J The War at Home: American Politics and Society in Wartime
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
Examines the relationship between war and domestic politics in the US since the start of 20th century. Students engage in historical and social scientific research to analyze the ways that overseas military commitments shaped US political institutions, and how domestic politics has in turn structured US engagements abroad. Moving chronologically from World War I to the Iraq War, subject draws on materials across the disciplines, including political documents, opinion polls, legal decisions, and products of American popular culture.

A. Berinsky, C. Capozzola

PUBL IC POL ICY

17.30J Making Public Policy
(Same subject as 11.002J)
Prereq: None
U (Fall)
4-0-8 HASS-S; CI-H
See description under subject 11.002J.

J. Layzer, C. Warshaw

17.303J Methods of Policy Analysis
(Same subject as 11.003J)
Prereq: 11.002J; Coreq: 14.01
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
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
Examines US policymaking 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 policymaking institutions and their roles in settling controversial policy questions. Fall term focuses on development of representative policies in the US, such as pollution controls, biotechnical engineering, and telecommunications. Selection and participation in Washington Summer Internship program...
required. Fulfills undergraduate public policy requirement in the major and minor.

C. Stewart

17.309J Science, Technology, and Public Policy
(Same subject as ESD.082J, STS.082J)
(Subject meets with 17.310J, ESD.103J, STS.482J)
Prereq: None
U (Fall)
4-0-8 HASS-S; 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. Meets with 17.310 when offered concurrently. Limited to 18.

K. Oye

17.310J Science, Technology, and Public Policy
(Same subject as ESD.103J, STS.482J)
(Subject meets with 17.309J, ESD.082J, STS.082J)
Prereq: Permission of instructor
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. Meets with 17.309 when offered concurrently.

K. Oye

17.315 Health Policy
Prereq: None
U (Spring)
4-0-8 HASS-S

Analyzes the health policy problems facing America including adequate access to care, the control of health care costs, and the encouragement of medical advances. Considers market and regulatory alternatives as well as international models including Canadian, Swedish, British, and German arrangements. Emphasis on historical development, interest group behavior, public opinion, and organizational influences in shaping and implementing policy.

A. Campbell

17.317 US Social Policy
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
4-0-8 HASS-S

Explores historical development and contemporary politics of the American welfare state. Examines interactions among political institutions, elites, the media, and the mass public. Emphasis on reciprocal relationship between policy designs and public opinion/political action. Investigates broad spectrum of government policies that shape well-being, opportunity and political influence, including welfare, social security, health care, education, and tax policy.

A. Campbell

17.320 Social Policy (New)
Prereq: Permission of Instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

Examines the politics of social policy in comparative perspective. Empirical and theoretical overview of the origins, development, and future of social provision in industrialized countries, in the context of broader political and historical trends. Examines concepts such as social citizenship, risk sharing, de-commodification, and welfare regimes, and the challenges of globalization, neo-liberalism, and demographic change. Topics include pensions, health care, poverty alleviation, and family policy. Combines classic work and research frontiers.

A. Campbell

17.33 Building a Better World
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
4-0-8 HASS-S; CI-H

Explores today’s key policy challenges, including economic development (in both rich and poor countries), state-building, corruption and the rule of law, the provision of basic public services, education, regulation of psychotropic drugs, management of scarce natural resources, and criminal justice. 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 significant practical component and extensive work in small groups. Limited to 18 per section.

C. Lawson

17.391J Human Rights in Theory and Practice
(Same subject as 11.164J)
(Subject meets with 11.497)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
2-0-10 HASS-S

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

See description under subject 1.801J.

N. Ashford, C. Caldart

17.397J Energy Decisions, Markets, and Policies
(Same subject as 11.161J, 14.43J, 15.031J, 21A.415J)
Prereq: 14.01, 15.016, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S

See description under subject 15.031J.

D. Lessard, R. Schmalensee, S. Silbey, C. Warshaw

17.398J Energy Policy for a Sustainable Future
(Same subject as 11.369J)
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

See description under subject 11.369J.

Staff

INTERNATIONAL RELATIONS/SECURITY STUDIES

International Relations

17.40 American Foreign Policy: Past, Present, and Future
Prereq: None
U (Fall)
3-0-9 HASS-S; CI-H

Reasons for America’s past wars and interventions. Consequences of American policies. Evaluation of these consequences for the US and the world. History covered includes World
Wars I and II, the Korean and Indochina wars, the Cuban Missile Crisis and current conflicts, including those in 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

17.406 Seminar on Politics and Conflicts in the Middle East
(Subject meets with 17.405)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
Credit cannot also be received for 17.408

17.408 Chinese Foreign Policy
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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. Meets with 17.407 when offered concurrently.

M. T. Fravel

17.41 Introduction to International Relations (New)
Prereq: None
U (Fall)
3-0-9 HASS-S; CI-H

Provides an introduction to the causes of international conflict and cooperation. Topics include war initiation, crisis bargaining, international terrorism, nuclear strategy, interstate economic relations, economic growth, international law, human rights, and environmental politics.

R. Nielsen

17.410 Globalization, Migration, and International Relations
(Subject meets with 17.411)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

17.411 Globalization, Migration, and International Relations
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S

Tracing the evolution of international interactions, subject examines the dimensions of globalization in terms of scale and scope. Includes international environmental issues, impacts and expansion of human activities, and the potential implications for global and national policy. Linkages among individuals, nation-states, transnational organizations and firms, international systems, and the global environment. Special focus on models of globalization, challenges of sustainable development, and on evolving types. Institutional responses to globalization and global change. 17.411 fulfills undergraduate public policy requirement in the major and minor. Students taking the graduate version are expected to explore the subject in greater depth through reading and individual research.

N. Choucri

17.418 Field Seminar in International Relations Theory
Prereq: Permission of instructor
G (Fall)
3-0-9 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. Fravel, V. Narang

17.42 Causes and Prevention of War
Prereq: None
U (Spring)
4-0-8 HASS-S; CI-H

Examines the causes of war, with a focus on practical measures to prevent and control war. Topics include causes and consequences of miscalculation 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 Middle East wars, and the Peloponnesian War.

S. Van Evera

17.420 Advances in International Relations Theory
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

Critical analysis of competing 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 2014–2015: Not offered
Acad Year 2015–2016: 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 pressure, and perspectives and structural views of power relations. Examines interaction of politics and economics on international trade, capital flows, foreign investment, intellectual 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 (Spring)  
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 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
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.  
R. Nielsen

17.428 American Foreign Policy: Theory and Method  
Prereq: Permission of instructor  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
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, historicography of American foreign policy, central historical episodes including the two World Wars and the Cold War, case study methodology, and historical investigative methods. Open to undergraduates by permission of instructor.  
S. Van Evera

17.430 Research Seminar in International Relations  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 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 2014–2015: Not offered  
Acad Year 2015–2016: 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 2014–2015: Not offered  
Acad Year 2015–2016: U (Spring)  
3-0-9 HASS-S  
17.434 International Relations of East Asia  
(Subject meets with 17.433)  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
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  
G (Spring)  
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

17.441 International Politics and Climate Change  
(Subject meets with 17.442)  
Prereq: None  
Acad Year 2014–2015: U (Spring)  
Acad Year 2015–2016: Not offered  
3-0-9 HASS-S  
17.442 International Politics and Climate Change  
(Subject meets with 17.441)  
Prereq: None  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: 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. Concludes by addressing the question of what is next for theory and policy. Students taking graduate version complete additional assignments.  
N. Choucri

17.445 International Relations Theory in the Cyber Age  
(Subject meets with 17.446)  
Prereq: None  
Acad Year 2014–2015: U (Fall)  
Acad Year 2015–2016: Not offered  
3-0-9 HASS-S  
17.446 International Relations Theory in the Cyber Age  
(Subject meets with 17.445)  
Prereq: Permission of instructor  
Acad Year 2014–2015: G (Fall)  
Acad Year 2015–2016: Not offered  
3-0-9 H-LEVEL Grad Credit  
Examines cyber dynamics and processes in international relations from different theoretical perspectives. Considers alternative theoretical and empirical frameworks consistent with characteristic features of cyberspace and emergent transformations at all levels of international interaction. Theories examined include realism and neorealism, institutionalism and liberalism, constructivism, and systems theory and lateral pressure. Highlights relevant features and proposes customized international relations theory for the cyber age. Students taking the graduate version are expected to pursue the subject in
greater depth through reading and individual research.
_N. Choucri_

**17.447 Cyberpolitics in International Relations**
(Subject meets with 17.448)
- **Prereq:** None
- **Acad Year 2014–2015:** Not offered
- **Acad Year 2015–2016:** U (Fall)
- **3-0-9 HASS-S**

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, D. Clark_

---

**Security Studies**

**17.468 Foundations of Security Studies**
- **Prereq:** Permission of instructor
- **Acad Year 2014–2015:** G (Fall)
- **Acad Year 2015–2016:** Not offered
- **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, Blaney, von Clausewitz, and Huntington. Students write a seminar paper in which theoretical insights are systematically applied to a current security issue.

_B. Posen_

**17.473 The Politics of Nuclear Proliferation**
- **Prereq:** None
- **Acad Year 2014–2015:** Not offered
- **Acad Year 2015–2016:** U (Fall)
- **3-0-9 HASS-S**

Provides an introduction to the politics and theories surrounding the proliferation of nuclear weapons. Introduces the basics of nuclear weapons, nuclear strategy, and deterrence theory. Examines the historical record during the Cold War as well as the proliferation of nuclear weapons to regional powers and the resulting deterrence consequences.

_V. Narang_

**17.475 Nuclear Forces and Missile Defenses**
(Subject meets with STS.072J)
- **Prereq:** None
- **U (Fall)**
- **3-0-9 HASS-S**

Provides an introduction to the politics and theories surrounding the proliferation of nuclear weapons. Introduces the basics of nuclear weapons, nuclear strategy, and deterrence theory. Examines the historical record during the Cold War as well as the proliferation of nuclear weapons to regional powers and the resulting deterrence consequences.

T. Postol

**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
- **U (Fall)**
- **3-0-9 HASS-S**

See description under subject STS.076J.

T. Postol

---

**17.478 Great Power Military Intervention**
- **Prereq:** Permission of instructor
- **Acad Year 2014–2015:** Not offered
- **Acad Year 2015–2016:** G (Fall)
- **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**

Examines the evolving roles and missions of US General Purpose Forces within the context of modern technological capabilities and Grand Strategy, which is a conceptual system of interconnected political and military means and ends. Topics include US Grand Strategies; the organization of the US military; the defense budget; and the capabilities and limitations of naval, air, and ground forces. Also examines the utility of these forces for power projection and the problems of escalation. Analyzes military history and simple models of warfare to explore how variations in technology and battlefield conditions can drastically alter effectiveness of conventional forces. 17.483 fulfills undergraduate public policy requirement in the major and minor. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.

_B. Posen_

**17.483 US Military Power**
(Subject meets with 17.482)
- **Prereq:** Freshmen need permission of instructor
- **U (Spring)**
- **3-0-9 HASS-S**

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_

**17.484 Comparative Grand Strategy and Military Doctrine**
- **Prereq:** Permission of instructor
- **G (Fall)**
- **Not offered regularly; consult department**
- **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
- **G (Spring)**
- **Not offered regularly; consult department**
- **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

COMPARATIVE POLITICS

17.50 Introduction to Comparative Politics
Prereq: None
U (Spring)
3-0-9 HASS-S; CI-H
Examines why democracy emerges and survives in some countries rather than in others; how political institutions affect economic development; and how American politics compares to that of other countries. Reviews economic, cultural, and institutional explanations for political outcomes. Includes case studies of politics in several countries. Assignments include several papers of varying lengths and extensive structured and unstructured class participation. Enrollment limited
M. Nobles

17.504 Ethnic Politics I
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
4-0-8 H-LEVEL Grad Credit
17.506 Ethnic Politics II
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
Explores why people join grassroots political organizations and social movements. Asks what accounts for the ultimate success or failure of these organizations and examines how social movements have altered political parties, political institutions, and social relations. Critically considers a range of theoretical treatments and several movements, including the US civil rights, poor peoples', pro-life/pro-choice and gay/lesbian movements.
M. Nobles

17.515 Comparative Electoral Politics
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-S
Subject discusses classic and current issues in electoral politics. Focus is mostly thematic, although the topics will be discussed in the context of different countries and regions. Examples of the topics are: party systems, old and new political cleavages, representation, electoral systems, and immigration and its effect on the party system. Two country-specific case studies explored in depth.
Staff

17.516 Transitional Justice
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S
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 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
Ethnic and racial conflict appear to be the hallmark of the post-Cold War world. Students explore the rise of ethnic/racial and nationalist sentiments and movements; the basis of ethnic and racial identity; the political claims and goals of such movements, and whether conflict is inevitable. Introduces the dominant theoretical approaches to race, ethnicity, and nationalism, and considers them in light of current events in Africa, Europe, Asia, and the Americas.
M. Nobles

17.528 Civil Society, Social Capital, and the State in Comparative Perspective
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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

17.53 The Rise of Asia (New)
Prereq: None
U (Spring)
3-0-9 HASS-S
Focuses on social, economic, political, and national security problems of Japan, China, and India—three rising powers in a dynamic region with the potential to shape global affairs. Examines each topic and country from the per-
17.537 Politics and Policy in Contemporary Japan
(Subject meets with 17.538)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
17.538 Politics and Policy in Contemporary Japan
(Subject meets with 17.537)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit

Analyzes contemporary Japanese politics, focusing primarily upon the post-World War II period. Includes examination of the dominant approaches to Japanese politics and society, the structure of the party system, the role of political opposition, the policy process, foreign affairs, and interest groups. Attention to defense, foreign, industrial, social, energy, and technology policy processes. Graduate students are expected to pursue the subject in greater depth through reading and class presentations. Assignments differ.

R. J. Samuels

17.544 Comparative Politics and China
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

Seminar has two main goals: explores the main theoretical and methodological approaches to the study of contemporary Chinese politics; and relates those approaches to broader trends in the field of comparative politics. What has the study of China contributed to the field of comparative politics, and vice versa? What are the most effective ways to integrate area studies, broader comparative approaches, and theory? Seminar presumes a basic understanding of the history and politics of contemporary China.

Staff

R. Bateson

17.547 The Rise of China
(Subject meets with 17.548)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-S
17.548 The Rise of China
(Subject meets with 17.547)
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

Examines the causes and consequences of China’s emergence as a global economic and political force. Employing perspectives from comparative politics and international relations, subject examines the connections between China’s domestic transformation and its foreign policy. Topics include the historical process of China’s rise, contemporary challenges facing the Chinese system, and the impact of China’s rise on issues of regional and global concern, including military security, economic competitiveness, environmental sustainability, and political stability. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.

Staff

R. Samuels, M. T. Fravel, V. Narang

17.551 Political Economy of Chinese Reform
(Subject meets with 17.552)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
Not offered regularly; consult department
3-0-9 HASS-S
17.552 Political Economy of Chinese Reform
(Subject meets with 17.551)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

Focuses on China’s transition from plan to market. What has the trajectory of institutional change in China been, and how has growth been achieved? Is that growth sustainable? Subject examines specific aspects of reform (enterprise, fiscal, financial, social welfare), and the systemic consequences of interaction between various reform measures. Additional topics include the interaction between political and economic change, the transformation of state-society relations, and the generalizability of China’s reform experience. Students taking the graduate version are expected to pursue the subject in greater depth through reading and individual research.

Staff

17.554 Introduction to Latin American Studies
(Same subject as 21A.130J, 21F.084J)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S; CI-H

Examines contemporary Latin American culture, politics, and history. Surveys geography, economic development, and race, religion, and gender in Latin America. Special emphasis on the Salvadoran civil war, human rights and military rule in Argentina and Chile, and migration from Central America and Mexico to the United States. Students analyze films, literature, visual art, journalism, historical documents, and social scientific research.

R. Bateson

17.556 Political Economy of Industrialization
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

Examines theoretical and empirical approaches to understanding the process of late development. Topics include the role of the state in alleviating or exacerbating poverty, the politics of industrial policy and planning, and the relationship between institutional change and growth. Considers how, over the past century, some of the world’s poorest nations achieved wealth while others remained mired in poverty. Discusses the social consequences for alternative strategies of development.

Staff

17.561 European Politics
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

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.
N. Karlinsky

17.565 Israel: History, Politics, Culture, and Identity
Prereq: None
U (Spring)
3-0-9 HASS-S
Credit cannot also be received for 17.567
Examines Israeli identity using a broad array of materials, including popular music, film, documentaries and art, in addition to academic historical writings. Topics include Israel's political system and society, ethnic relations, settlement projects, and the Arab minorities in the Jewish state. Students also discuss whether there is a unique Israeli culture and the struggle for Israel's identity.
N. Karlinsky

17.567 Israel: History, Politics, Culture, and Identity
Prereq: None
U (IAP)
3-0-6 HASS-S
Credit cannot also be received for 17.565
Examines Israeli identity using a broad array of materials, including popular music, film, documentaries and art, in addition to academic historical writings. Topics include Israel's political system and society, ethnic relations, settlement projects, and the Arab minorities in the Jewish state. Students also discuss whether there is a unique Israeli culture and the struggle for Israel's identity.
N. Karlinsky

17.568 Comparative Politics and International Relations of the Middle East (New)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Surveys both classic and cutting-edge work on the politics of the Middle East, broadly defined. Topics include the causes and consequences of political and economic development, authoritarianism and democratization, the influence of social movements, the role of women in Middle East priorities, regional inter-state relations, Islamism, terrorism, colonialism and foreign occupation, state-building, resistance and rebellion, and the Arab uprisings.
R. Nielsen

3-0-9 HASS-S
17.569 Russia's Foreign Policy: Toward the Post-Soviet States and Beyond (New)
Prereq: None
U (Spring)
3-0-9 HASS-S
Analyses Russia's foreign policy, with a focus on relations with the other post-Soviet states. Frames the discussion with examination of US-Russian and Sino-Russian relations. Looks at legacies of the Soviet collapse, strengths and vulnerabilities of Russia, and the ability of other states to maintain their sovereignty. Topics include the future of Central Asia, the Georgian war, energy politics, and reaction to the European Union's Eastern Partnership. Readings focus on international relations, historical sources, and contemporary Russian and Western sources.
C. Salvez

17.570 Soviet and Post-Soviet Politics and Society: 1917 to the Present
(Same subject as 21H.245J)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S; CI-H
See description under subject 21H.245J.
Staff

17.571 African Politics
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
Explores major issues, themes and theories in the politics of contemporary Sub-Saharan Africa. Topics include the nature and legacies of colonial rule; personalism, clientelism and corruption; the politics of identity; civil wars; the causes and consequences of political and economic liberalization; and the reasons for Africa's economic stagnation and current resurgence.
Staff

17.572 African Politics
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 students develop the skills to become both more intelligent consumers and more effective producers of this literature. Covers both classic contributions to the literature and more recent research.
Staff

17.581 Riots, Rebellions, Revolutions
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
Examines different types of violent political conflict. Compares and contrasts several social science approaches (psychological, sociological, and political) and analyzes their ability to explain variation in outbreak, duration and outcome of conflict. Examines incidents such as riots in the US during the 1960's, riots in India, the Yugoslav wars, and the Russian Revolution, in addition to current international events.
R. Petersen

17.582 Civil War
Prereq: Permission of instructor
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.
F. Christia

17.583 Conflict and the Graphic Novel
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S
Presents the roots and consequences of violent conflict through the graphic novel. Proceeds thematically and addresses an array of violent dynamics and processes such as revolution, occupation, insurgency, ethnic conflict, terrorism and genocide through graphic novels. Covers some of the most important cases of violent unrest over the last seventy years such as the Holocaust, the war in Vietnam, the 1979 Iranian Revolution, the Israeli-Palestinian conflict, the ethnic conflict in the former Yugoslavia, and the recent Iraq war.
F. Christia
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.
T. Yamamoto, I.S. Kim

17.802 Quantitative Research Methods II: Causal Inference
Prereq: 17.800, 17.871, or permission of instructor
G (Spring)
4-0-8 H-LEVEL Grad Credit
Survey of statistical methods for causal inference in political science and public policy research. Covers a variety of causal inference designs, including experiments, matching, regression, panel methods, difference-in-differences, synthetic control methods, instrumental variables, regression discontinuity designs, quantile regression, and bounds.
D. Hidalgo

17.804 Quantitative Research Methods III: Generalized Linear Models and Extensions
Prereq: 17.802 or permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Provides a survey of statistical tools for model-based inference in political science and public policy. Topics include generalized linear models for various data types and their extensions, such as discrete choice models, survival outcome models, mixed effects and multilevel models. Covers both frequentist and Bayesian approaches.
T. Yamamoto

17.806 Quantitative Research Methods IV: Advanced Topics
Prereq: 17.804 or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
4-0-8 H-LEVEL Grad Credit
Covers advanced statistical tools that are useful for empirical research in political science and public policy. Possible topics include missing data, survey sampling and experimental designs for field research, machine learning, text mining, clustering, Bayesian methods, spatial statistics, and web scraping.
D. Hidalgo, T. Yamamoto

17.810 Game Theory and Political Theory
(Subject meets with 17.811)
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
4-0-8 H-LEVEL Grad Credit

17.811 Game Theory and Political Theory
(Subject meets with 17.810)
Prereq: None
U (Fall)
Not offered regularly; consult department
4-0-8 HASS-S

Introduces students to the rudiments of game theory within political science. Provides students with the ability to solve simple games. Readings draw from basic texts on game theoretic modeling and applied articles in American politics, international relations, and comparative politics. Students taking the graduate version evaluate applied theory articles in the major journals.
Staff

17.830 Empirical Methods in Political Economy
(New)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Reviews recent quantitative empirical studies on important, substantive questions in political economy. Designed to increase students' understanding of the core research designs and measurement strategies employed in the empirical analysis of political institutions and political behavior. Topics include the political and economic consequences of direct democracy, reservations for political minorities, corruption, political effects of the media, and politics in authoritarian regimes.
D. Hidalgo

17.850 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. Exposes students to major research questions and different ways of examining them. Limited to Course 17 PhD students.
R. Bateson, R. Nielsen
17.869 Political Science Scope and Methods  
Prereq: None  
U (Fall)  
3-0-9 HASS-S  
Introduces principles of empirical and theoretical analysis in political science through research projects currently conducted in the department. Different department faculty lead modules that introduce students to major research questions and different ways of examining those questions. Emphasizes how this research in progress relates to larger themes, and how researchers confront obstacles to inference in political science. Includes substantial instruction and practice in writing (with revision) and oral presentations. Intended primarily for majors and minors.  
F. Christia

17.871 Political Science Laboratory  
Prereq: 17.869 or permission of instructor  
U (Spring)  
3-6 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

17.878 Qualitative Research: Design and Methods  
Prereq: Permission of instructor  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
Prepares students to conduct independent qualitative research. Topics include research design, human subjects protocols and research ethics, risk management, participant observation and interview techniques, and data collection and analysis. During the term, students complete a qualitative research project in the Boston area. Especially appropriate for students planning to do fieldwork.  
R. Bateson

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.  
Staff

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 also responsible for directed readings, short writing assignments, and six seminar sessions. Subject can only be repeated for credit if area of community service is different.  
T. Weiner

17.905–17.911 Reading Seminar in Social Science  
Prereq: None  
U (Fall, IAP, Spring, Summer)  
Units arranged  
Can be repeated for credit  
Reading and discussion of special topics in the fields of social science. Open to advanced undergraduates by arrangement with individual staff members. 17.909 is taught P/D/F.  
Staff

17.922 Martin Luther King, Jr. Design Seminar  
Prereq: None  
U (IAP)  
3-0-9  
Can be repeated for credit  
Facilitates design and construction of installations and other community projects in conjunction with and beyond MIT's celebration of Dr. King. Students discuss the ideas and goals of Dr. King and other human rights leaders in the US and the world. The first half of the class develops in-depth understanding of the history of US racial issues as well as past and present domestic and international political struggles. Addresses issues of justice, equality and racism through videos, readings and writings, and class discussions. In the second half, students work as a group complete the installation and projects which serve as models for connecting academics with real life problems and struggle.  
T. Weiner

17.923 Martin Luther King, Jr. Design Seminar for Facilitators/Teachers  
Prereq: 17.922  
U (IAP)  
3-0-9  
Can be repeated for credit  
Students participate in the class but also assist instructor in the design and execution of the curriculum and actively participate in the instruction and monitoring of class participants. Students prepare subject materials, lead discussion groups, and review progress. Includes daily evaluation and meetings to reflect on the class itself and the students' performance as leaders.  
T. Weiner

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 gradu-
ate 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.

C. Lawson

**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**

**17.5912 Special Undergraduate Subject in Political Science**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

**17.5914 Special Undergraduate Subject in Political Science**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Reading and discussion of topics in the field of social science not covered in the regular curriculum.

**Staff**

**17.5916, 17.5917 Special Undergraduate Subject in Political Science**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

**17.5918, 17.5919 Special Undergraduate Subject in Political Science**
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Reading and discussion of topics in the field of social science not covered in the regular curriculum.

**Staff**

**17.5950–17.5953 Special Graduate Subject in Political Science**
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Open to qualified graduate students who would like to pursue special subjects or projects. Please consult graduate administration prior to registration.

**Staff**
Bachelor of Science in Political Science/Course 17

**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 [all but three subjects can inform 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 [can be satisfied by 17.871 in the Departmental Program]</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**

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

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Subjects</strong>&lt;sup&gt;(1)&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&lt;sup&gt;*&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>17.THT Thesis Research Design Seminar, 12, CI-M; 17.869, 17.871, or permission of instructor</td>
<td></td>
</tr>
<tr>
<td>17.ThU Undergraduate Political Science Thesis (at least 12 units; additional units by special arrangement)</td>
<td></td>
</tr>
</tbody>
</table>

| **Restricted Electives**<sup>60–84</sup>                                 |       |
| Normally seven subjects divided as follows:                              |       |
| Political philosophy/social theory: one political science subject in the field of political philosophy/social theory (17.00–17.099) |       |
| American politics: one political science subject in the field of American politics (17.20–17.299) |       |
| 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 |       |
| 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) |       |
| 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. |       |

**Departmental Program Units That Also Satisfy the GIRs**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(65–75)</td>
</tr>
</tbody>
</table>

**Unrestricted Electives**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>120–134</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Units</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**

* Alternate prerequisites are listed in the subject description.

<sup>(1)</sup> Students typically enroll in subjects as follows: 17.869, fall term, junior year; 17.871, spring term, junior year; 17.THT, fall term, senior year; 17.ThU, 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).
COURSE 18
MATHEMATICS

GENERAL MATHEMATICS

18.01 Calculus
Prereq: None
U (Fall, Spring)
5-0-7 CALC I
Credit cannot also be received for 18.014, 18.01A, CC.181A, ES.1801, ES.181A


Fall: J. W. Bush
Spring: Information: G. Staffilani

18.01A Calculus
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, CC.181A, 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.

J. W. Bush

18.014 Calculus with Theory
Prereq: None
U (Fall)
5-0-7 CALC I
Credit cannot also be received for 18.01, 18.01A, CC.181A, 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.

J. Geiger

18.02 Calculus
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 CALC II
Credit cannot also be received for 18.022, 18.023, 18.024, 18.02A, CC.1802, CC.182A, ES.1802, ES.182A

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.

J. Geiger

18.022 Calculus
Prereq: Calculus I (GIR)
U (Fall)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.022, 18.023, 18.024, 18.02A, CC.1802, CC.182A, ES.1802, ES.182A

Credit cannot also be received for 18.022, 18.023, 18.024, 18.02A, CC.1802, CC.182A, ES.1802, ES.182A

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.

J. Geiger

18.023 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, 18.022, 18.023, 18.024, 18.02A, CC.1802, CC.182A, ES.1802, ES.182A

Continues 18.02. 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.

J. Geiger

18.024 Calculus with Theory
Prereq: Calculus I (GIR)
U (Spring)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.022, 18.023, 18.024, 18.02A, CC.1802, CC.182A, ES.1802, ES.182A

Continues 18.02. 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.

J. Geiger

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 differential equations, including modeling physical systems. Solution of first-order ODEs by analytical, graphical, and numerical methods. Linear ODEs with constant coefficients. Complex numbers and exponentials. Inhomogeneous equations: polynomial, sinusoidal, and exponential inputs. Oscillations,

Fall: L. Demanet
Spring: G. Staffilani, D. Jerison

18.034 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
U (Spring)
5-0-7 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: G. Staffilani

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)
4-0-8 REST


J. Orloff

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. Postnikov
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.

F. T. Leighton, A. R. Meyer, A. Moitra

18.075 Methods for Scientists and Engineers
Prereq: Calculus II (GIR); 18.03 or 18.034
G (Spring)
3-0-9 H-LEVEL Grad Credit

Covers much of the same material as 18.03 with more emphasis on matrix algorithms and many applications.

Information: G. Staffilani

18.089 Review of Mathematics
Prereq: Permission of instructor
G (Summer)
5-0-7

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: G. Staffilani

18.094J Teaching College-Level Science and Engineering
(Same subject as 1.95J, 5.95J, 6.982J, 7.59J, 8.395J)
(Subject meets with 2.978)
Prereq: None
G (Fall)
2-0-2 [P/D/F]
See description under subject 5.95J.

J. Rankin

18.095 Mathematics Lecture Series
Prereq: Calculus I (GIR)
U (IAP)
2-0-4 [P/D/F]

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: G. Staffilani

18.098 Independent Study
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: G. Staffilani
ANALYSIS

18.100A Real Analysis
Prereq: Calculus II (GIR) or 18.014 and Coreq: Calculus II (GIR)
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)
Credit cannot also be received for 18.100B, 18.100C

18.100B Real Analysis
Prereq: Calculus II (GIR) or 18.014 and Coreq: Calculus II (GIR)
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)
Credit cannot also be received for 18.100A, 18.100C

18.100C Real Analysis
Prereq: Calculus II (GIR) or 18.014 and Coreq: Calculus II (GIR)
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. Conceived 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.

Fall: 18.100A: A. P. Mattuck
18.100B: P. Isett
18.100C: E. Baer
Spring: 18.100A: S. Dyatlov
18.100B: J.-L. Kim
18.100C: R. Bezrukavnikov

18.101 Analysis and Manifolds
Prereq: 18.100; 18.06, 18.700, or 18.701 G (Fall)
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)
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 G (Spring)
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)

R. B. Meise

18.103 Fourier Analysis: Theory and Applications
Prereq: 18.100; 18.06, 18.700, or 18.701 G (Fall)
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)
Roughly half the subject devoted to the theory of the Lebesgue integral with applications to probability, and half to Fourier series and Fourier integrals.

L. Guth

18.104 Seminar in Analysis
Prereq: 18.100
U (Fall)
3-0-9
Students present and discuss material from books or journals. Topics vary from year to year. Instruction and practice in written and oral communication provided. Enrollment limited.

V. W. Guillemin

18.112 Functions of a Complex Variable
Prereq: 18.100; 18.06, 18.700, or 18.701 G (Fall)
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)

T. Mrowka

18.116 Riemann Surfaces
Prereq: 18.112, 18.965
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.

T. Mrowka

18.117 Topics in Several Complex Variables
Prereq: 18.112, 18.965
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 Kahler manifolds.

V. W. Guillemin

18.125 Real and Functional Analysis
Prereq: 18.100
G (Spring)
3-0-9 H-LEVEL Grad Credit
Provides a rigorous introduction to Lebesgue’s theory of measure and integration. Covers material that is essential in analysis, probability theory, and differential geometry.

D. W. Stroock

18.135 Geometric Analysis
Prereq: 18.745 or 18.755
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.

S. Helgason
18.137 Topics in Geometric Partial Differential Equations  
Prereq: Permission of instructor  
Acad Year 2014–2015: G (Fall)  
Acad Year 2015–2016: Not offered  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Topics vary from year to year.  
R. B. Melrose

18.158 Topics in Differential Equations  
Prereq: 18.157  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
3-0-9 H-LEVEL Grad Credit  
Can be repeated for credit  
Topics vary from year to year.  
L. Saint-Raymond

18.176 Stochastic Calculus  
Prereq: 18.175  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Sums of independent random variables, central limit phenomena, infinitely divisible laws, Levy processes, Brownian motion, conditioning, and martingales. Prior exposure to probability (e.g., 18.440) recommended.  
V. Gorin

18.177 Topics in Stochastic Processes  
Prereq: 18.175  
G (Fall, Spring)  
3-0-9 H-LEVEL Grad Credit  
Topics vary from year to year.  
Fall: J. Miller  
Spring: A. Guionnet

18.199 Graduate Analysis Seminar  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-0-9 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.  
V. W. Guillemin
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 18.062; 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: P. Csikvari
Spring: J. Novak

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 Discrete Applied Mathematics
Prereq: Calculus II (GIR)
U (Fall)
4-0-11
Credit cannot also be received for 18.310A
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.
J. Fox, P. W. Shor

18.310A Principles of Discrete Applied Mathematics
Prereq: Calculus II (GIR)
U (Spring)
3-0-9
Credit cannot also be received for 18.310
Study of illustrative topics in discrete applied mathematics, including sorting algorithms, probability theory, information theory, coding theory, secret codes, generating functions, and linear programming.
M. X. Goemans

18.311 Principles of Continuum 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.
P. Csikvari

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.
A. Postnikov

18.316 Seminar in Combinatorics
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.
J. Fox

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.
C. Lee

18.325 Topics in Applied Mathematics
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
L. Demanet
18.330 Introduction to Numerical Analysis
Prereq: Calculus II (GIR); 18.03 or 18.034
U (Spring)
3-0-9
H. Reid

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 (Spring)
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

18.336J Fast Methods for Partial Differential and Integral Equations
(Same subject as 6.336J)
Prereq: 6.336, 6.920, 18.085, 18.335, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Unified introduction to the theory and practice of modern, near linear-time, numerical methods for large-scale partial-differential and integral equations. Topics include preconditioned iterative methods; generalized Fast Fourier Transform and other butterfly-based methods; multiresolution approaches, such as multigrid algorithms and hierarchical low-rank matrix decompositions; and low and high frequency Fast Multipole Methods. Example applications include aircraft design, cardiovascular system modeling, electronic structure computation, and tomographic imaging.
A. Townsend

18.337J Parallel Computing
(Same subject as 6.338J)
Prereq: 18.06, 18.700, or 18.701
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Interdisciplinary introduction to parallel computing and modern big data analysis using Julia. Covers scientific computing topics such as dense and sparse linear algebra, N-body problems, and Fourier transforms, and geometric computing topics such as mesh generation and mesh partitioning. Focuses on application of these techniques to machine learning algorithms in big data applications. Provides direct experience with programming traditional-style supercomputing as well as working with modern cloud computing stacks. Designed to separate the realities and myths about the kinds of problems that can be solved on the world’s fastest machines.
A. Edelman

18.338 Eigenvalues of Random Matrices
Prereq: 18.701 or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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 methods, and compressed sensing. Knowledge of MATLAB helpful, but not required.
A. Edelman

18.352J Theoretical Environmental Analysis
(Same subject as 12.207J)
Prereq: 18.03 or 18.034; Physics II (GIR)
U (Spring)
3-0-9 H-LEVEL Grad Credit
Fundamental concepts illustrated through problems drawn from a variety of areas, including geophysics, biology, and the dynamics of sport. Particular emphasis on the interplay between dimensional analysis, scaling arguments, and theory. Includes classroom and laboratory demonstrations.
J. Dunkel

18.353J Nonlinear Dynamics: 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.
R. Lagrange

18.354J Nonlinear Dynamics: Continuum Systems
(Same subject as 1.062J, 12.207J)
Prereq: 18.03 or 18.034; Physics II (GIR)
G (Spring)
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)
General mathematical principles of continuum systems. From microscopic to macroscopic descriptions in the form of linear or nonlinear (partial) differential equations. Exact solutions, dimensional analysis, calculus of variations and singular perturbation methods. Stability, waves and pattern formation in continuum systems. Subject matter illustrated using natural fluid and solid systems found, for example, in geophysics and biology.
J. Dunkel

18.355 Fluid Mechanics
Prereq: 18.354, 2.25, or 12.800
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Topics include the development of Navier-Stokes equations, inviscid flows, boundary layers, lubrication theory, Stokes flows, and surface tension. Fundamental concepts illustrated through problems drawn from a variety of areas, including geophysics, biology, and the dynamics of sport. Particular emphasis on the interplay between dimensional analysis, scaling arguments, and theory. Includes classroom and laboratory demonstrations.
J. W. Bush

18.357 Interfacial Phenomena
Prereq: 18.354, 18.355, 12.800, 2.25, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Fluid systems dominated by the influence of interfacial tension. Elucidates the roles of curvature pressure and Marangoni stress in a variety of hydrodynamic settings. Particular attention to drops and bubbles, soap films and minimal surfaces, wetting phenomena, water-repellency, surfactants, Marangoni flows, capillary origami and contact line dynamics. Theoretical developments are accompanied by classroom demonstrations. Highlights the role of surface tension in biology.
J. W. Bush
18.369 Mathematical Methods in Nanophotonics
Prereq: 18.305 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.
T. R. Akylas, R. R. Rosales

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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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

18.384 Undergraduate Seminar in Physical Mathematics
Prereq: 18.311, 18.353, 18.354, or permission of instructor
U (Fall)
3-0-9
Covers the mathematical modeling of physical systems, with emphasis on the reading and presentation of papers. Addresses a broad range of topics, with particular focus on macroscopic physics and continuum systems: fluid dynamics, solid mechanics, and biophysics. Instruction and practice in written and oral communication provided. Enrollment limited.
P.-T. Brun

18.385j Nonlinear Dynamics and Chaos
(Same subject as 2.036J)
Prereq: 18.03 or 18.034
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
R. R. Rosales

18.386 Advanced Nonlinear Dynamics and Chaos
Prereq: 18.385 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Information: R. R. Rosales

18.389 Quantum Field Theories
Prereq: Permission of instructor
G (Spring)
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. 3.822 and 3.823 helpful.
D. Z. Freedman

18.390 Group Theory with Applications to Physics
Prereq: 8.321
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. 3.822 and 3.823 helpful.
D. Z. Freedman

18.395 Group Theory with Applications to Physics
Prereq: 8.321
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. 3.822 and 3.823 helpful.
D. Z. Freedman

18.396 Supervisory Quantum Field Theories
(Same subject as 8.831J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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
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

18.399 Undergraduate Seminar in Physical Mathematics
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: Not offered
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
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.
A. Moitra

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 (except for Course 18 students)
A more extensive and theoretical treatment of the material in 6.045J/18.400J, 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
D. Moshkovitz

18.409J Topics in Theoretical Computer Science
Prereq: Permission of instructor
G (Spring)
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.
A. Moitra

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.
E. Demaine, M. Goemans

18.415J Advanced Algorithms
(Same subject as 6.854J)
Prereq: 6.041, 6.042, or 18.440; 6.046
G (Fall)
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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
5-0-7 H-LEVEL Grad Credit
See description under subject 6.856J.
D. R. Karger

18.417J Introduction to Computational Molecular Biology
Prereq: 6.01, 6.006, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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. Berger

18.418J 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 SIGACT 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)
Thorough treatment of linear programming and combinatorial optimization. Topics include matching theory, network flow, matroid optimization, and how to deal with NP-hard optimization problems. Prior exposure to discrete mathematics (such as 18.310) helpful.
M. X. Goemans
18.434 Seminar in Theoretical Computer Science
Prereq: 18.410
U (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.
R. Peng

18.435 Quantum Computation
(Same subject as 2.111J, 8.370J)
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.
J. Chuang, E. Farhi, S. Lloyd, P. W. Shor

18.436 Quantum Information Science
(Same subject as 6.443J, 8.371J)
Prereq: 18.435
G (Spring, Summer)
3-0-9 H-LEVEL Grad Credit
See description under subject 8.371J.
Information: P. W. Shor

18.437 Distributed Algorithms
(Same subject as 6.852J)
Prereq: 6.046
G (Fall)
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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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

18.439 Topics in Mathematics with Applications in Finance (New)
Prereq: 18.03; 18.06; 18.08 or 18.440
U (Fall)
3-0-9
Introduction to mathematical concepts and techniques used in finance. Lectures focusing on linear algebra, probability, statistics, stochastic processes, and numerical methods are interspersed with lectures by financial sector professionals illustrating the corresponding application in the industry. Prior knowledge of economics or finance helpful but not required.
P. Kempthorne, V. Strela, J. Xia

For additional related subjects in statistics, see:
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, 15.061, 15.065, 15.070, 15.075, 15.076, 15.098, and 15.306
Mathematics: 18.05, 18.175, 18.176, 18.177, 18.440, 18.443, 18.445, 18.465, 18.466, and 18.472

See also: 2.061, 2.830, 5.70, 5.72, 7.02, 8.044, 8.08, 10.816, 11.220, 11.221, 16.322, 17.872, 17.874, 22.38, HST.191, and MAS.622J.

LOGIC

18.504 Seminar in Logic
Prereq: 18.100; 18.06, 18.510, 18.511, 18.700, or 18.701
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
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.
H. Cohn
18.510 Introduction to Mathematical Logic and Set Theory
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall) 3-0-9
H. Cohn

18.511 Introduction to Computability and Undecidability
Prereq: None
U (Fall)
Not offered regularly; consult department 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
G (Spring)
Not offered regularly; consult department 3-0-9 H-LEVEL Grad Credit
Information: B. Poonen

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.
D. A. Vogan

18.701 Algebra I
Prereq: 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 (Spring) 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: 18.701; or 18.06, 18.703; or 18.700, 18.703
U (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.
C. Walton

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.
Y. Liu

18.706 Noncommutative Algebra
Prereq: 18.705
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring) 3-0-9 H-LEVEL Grad Credit
Topics may include representations of quivers, 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.
G. Lusztig

18.715 Introduction to Representation Theory
(18.712)
Prereq: 18.702 or 18.703
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Algebras, representations, Schur’s lemma. Representations of finite groups, Maschke’s theorem, characters, applications. Induced representations, Burnside’s theorem, Mackey formula, Frobenius reciprocity. Representations of quivers.
P. I. Etingof

18.721 Introduction to Algebraic Geometry
Prereq: 18.702, 18.901
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring) 3-0-9
Presents basic examples of complex algebraic varieties, affine and projective algebraic geometry, sheaves, cohomology.
M. Artin

18.725 Algebraic Geometry I
Prereq: None. Coreq: 18.705
G (Fall) 3-0-9 H-LEVEL Grad Credit
Introduces the basic notions and techniques of modern algebraic geometry. Covers fundamental notions and results about algebraic varieties over an algebraically closed field; relations between complex algebraic varieties and complex analytic varieties; and examples with emphasis on algebraic curves and surfaces. Introduction to the language of schemes and properties of morphisms. Knowledge of elementary algebraic topology, elementary differential geometry recommended, but not required.
T. Schlank
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.
R. Bezrukavnikov

18.727 Topics in Algebraic Geometry
Prereq: 18.725
G (Fall)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
Information: D. A. Vogan

18.735 Topics in Algebra
Prereq: 18.705
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
R. Bezrukavnikov

18.737 Algebraic Groups
Prereq: 18.705
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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.
F. Charles

18.739 Theory of Invariants
Prereq: 18.705
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Topics may include structure of finite-dimensional Lie algebras; theorems of Engel and Lie; Cartan subalgebras and regular elements; trace form and Cartan’s criterion; Chevalley’s conjugacy theorem; classification and construction of semisimple Lie algebras; Weyl group; universal enveloping algebra and the Casimir operator; Weyl’s complete reducibility theorem, Levi and Malcev theorems; classification of irreducible finite-dimensional representations of semisimple Lie algebras; Weyl’s character and dimension formulas.
D. A. Vogan

18.747 Infinite-dimensional Lie Algebras
Prereq: 18.745
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.
D. A. Vogan

18.757 Representations of Lie Groups
Prereq: 18.745 or 18.755
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.
D. A. Vogan

18.758 Representations of Lie Groups
Prereq: 18.757
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Introduction to unitary representations of semi-simple 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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.
P. I. Etingof

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.
J.-L. Kim

18.782 Introduction to Arithmetic Geometry
Prereq: 18.702
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9
Introduction to arithmetic geometry, motivated by the problem of finding rational points on curves. Exposes students to p-adic numbers and some fundamental results from number theory and algebraic geometry, such as the Hasse-Minkowski theorem and the Riemann-Roch theorem for curves. Additional topics may include Mordell’s theorem, the Weil conjectures, and Jacobian varieties.
A. Sutherland

18.783 Elliptic Curves
Prereq: None. Coreq: 18.702, 18.703, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)
Computationally focused introduction to elliptic curves, with applications to number theory and cryptography. Topics include point-counting,
isogenies, pairings, and the theory of complex multiplication, with applications to integer factorization, primality proving, and elliptic curve cryptography. Includes a brief introduction to modular curves and the proof of Fermat’s Last Theorem.

A. Sutherland

18.784 Seminar in Number Theory
Prereq: 18.06, 18.100
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.
V. G. Kac

18.785 Number Theory I
Prereq: 18.112, 18.702
G (Fall)
3-0-9 H-LEVEL Grad Credit
Dedekind domains, unique factorization of ideals, splitting of primes. Lattice methods, finiteness of the class group,28pt\par
Dirichlet’s unit theorem. Local fields, ramification, discriminants. Zeta and L-functions, analytic class number formula. Adèles and ideles. Statements of class field theory and the Chebotarev density theorem.

B. Poonen

18.786 Number Theory II
Prereq: 18.785
G (Spring)
3-0-9 H-LEVEL Grad Credit
Continuation of 18.785. More advanced topics in number theory, such as Galois cohomology, proofs of class field theory, modular forms and automorphic forms, Galois representations, or quadratic forms.

B. Poonen

18.787 Topics in Number Theory
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Topics vary from year to year.

B. Poonen

MATHEMATICS LABORATORY

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.

A. Sutherland

TOPOLOGY AND GEOMETRY

18.901 Introduction to Topology
Prereq: 18.100 or permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit H (except for Course 18 students)
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: E. Dotto

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.

G. Tabuada

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 Kunneth theorems, cohomology, cup products, Poincare duality.

G. Tabuada

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.

H. R. Miller

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
G (Spring)
3-0-9 H-LEVEL Grad Credit (except for Course 18 students)

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 forms, Christoffel symbols. Discusses the distinction between extrinsic and intrinsic aspects, in particular Gauss' theorem egregium. The Gauss-Bonnet theorem. Geodesics. Examples such as hyperbolic space.

T. Colding

18.952 Theory of Differential Forms
Prereq: 18.101; 18.700 or 18.701
U (Spring)
3-0-9

Multilinear algebra: tensors and exterior forms. Differential forms on \( \mathbb{R}^n \): exterior differentiation, the pull-back operation and the Poincare lemma. Applications to physics: Maxwell's equations from the differential form perspective. Integration of forms on open sets of \( \mathbb{R}^n \). The change from the differential form perspective. Integration of forms on manifolds and De Rham theory. Integration of forms on manifolds and Stokes' theorem. The push-forward operation for forms. Thom forms and intersection theory. Applications to differential topology.

V. W. Guillemin

18.965 Geometry of Manifolds I
Prereq: 18.101, 18.950 or 18.952
G (Fall)
3-0-9 H-LEVEL Grad Credit

18.966 Geometry of Manifolds II
Prereq: 18.965
G (Spring)
3-0-9 H-LEVEL Grad Credit

Differential forms, introduction to Lie groups, the DeRham theorem, Riemannian manifolds, curvature, the Hodge theory. 18.966 is a continuation of 18.965 and focuses more deeply on various aspects of the geometry of manifolds. Contents vary from year to year, and can range from Riemannian geometry (curvature, holonomy) to symplectic geometry, complex geometry and Hodge-Kahler theory, or smooth manifold topology. Prior exposure to calculus on manifolds, as in 18.952, is recommended.

Fall: E. Murphy
Spring: T. Colding

18.969 Topics in Geometry
Prereq: 18.965
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit

Content varies from year to year.

W. Minicozzi

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.

T. Mrowka

18.994 Seminar in Geometry
Prereq: 18.101, 18.102, 18.103, or 18.112
U (Fall)
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.

J. Lauer

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: A. Borodin, W. Minicozzi

18.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 a PhD thesis; to be arranged by the student and an appropriate MIT faculty member.

Information: A. Borodin, W. Minicozzi

18.5096 Special Subject in Mathematics
Prereq: Permission of instructor
U (IAP, Spring)
Units arranged
Can be repeated for credit

18.5097 Special Subject in Mathematics
Prereq: Permission of instructor
U (IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Opportunity for group study of subjects in mathematics not otherwise included in the curriculum. Offerings are initiated by members of the Mathematics faculty on an ad hoc basis, subject to departmental approval. 18.5097 is graded P/D/F.

Information: G. Staffilani

18.5995–18.5998 Special Subject in Mathematics
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: G. Staffilani
### Bachelor of Science in Mathematics/Course 18

#### General Institute Requirements (GIrS)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</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 (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 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).

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Subjects</td>
<td>12</td>
</tr>
<tr>
<td>One of the following two subjects:</td>
<td></td>
</tr>
<tr>
<td>18.03 or 18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>96–102</td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>General Mathematics Option</td>
<td></td>
</tr>
<tr>
<td>Eight 12-unit subjects of essentially 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.</td>
<td></td>
</tr>
<tr>
<td>Applied Mathematics Option</td>
<td></td>
</tr>
<tr>
<td>18.310A Principles of Discrete Applied Mathematics, 12; Calculus II (GIR) or 18.310 Principles of Discrete Applied Mathematics, 15, CI-M; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.311 Principles of Continuum Applied Mathematics, 12; Calculus II (GIR), 18.03*</td>
<td></td>
</tr>
<tr>
<td>One of the following two subjects:</td>
<td></td>
</tr>
<tr>
<td>18.04 Complex Variables with Applications, 12; Calculus II (GIR), 18.03*</td>
<td></td>
</tr>
<tr>
<td>18.112 Functions of a Complex Variable, 12; 18.100, 18.06*</td>
<td></td>
</tr>
<tr>
<td>One of the following two subjects:</td>
<td></td>
</tr>
<tr>
<td>18.06 Linear Algebra, 12, REST; Calculus II (GIR) or 18.700 Linear Algebra, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>Four additional 12-unit Course 18 subjects from the following two groups with at least one subject from each group:</td>
<td></td>
</tr>
<tr>
<td>Group I—Probability and statistics, combinatorics, computer science</td>
<td></td>
</tr>
<tr>
<td>Group II—Numerical analysis, physical mathematics, nonlinear dynamics</td>
<td></td>
</tr>
<tr>
<td>Theoretical Mathematics Option</td>
<td></td>
</tr>
<tr>
<td>18.100 Real Analysis, 12; Calculus II (GIR)*</td>
<td></td>
</tr>
<tr>
<td>18.701 Algebra I, 12; 18.100*</td>
<td></td>
</tr>
<tr>
<td>18.702 Algebra II, 12; 18.701</td>
<td></td>
</tr>
<tr>
<td>18.901 Introduction to Topology, 12; 18.100*</td>
<td></td>
</tr>
<tr>
<td>One of the following subjects:</td>
<td></td>
</tr>
<tr>
<td>18.101 Analysis and Manifolds, 12; 18.100, 18.06*</td>
<td></td>
</tr>
<tr>
<td>18.102 Introduction to Functional Analysis, 12; 18.100, 18.06*</td>
<td></td>
</tr>
<tr>
<td>18.103 Fourier Analysis—Theory and Applications, 12; 18.100, 18.06*</td>
<td></td>
</tr>
<tr>
<td>An undergraduate seminar from the following list: 18.104, 18.504, 18.704, 18.784, 18.904, 18.994 (12 units).</td>
<td></td>
</tr>
<tr>
<td>Two additional 12-unit Course 18 subjects of essentially different content, with the first decimal digit one or higher (24 units)</td>
<td></td>
</tr>
<tr>
<td>Departmental Program Units That Also Satisfy the GIRs</td>
<td>(12)</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
<td>78–84</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 and corequisites are listed in the subject description.

(1) Students may substitute one of the more advanced subjects 18.152 Introduction to Partial Differential Equations or 18.303 Linear Partial Differential Equations: Analysis and Numerics for 18.03.

(2) Students may substitute the more advanced subject 18.701 Algebra I.

(3) A list of acceptable subjects is available from Math Academic Services 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>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)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement [one subject can be satisfied by 18.03, 18.034, 18.06, or 18.700 in the Departmental Program]</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total GIR Subjects Required for SB Degree**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total GIR Subjects</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>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>
</tbody>
</table>

**Required Subjects**

<table>
<thead>
<tr>
<th>Subject Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03 or 18.034 Differential Equations, 12, REST; Calculus II (GIR)</td>
<td>96–99</td>
</tr>
<tr>
<td>18.06 or 18.700 Linear Algebra, 12, REST; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.100J 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, 18.062J</td>
<td></td>
</tr>
<tr>
<td>One subject from each of the following three groups:</td>
<td></td>
</tr>
<tr>
<td>18.062J Mathematics for Computer Science, 12, REST; Calculus I (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.310 Principles of Discrete Applied Mathematics, 12; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.310 Principles of Discrete Applied Mathematics, 15, CI-M; Calculus II (GIR)</td>
<td></td>
</tr>
<tr>
<td>18.100J Automata, Computability, and Complexity, 12; 18.062J</td>
<td></td>
</tr>
<tr>
<td>18.404J Theory of Computation, <em>12; 18.062J</em></td>
<td></td>
</tr>
<tr>
<td>6.005 Elements of Software Construction, 12; 6.01, 18.062J*</td>
<td></td>
</tr>
<tr>
<td>6.093 Computer System Engineering, 12; 6.004, 6.02</td>
<td></td>
</tr>
</tbody>
</table>

**Restricted Electives**

<table>
<thead>
<tr>
<th>Subject Description</th>
<th>Units</th>
</tr>
</thead>
</table>

**Departmental Program Units That Also Satisfy the GIRs**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(24)</td>
<td></td>
</tr>
</tbody>
</table>

**Unrestricted Electives**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>180–186</td>
<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 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 one of the more advanced subjects 18.152 Introduction to Partial Differential Equations or 18.303 Linear Partial Differential Equations: Analysis and Numerics for 18.03.

*Students may substitute the more advanced subject 18.705 Algebra 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](http://student.mit.edu/catalog/index.cgi).
from clonal diseases. Students taking 20.215 do additional research and computer modeling.

E. V. Gostjeva, W. G. Thilly

20.104J Environmental Cancer Risks, Prevention, and Therapy
(Same subject as 1.081J)
Prereq: Calculus II (GIR), Biology (GIR), Chemistry (GIR)
U (Spring)
3-0-9
Analysis of the history of cancer and vascular disease mortality rates in predominantly European- and African-American US cohorts, 1895-2010, to discover specific historical shifts. Shifts identified are explored in terms of contemporaneously changing environmental risk factors: air-, food- and water-borne chemicals; subclinical infections; diet and lifestyles. Role of occupational data identifying general risk factors. Considers the hypotheses that environmental factors affect metakaryotic stem cell mutation rates in fetuses and juveniles and/or the growth rates of preneoplastic stem cells in adults. Interaction of environmental and inherited risks. Introduces the use of metakaryocidal drugs to treat cancer in clinical trials.

W. Thilly, R. McCunney

20.106J Systems Microbiology
(Same subject as 1.084J)
Prereq: Chemistry (GIR), Biology (GIR)
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9
Introductory microbiology from a systems perspective—considers microbial diversity and the integration of data from a molecular, cellular, organismal, and ecological context to understand the interaction of microbial organisms with their environment. Special emphasis on specific viral, bacterial, and eukaryotic microorganisms and their interaction with animal hosts with focus on contemporary problems in areas such as vaccination, emerging disease, antimicrobial drug resistance, and toxicology.

E. DeLong, J. Runstadler

20.109 Laboratory Fundamentals in Biological Engineering
(Subject meets with 20.S109)
Prereq: Biology (GIR), Chemistry (GIR), 6.0002, 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. Students complete some laboratory time online in advance of each class. Enrollment limited; priority to Course 20 majors.

Fall: A. Belcher, B. Engelward, S. Hughes, N. Kuldell, A. Stachowiak
Spring: A. Jasano, J. Runstadler, A. Stachowiak, S. Hughes

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, 20.111

L. Griffith, C. Voigt
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)
Credit cannot also be received for 2.772, 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. Meets with 5.60 first half of term.
E. Alm, M. Yaffe

20.129J Biological Circuit Engineering Laboratory
(Same subject as 6.129J)
Prereq: Biology (GIR), Calculus II (GIR)
U (Spring)
2-8-2 Institute LAB
See description under subject 6.129J.
T. Lu, R. Weiss

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 Fundamentals of Drug Development
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
Addresses the scientific basis for the development of new drugs. First half of term begins with an overview of the drug discovery process, followed by fundamental principles of pharmacokinetics, pharmacodynamics, metabolism, and the mechanisms by which drugs cause therapeutic and toxic responses. Second half applies principles to case studies and literature discussions of current problems with specific drugs, drug classes, and therapeutic targets.
P. C. Dedon, M. A. Murcko, S. R. Tannenbaum

Prereq: Permission of instructor
G (Spring)
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. Offered first half of spring term.
J. G. Fox, B. Marini, M. Whary

20.205J Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience
(Same subject as 9.26J)
Prereq: 7.28, 7.32, or 20.020; 9.01 or 9.09
U (Spring)
3-0-9
See description under subject 9.26J.
F. Zhang

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 Macroepidemiology, Population Genetics, and Stem Cell Biology of Human Clonal Diseases
(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 risks for common human cancers and vascular diseases. Includes an introduction to metakaryotic stem cell biology. Analyzes large, organized historical public health databases using quantitative cascade computer models that include population stratification of stem cell mutation rates in fetal/juvenile tissues and growth rates in preneoplastic and atherosclerotic plaques. Means to test hypotheses (CAST) that certain genes carry mutations conferring risk for common cancers via genetic analyses in large human cohorts.
W. G. Thilly

20.219 Selected Topics in Biological Engineering
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

20.260 Analysis and Presentation of Complex Biological Data
(Subject meets with 20.560)
Prereq: Permission of instructor
U (IAP)
2-0-2 [P/D/F]
Illustrates best practices in the statistical analysis of complex biological datasets and the graphical representation of such analyses. Covers fundamental concepts in probability and statistical theory as well as principles of information design. Provides mathematical concepts and tools that enable students to make sound judgments about the application of statistical methods and to present statistical results in clear and compelling visual formats. Assignments focus on key concepts and their application to practical examples. Assumes basic knowledge of calculus and programming in MATLAB or R. Students taking graduate version complete additional assignments.
P. Blainey

20.300 Advanced Workshop in Biological Engineering Communication: Professors Share Their Practices
Prereq: Permission of instructor
U (IAP)
3-0-0 [P/D/F]
Working scientists and engineers discuss best practices for written, visual, and oral communication in the classroom, the lab, and the workplace. In a series of lectures, successful academics and industry professionals share how
they prepare papers, talks, and graphics. Recitations allow deeper exploration of the lecture topics. With faculty guidance, students develop their own projects during workshops. Emphasizes systematic approaches and transferable skills such as effective drafting and revision. Topics include creating compelling visuals to represent data and concepts; formal/informal writing, from research papers to cover letters; and developing memorable talks and presentations. Examples drawn from biological engineering research. Enrollment limited; preference to Course 20 majors.

E. Alm, J. Goldstein, A. Stachowiak

20.305J Principles of Synthetic Biology
(Same subject as 6.580J)
(Subject meets with 6.589J, 20.405J)
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)
(Subject meets with 20.409)
Prereq: Biology (GIR), Physics II (GIR), 6.0002, 18.03, 20.330; 2.001, 20.310, or 6.02; or permission of instructor
U (Fall, Spring)
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 electromechanical probes (atomic force microscopy, optical traps, MEMS devices). Application of statistics, probability, signal and noise analysis, and Fourier techniques to experimental data. Enrollment limited; preference to Course 20 juniors and seniors.

Fall: P. Blainey, A. Jasanoff, S. Manalis, S. Nagle, S. Wasserman
Spring: E. Boyden, M. Jonas, S. Nagle, P. So, S. Wasserman, M. Yanik

20.310J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.797J, 3.053J, 6.024J)
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.

R. D. Kamm, A. J. Grodzinsky, K. Van Vliet

20.320 Analysis of Biomolecular and Cellular Systems
Prereq: 20.110, 18.03, 6.0002; 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 2.793J, 6.023J)
Prereq: Physics II (GIR); 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

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 term and complete a final design project in the second half. Lab emphasizes design process and skillful realization of a robust system. Enrollment limited; preference to Course 20 majors and minors.

E. Boyden, M. Jonas, S. F. Nagle, P. So, S. Wasserman, M. F. Yanik

20.360J 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, L. Griffith
20.363J Biomaterials Science and Engineering
(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 and Neurophysiology
(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) 4-2-6
See description under subject 6.021J.
J. Han, T. Heldt, J. Voldman

20.380J 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.
D. Irvine, K. Ribbeck, C. Voigt

20.385J 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

20.390J Foundations of Computational and Systems Biology
(Same subject as 6.802J, 7.36J)
(Subject meets with 6.874J, 7.91J, 20.490J, HST.506J)
Prereq: Biology (GIR); 6.0002 or 6.01; or 7.05; or permission of instructor
U (Spring) 3-0-9
See description under subject 7.36J.
C. Burge, E. Fraenkel, D. Gifford

20.405J Principles of Synthetic Biology
(Same subject as 6.589J)
(Subject meets with 6.580J, 20.305J)
Prereq: None
G (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

20.409 Biological Engineering II: Instrumentation and Measurement
(Subject meets with 2.673J, 20.309J)
Prereq: Permission of instructor
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, 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. Limited to 5 graduate students.
Fall: P. Blainey, A. Jasanoff, S. Manalis, S. Nagle, S. Wasserman
Spring: E. Boyden, S. Nagle, P. So, S. Wasserman, M. Yanik

20.410J Molecular, Cellular, and Tissue Biomechanics
(Same subject as 2.785J, 3.971J, 6.524J, 10.537J)
Prereq: Biology (GIR); 2.002, 2.006, 6.013, 10.301, or 10.302
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, or 2.01 and 2.02A; Chemistry (GIR), Biology (GIR); or permission of instructor
G (Fall) 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 and physical chemistry to molecular and cellular biological systems. Information theory is used
to analyze sequence conservation and co-evolution, statistical mechanics is used to treat binding equilibria and biopolymer conformation, and transition-state theory is used to analyze kinetics of rate processes in the cell. Example case studies include transcription factor binding and target site recognition in DNA, cooperative binding of ligands to cell surface receptors, and DNA and RNA structure and dynamics in viruses, bacteria, and eukaryotic cells. Quantitative experimental assays to measure protein and nucleic acid structure and dynamics are discussed in detail.

*M. Bathe, P. Spector*

**20.416J Topics in Biophysics and Physical Biology**  
(Same subject as 7.74J, 8.590J)  
Prereq: None  
G (Fall)  
3-0-4 P/D/F

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

*M. Bathe, J. Gore*

**20.420J Biomolecular Kinetics and Cellular Dynamics**  
(Same subject as 10.538J)  
Prereq: 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, R. D. Kamm*

**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.

*D. Lauffenburger, F. White, M. Yaffe*

**20.441J Biomaterials: Tissue Interactions**  
(Same subject as 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 development and implementation of biomaterials for the fabrication of medical devices/implants, including artificial organs and matrices for tissue engineering and regenerative medicine. Employs a conceptual model, the ‘‘unit cell’’ process for analysis of the mechanisms underlying wound healing and tissue remodeling following implantation of biomaterials/devices in various organs, including matrix synthesis, degradation, and contraction. Methodology of tissue and organ regeneration. Discusses methods for biomaterials surface characterization and analysis of protein adsorption on biomaterials. Design of implants and prostheses based on control of biomaterials-tissue interactions. Comparative analysis of intact, biodegradable, and bioreplaceable implants by reference to case studies. Criteria for restoration of physiological function for tissues and organs.

*I. V. Yannas, M. Spector*

**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.

*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, 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

Compares the complex molecular and cellular interactions in health and disease between commensal microbial communities, pathogens and the human or animal host. Special focus is given to current research on microbe/host interactions, infection of significant importance to public health, and chronic infectious disease. Classroom will include lecture, but emphasize critical evaluation and class discussion of recent scientific papers, and the development of new research agendas in the fields presented.

*J. C. Niles, J. Runstadler, R. Sasisekharan*
20.451J Design of Medical Devices and Implants
(Same subject as 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: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.881J.

20.454J Neurotechnology Ventures
(Same subject as 9.455J, 15.128J, MAS.883J)
Prereq: 3.034, 20.110, or permission of instructor
G (Fall)
2-0-7 H-LEVEL Grad Credit
See description under subject MAS.883J.
J. Bonsen, E. S. Boyden, R. Ellis-Behnke

20.463J Biomaterials Science and Engineering
(Same subject as 3.963J)
(Subject meets with 3.055J, 20.363J)
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
(Same subject as 2.794J, 6.521J, 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 6.521J.
D. M. Freeman, J. Han, T. Heldt, J. Voldman, M. F. Yanik

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.
T. Heldt, R. G. Mark, C. M. Stultz

20.472J Neuroimaging Cells and Circuits
(Same subject as 9.472J)
Prereq: Permission of instructor
G (Fall)
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, 7.91, 18.417, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 6.581J.
B. Tidor, J. K. White

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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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
See description under subject 20.260.
P. T. So, C. Sheppard

20.487J Optical Microscopy and Spectroscopy for Biology and Medicine
(Same subject as 7.915J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 6.802J, 6.874J, 7.36J, 20.390J, HST.506J)
Prereq: Biology (GIR), 6.0002 or 6.01; or 7.05; or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 7.911.
C. Burge, E. Fraenkel, D. Gifford

20.507J Biological Chemistry I
(Same subject as 5.07J)
Prereq: 5.12
U (Fall)
5-0-7 REST
Credit cannot also be received for 7.05
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
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 5.54J.
B. Pentelute, M. Shoulders

20.560 Analysis and Presentation of Complex Biological Data
(Subject meets with 20.260)
Prereq: Permission of instructor
G (IAP)
2-0-2 [P/D/F]
Illustrates best practices in the statistical analysis of complex biological datasets and the graphical representation of such analyses. Covers fundamental concepts in probability and statistical theory as well as principles of information design. Provides mathematical concepts and tools that enable students to make sound judgments about the application of statistical methods and to present statistical results in clear and compelling visual formats. Assignments focus on key concepts and their
application to practical examples. Assumes basic knowledge of calculus and programming in MATLAB or R. Students taking graduate version complete additional assignments.

P. Blainey

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

20.903 Independent Study in Biological Engineering
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 faculty member. Projects require prior approval, as well as a substantive paper. Minimum 6-12 units required.
Staff

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

20.951 Thesis Proposal
Prereq: Permission of instructor
G (Fall, Spring, Summer)
0-24-0 [P/D/F] H-LEVEL Grad 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 Engineering Practice Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (Fall, IAP)
1-0-0 [P/D/F]

See description under subject 2.EPW.
Staff

20.970 Special Subject in Biological Engineering
Prereq: Permission of instructor
G (Fall, Spring, Summer)
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. Consult S. Manalis
## 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 [can be satisfied by 5.12 and 18.03 in the Course 20 Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 20.109]</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

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

#### Required Core Subjects

<table>
<thead>
<tr>
<th>Subject Name</th>
<th>Units</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03</td>
<td>12</td>
<td>REST, Calculus II (GIR)</td>
</tr>
<tr>
<td>20.110J</td>
<td>12</td>
<td>REST, Calculus II (GIR), Chemistry (GIR) or 20.111J Physical Chemistry of Biomolecular Systems, 12; Calculus II (GIR), Chemistry (GIR), Physics I (GIR), Physics II (GIR)</td>
</tr>
<tr>
<td>5.12</td>
<td>12</td>
<td>REST, Chemistry (GIR)</td>
</tr>
<tr>
<td>20.109</td>
<td>15</td>
<td>LAB, CI-M, Biology (GIR), Chemistry (GIR), 6.0002, 18.03, 20.110*</td>
</tr>
<tr>
<td>7.03</td>
<td>12</td>
<td>REST, Biology (GIR)</td>
</tr>
<tr>
<td>6.0001</td>
<td>12</td>
<td>REST, Chemistry (GIR)</td>
</tr>
<tr>
<td>6.0002</td>
<td>6</td>
<td>REST, Biology (GIR), Chemistry (GIR), 6.0002, 18.03, 20.110</td>
</tr>
<tr>
<td>5.07</td>
<td>12</td>
<td>REST; 5.12*</td>
</tr>
<tr>
<td>7.05</td>
<td>12</td>
<td>REST; 5.12*</td>
</tr>
<tr>
<td>7.06</td>
<td>12</td>
<td>7.03, 7.05</td>
</tr>
<tr>
<td>20.310J</td>
<td>12</td>
<td>REST, Biology (GIR), 2.370*, 18.03*, Biology (GIR)</td>
</tr>
<tr>
<td>20.320</td>
<td>12</td>
<td>20.110, 18.03, 6.0002, 5.07</td>
</tr>
<tr>
<td>20.300J</td>
<td>12</td>
<td>Physics II (GIR), 20.320*</td>
</tr>
<tr>
<td>20.309</td>
<td>12</td>
<td>REST, Biology (GIR), Physics II (GIR), 6.0002, 18.03, 20.310; 20.320*; or permission of instructor</td>
</tr>
<tr>
<td>20.310</td>
<td>12</td>
<td>7.06, 20.309</td>
</tr>
</tbody>
</table>

#### Restricted Electives

21–24

#### Departmental Program Units That Also Satisfy the GIRs

(36)

#### Unrestricted Electives

48

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

192–195

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.

* The combination of 6.0001 and 6.0002 counts as a REST subject.

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 below.

21.THT Humanities Pre-Thesis Tutorial
Prereq: As specified for particular field
U (Fall, Spring)
Units arranged
Can be repeated for credit
Definition of and early-stage work on thesis project leading to 21.ThU Undergraduate Thesis in Humanities. Taken during the first term of the student’s two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Required for all students in Course 21, and those doing 21-E and 21-S degrees, for whom the thesis is a degree requirement. 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 Undergraduate 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

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [all but two Humanities, Arts, and Social Sciences Distribution 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>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>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).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PLUS Departmental Program</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>Restricted Electives</td>
<td>126–162</td>
</tr>
<tr>
<td>German</td>
<td></td>
</tr>
<tr>
<td>Eight elective subjects in the field (which may include a pre-thesis and a thesis), plus a four-subject cluster$^{(2)}$.</td>
<td></td>
</tr>
</tbody>
</table>

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. Students must designate CI-M subjects by petitioning the Subcommittee on the Communication Requirement.

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(54–72)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>90–108</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<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

$^{(1)}$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

<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 Distribution subjects can be satisfied by subjects in the Departmental Program</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
<td></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**
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**
Seven elective subjects (should follow the general structure of the Ancient and Medieval Studies Minor Program), a pre-thesis tutorial, and a thesis.

**Anthropology**
Nine subjects including 21A.00 or 21A.01, 21A.802, and 21A.852. An honors thesis may be done at the invitation and approval of faculty.

**Asian and Asian Diaspora Studies**
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**
Eight CMS subjects, including 21L.011 or CMS.100, one mid-tier subject (CMS.400, CMS.403, CMS.405, or CMS.429), one capstone subject (21L.706 or CMS.701), 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)**
Nine elective subjects, which may include a pre-thesis and thesis, subject to faculty approval.

**History**
Seven elective subjects, a pre-thesis tutorial, and a thesis.

**Latin American and Latino Studies**
Introduction to Latin American Studies (21F.084J/17.55J/21A.130J) 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**
Eight elective subjects (including two seminars and subjects in three historical periods or thematic complexes).

**Music**
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**
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 6-unit pre-thesis tutorial and a 12-unit thesis.

**Theater Arts**
Eight subjects (including Script Analysis, Theater Practicum, and Stagecraft), a pre-thesis tutorial, and a thesis.

**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.
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.

Writing: Digital Media
Three subjects in digital media (21W.764, 21W.765), and a CI-M subject in writing, three related subjects from another department, a pre-thesis tutorial, and a thesis.

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.

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.

For 21S
Six elective subjects restricted to one of the science curricula and approved by a faculty member in the field.

Departmental Program Units That Also Satisfy the GIRs

Unrestricted Electives

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 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 by special arrangement with the Dean of the School of Humanities, Arts, and Social Sciences.

(3) Russian language subjects beyond level IV 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 eight areas: Core Subjects; Culture and Identity; Religion and Belief; Global Health; Environment, Development, and Conflict; Science, Technology, and Media; Cross-cultural Dialog and Investigations; and Independent Study, Special Subjects, and Thesis.

## CORE SUBJECTS

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

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

Staff

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

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

H. Paxson, M. Vidart-Delgado

## CULTURE AND IDENTITY

### 21A.101J Identity and Difference
(Same subject as WGS.170J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S; 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.102 Ethnic and National Identity
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S; 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.103J The Science of Race, Sex, and Gender
(Same subject as STS.046J, WGS.225J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

See description under subject WGS.225J.

A. Sur, S. Helmreich

### 21A.104 Memory, Culture, and Forgetting
(Subject meets with 21A.119)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-0-7 HASS-S

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

M. Buyandelger

### 21A.111J Rethinking the Family, Sex, and Gender
(Same subject as WGS.172J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S

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

H. Paxson
21A.119 Memory, Culture, and Forgetting
(Subject meets with 21A.104)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9
Introduces scholarly debates about the sociocultural practices through which individuals and societies create, sustain, recall, and erase memories. Emphasis is given to the history of knowledge, construction of memory, the role of authorities in shaping memory, and how societies decide on whose versions of memory are more “truthful” and “real.” Other topics include how memory works in the human brain, memory and trauma, amnesia, memory practices in the sciences, false memory, sites of memory, and the commodification of memory. Students taking graduate version complete additional assignments.
M. Buyandelger

21A.120 American Dream: Exploring Class in the US
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
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.125J Black Matters: Introduction to Black Studies
(Same subject as 2A.912J, 21H.106J, 21L.008J, 21W.741J, WGS.190J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-A, HASS-H; CI-H
See description under subject 24.912J.
Staff

21A.130J Introduction to Latin American Studies
(Same subject as 17.55J, 21F.084J)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S; CI-H
See description under subject 17.55J.
R. Bateson

21A.140J Cultures of East Asia
(Same subject as 21F.047J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
Explores diverse cultures, everyday experiences, and political economies in East Asian countries, such as China, Japan, Korea, and Singapore, with additional examples from the surrounding regions. Examines the different ways people in these regions experience and understand globalization, as well as the changing structures of kinship and family, work and organizational culture, media, consumption, and the role of government. Readings cover ethnographic studies of the world’s largest seafood market in Tokyo, the effect of the Asian financial crisis on South Korea, the role of science in formulating China’s one child policy and its economic and social implications, and the state and ethnic diversity in Singapore.
M. Buyandelger

21A.141J Images of Asian Women: Dragon Ladies and Lotus Blossoms
(Same subject as 21F.048J, WGS.274J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
Explores some of the forces and mechanisms through which stereotypes are built and perpetuated. In particular, examines stereotypes associated with Asian women in colonial, nationalist, state-authoritarian, and global/diasporic narratives about gender and power. Students read ethnography, fiction, and history, and view films to examine the politics and circumstances that create and perpetuate the representation of Asian women as dragon ladies, lotus blossoms, despotic tyrants, desexualized servants, and docile subordinates. Students are introduced to debates about Orientalism, gender, and power.
M. Buyandelger

21A.142J Japanese Literature and Cinema
(Same subject as 21F.065J)
(Subject meets with 21F.593)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H
See description under subject 21F.065J.
J. Cullen

21A.143J Japanese Popular Culture
(Same subject as 21F.039J)
(Subject meets with 21F.591)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Explores the diverse ways that people teach and learn in different countries, disciplines, and subcultures (computer gamers, magicians, jazz musicians, etc.). Compares schooling to other forms of knowledge transmission, from initiation and apprenticeship to recent innovations in online education. Students discuss various learning theories and apply them to a variety of in-class activities using qualitative methods to conduct original research on topics of their choice. Limited to 15.
G. Jones

21A.150 Teaching and Learning: Cross-Cultural Perspectives
Prereq: None
U (Fall)
3-0-9 HASS-S
Explores the diverse ways that people teach and learn in different countries, disciplines, and subcultures (computer gamers, magicians, jazz musicians, etc.). Compares schooling to other forms of knowledge transmission, from initiation and apprenticeship to recent innovations in online education. Students discuss various learning theories and apply them to a variety of in-class activities using qualitative methods to conduct original research on topics of their choice. Limited to 15.
H. Paxson

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

21A.200 Magic, Science, and Religion
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
Explores the origins of magic, science, and religion as forms of belief within and across cultures. Addresses the place of rationality and belief in competing sociocultural theories, with a focus on analyzing modern perspectives. 
Examines how cases of overlap between magic, science, and religion raise new questions about modernity and human nature.
G. Jones

21A.201J The Supernatural in Music, Literature and Culture
(Same subject as 21L.013J, 21M.013J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A, HASS-H; CI-H
See description under subject 21M.013J.
C. Shadle, M. Fuller

21A.203 Anthropology through Speculative Fiction
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
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

GLOBAL HEALTH

21A.300 Practicum in Global Health and Development
(Subject meets with 21A.329)
Prereq: None
U (Fall)
3-3-6 HASS-S
Provides training for students to critically analyze the relationship between "health" and "development." Draws upon the theory and methods of medical anthropology, social medicine, public health, and development to track how culture, history, and political economy influence health and disease in global communities.
Students work in teams to formulate research questions, and collect and analyze qualitative data in clinical and community settings in the greater Boston area, in order to design effective development interventions aimed at reducing health disparities in the US and abroad.
Students taking graduate version complete additional assignments.
E. C. James

21A.301 Disease and Health: Culture, Society, and Ethics
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
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.302J Dilemmas in Biomedical Ethics: Playing God or Doing Good?
(Same subject as WGS.271J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
An introduction to the cross-cultural study of biomedical ethics. Examines moral foundations of the science and practice of western biomedicine through case studies of abortion, contraception, cloning, organ transplantation and other issues. Evaluates challenges that new medical technologies pose to the practice and availability of medical services around the globe, and to cross-cultural ideas of kinship and personhood. Discusses critiques of the biomedical tradition from anthropological, feminist, legal, religious, and cross-cultural theorists.
E. C. James

21A.303J The Anthropology of Biology
(Same subject as STS.060J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
Applies the tools of anthropology to examine biology in the age of genomics, biotechnological enterprise, biodiversity conservation, pharmaceutical bioprospecting, and synthetic biology. Examines such social concerns such as bioterrorism, genetic modification, and cloning. Offers an anthropological inquiry into how the substantives 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.304J Reproductive Politics and Technologies
(Same subject as WGS.175J)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-S
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.306 Culture, Embodiment, and the Senses
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
Examines historical and cross-cultural debates about the relationship between mind, brain, emotion, and behavior; memory and recall;
sensory experience; and illness and healing. Assesses cultural traditions that challenge scientific interpretations of experience arising from western philosophical and physiological models. Explores how experience itself is culturally mediated, interpreted, and elaborated within symbolic, political, and other fields.

E. C. James

21A.319J History and Anthropology of Medicine and Biology
(Subject meets with STS.330J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject STS.330J.
S. Helmreich

21A.329 Practicum in Global Health and Development
(Subject meets with 21A.300)
Prereq: None
G (Fall)
3-3-6

Provides training for students to critically analyze the relationship between “health” and “development.” Draws upon the theory and methods of medical anthropology, social medicine, public health, and development to track how culture, history, and political economy influence health and disease in global communities. Students work in teams to formulate research questions, and collect and analyze qualitative data in clinical and community settings in the greater Boston area, in order to design effective development interventions aimed at reducing health disparities in the US and abroad. Students taking graduate version complete additional assignments.

E. C. James

ENVIRONMENT, DEVELOPMENT, AND CONFLICT

21A.400 The Stakes of International Development
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S; CI-H

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

C. Walley

21A.409J Ethics of Intervention
(Subject meets with 11.238J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 it is 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.410 Environmental Struggles
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

Offers an international perspective on the environment. Using environmental conflict to consider the stakes that groups in various parts of the world have in nature, while also exploring how ecological and social dynamics interact and change over time, subject considers controversial environmental issues as: nuclear contamination in Eastern Europe; genetic biopropecting 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.411J People and Other Animals
(Subject meets with 21A.419J, 21H.380J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-0-10

See description under subject 21H.380J.

H. Ritvo

21A.415J Energy Decisions, Markets, and Policies
(Subject meets with 11.161J, 14.43J, 15.031J, 17.397J)
Prereq: 14.01, 15.016, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
4-0-8 HASS-S

See description under subject 15.031J.
D. Lessard, R. Schmalensee, S. Silbey, C. Warshaw

21A.419J People and Other Animals
(Subject meets with 21H.380J)
(Subject meets with 21A.411J, 21H.380J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
2-0-10

See description under subject 21H.380J.

H. Ritvo

21A.429J Environmental Conflict and Social Change
(Subject meets with 11.161J, 14.43J, 15.031J, 17.397J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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.439J Food and Power
(Subject meets with STS.429J)
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit

See description under subject STS.429J.

H. Paxson
21A.442J Violence, Human Rights, and Justice
(Same subject as WGS.270J)
Prereq: None
U (Fall)
3-0-9 HASS-S

An examination of the problem of mass violence and oppression in the contemporary world, and of the concept of human rights as a defense against such abuse. Explores questions of cultural relativism, race, gender and ethnicity. Examines case studies from war crimes tribunals, truth commissions, anti-terrorist policies and other judicial attempts to redress state-sponsored wrongs. Considers whether the human rights framework effectively promotes the rule of law in modern societies. Students debate moral positions and address ideas of moral relativism.
E. C. James

21A.445J Slavery and Human Trafficking in the 21st Century
(Same subject as WGS.272J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

Explores the issue of human trafficking for forced labour and sexual slavery, focusing on its representation in recent scholarly accounts and advocacy as well as in other media. Ethnographic and fictional readings along with media analysis help to develop a contextualized and comparative understanding of the phenomena in both past and present contexts. Examines the wide range of factors and agents that enable these practices, such as technology, cultural practices, social and economic conditions, and the role of governments and international organizations. Discusses the analytical, moral and methodological questions of researching, writing, and representing trafficking and slavery.
M. Buyandelger

21A.455J Law and Society
(Same subject as 11.163J, 17.249J)
(Subject meets with 21A.459)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-S

Studies legal reasoning, types of law and legal systems, and relationship of law to social class and social change. Emphasizes the profession and practice of law, including legal education, stratification within the bar, and the politics of legal services. Investigates emerging issues in the relationship between institutions of law and science.
S. Silbey

21A.459 Seminar in Readings on Law and Society
(Subject meets with 11.163J, 17.249J, 21A.455J)
Prereq: Permission of instructor
G (Fall)
Not offered regularly; consult department
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.461 What Is Capitalism?
Prereq: None
U (Fall)
3-0-9 HASS-S; CI-H

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

21A.462 Fun and Games: Cross-Cultural Perspectives
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S

Surveys major theories of play in 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.503J Language and Technology
(Same subject as 24.913J, STS.070J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S

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.

G. Jones

21A.504J Cultures of Computing
(Same subject as STS.086J, WGS.276J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

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.505J The Anthropology of Sound
(Same subject as STS.065J)
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-S
Credit cannot also be received for CMS.407

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

H. Paxson

21A.506 The Business of Politics: A View of Latin America
Prereq: None
U (Spring)
3-0-9 HASS-S

Examines the birth and international expansion of an American industry of political marketing with an emphasis on Latin America. Focuses attention on the cultural processes, sociopolitical contexts and moral utopias that shape the practice of political marketing in the US and in different Latin American countries. By looking at the debates and expert practices at the core of the business of politics, explores how the “universal” concept of democracy is interpreted and reworked through space and time. Examines how different cultural groups experimenting with political marketing understand the role of citizens in a democracy.

M. Vidart-Delgado

21A.507J Resonance: Sonic Experience, Science, and Art (New)
(Same subject as 4.648J)
Subject meets with 4.648J, 21A.519J
Prereq: None
G (Fall)
3-0-9
See description under subject 4.648J.

S. Helmreich, C. Jones

21A.509J Art, Craft, Science
(Same subject as STS.474J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9
Credit cannot also be received for 21A.501, STS.074

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

21A.519J Resonance: Sonic Experience, Science, and Art (New)
(Same subject as 4.649J)
Subject meets with 4.648J, 21A.507J
Prereq: None
G (Fall)
3-0-9
See description under subject 4.649J.

S. Helmreich, C. Jones

21A.550J DV Lab: Documenting Science through Video and New Media
(Same subject as STS.064J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-3-12 HASS-S

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.551J Advanced DV Lab: Documenting Science through Video and New Media
(Same subject as STS.068J)
Prereq: 21A.550 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-3-6 HASS-S

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
CROSS-CULTURAL DIALOG AND INVESTIGATIONS

21A.801J Cross-Cultural Investigations: Technology and Development
(Same subject as EC.702J, STS.071J)
(Subject meets with EC.792J, 21A.839J, STS.481J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 H-LEVEL Grad Credit
Enhances cross-cultural understanding through discussion of practical, ethical, and epistemological issues in conducting social science and applied research in foreign countries or unfamiliar communities. Includes research practicum to help students develop interviewing, participant-observation, and other qualitative research skills, as well as critical discussion of case studies. Open to all interested students, but intended particularly for those planning to undertake exploratory research or applied work abroad. Students taking graduate version complete additional assignments.
C. Walley

21A.802 Seminar in Ethnography and Fieldwork
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-S
Introduction to ethnographic practices: the study of and communicating about culture. Subject provides instruction and practice in writing, revision of fieldnotes, and a final paper. Preference to Anthropology majors and minors.
Staff

21A.809 Designing Empirical Research in the Social Sciences
(Subject meets with 15.347)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 qualitative and quantitative methodologies. Explores a variety of approaches to research design, evaluates the products of empirical research, and practices several common techniques. Discusses several major theoretical paradigms used as interpretive frameworks for social science research. Students develop a proposal for their own research project.
S. Silbey

21A.819J Qualitative Research Methods
(Same subject as 15.349J)
Prereq: Permission of instructor
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.829J Ethnography
(Same subject as STS.360J)
Prereq: Permission of instructor; Coreq: 21A.859
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject STS.360J.
M. Fischer

21A.839J Cross-Cultural Investigations: Technology and Development
(Same subject as EC.792J, STS.481J)
(Subject meets with EC.702J, 21A.801J, STS.071J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
Enhances cross-cultural understanding through discussion of practical, ethical, and epistemological issues in conducting social science and applied research in foreign countries or unfamiliar communities. Includes research practicum to help students develop interviewing, participant-observation, and other qualitative research skills, as well as critical discussion of case studies. Open to all interested students, but intended particularly for those planning to undertake exploratory research or applied work abroad. Students taking graduate version complete additional assignments.
C. Walley

21A.852 Seminar in Anthropological Theory
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS-S
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.
Staff

21A.859J 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.
S. Helmreich

INDEPENDENT STUDY, SPECIAL SUBJECTS, AND THESIS

21A.901 Independent Study in Anthropology
Prereq: Two subjects in Anthropology
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Opportunity for independent study, guided research, practicum, or field work under regular supervision by a faculty member. Projects require prior approval of the instructor and Head of the Anthropology Program. Normal maximum is 6 units; exceptional 9- or 12-unit projects occasionally approved. 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.902 Independent Study in Anthropology
Prereq: Two subjects in Anthropology
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Opportunity for independent study, guided research, practicum, or field work under regular supervision by a faculty member. Projects require prior approval of the instructor and Head of the Anthropology Program. Normal maximum
is 6 units; exceptional 9- or 12-unit projects occasionally approved. 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.929 Graduate Independent Study**
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

**21A.939 Graduate Independent Study**
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

**Opportunity for study or projects at an advanced level with an Anthropology faculty member.**
Consult Program Head

**21A.950 Teaching Anthropology**
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit

For qualified graduate students serving as either a teaching assistant or instructor for subjects in Anthropology. Enrollment limited by availability of suitable teaching assignments.

Staff

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

Staff

**21A.S10, 21A.S11 Special Graduate Subject in Anthropology**
Prereq: None
G (Fall, IAP, 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 theses. Includes substantial practice in writing (with revision) and oral presentations.

Consult Program Head

**21A.THU Undergraduate Thesis in Anthropology**
Prereq: 21A.ThT
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

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

Staff

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

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

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

Staff
# 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>
<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

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>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21A.00</td>
<td>Introduction to Anthropology: Comparing Human Cultures, 12, HASS-S</td>
<td>12</td>
</tr>
<tr>
<td>21A.01</td>
<td>How Culture Works, 12, HASS-S</td>
<td>12</td>
</tr>
<tr>
<td>21A.802</td>
<td>Seminar in Ethnography and Fieldwork, 12, HASS-S, CI-M *</td>
<td>12</td>
</tr>
<tr>
<td>21A.852</td>
<td>Seminar in Anthropological Theory, 12, HASS-S, CI-M *</td>
<td>12</td>
</tr>
</tbody>
</table>

### Restricted Electives

A coherent program of eight anthropology subjects which may include a pre-thesis tutorial and a thesis. The decision to write a thesis is made in consultation between the student and advisor.

### 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>72–78</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Units</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.

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).
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 country.

21F.011 Topics in Indian Popular Culture
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H; CI-H
Can be repeated for credit

Overview of Indian popular culture over the last two decades, through a variety of material such as popular fiction, music, television and Bombay cinema. Explores major themes and their representations in relation to current social and political issues, elements of the formulaic masala movie, music and melodrama, ideas of nostalgia and incumbent change in youth culture, and questions of gender and sexuality in popular fiction. Taught in English. Enrollment limited.
A. Banerjee

21F.019 Communicating Across Cultures
(Subject meets with 21F.021)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H; CI-H

21F.021 Communicating Across Cultures
(Subject meets with 21F.019)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.
J. Dunphy

21F.022J International Women’s Voices
(Same subject as 21L.048J, WGS.141J)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

See description under subject 21L.048J.
M. Resnick

21F.024J The Linguistic Study of Bilingualism
(Same subject as 24.906J)
Prereq: None
U (Fall)
3-0-9 HASS-S; CI-H

See description under subject 24.906J.
S. Flynn

21F.027J Visualizing Japan in the Modern World
(Same subject as CMS.874J)
(Subject meets with 21F.590)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H; CI-H

Studies how visual images shape the identity of peoples, cultures, and events in Japan. Uses prototype digital projects as case studies to introduce the conceptual and practical issues involved in "visualizing cultures." Projects look at American and Japanese graphics depicting contacts between Japan and the West in the 19th and early 20th centuries. Taught in English. Enrollment limited.
S. Miyagawa

21F.030J Introduction to East Asian Cultures: From Zen to K-Pop
(Same subject as WGS.236J)
(Subject meets with 21F.193)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Examines traditional forms of East Asian culture (including literature, art, performance, food, and religion) as well as contemporary forms of popular culture (film, pop music, karaoke, and manga). Covers China, Japan, Korea, Taiwan, and Hong Kong, with an emphasis on China. Considers women’s culture, as well as the influence and presence of Asian cultural expressions in the US. Uses resources in the Boston area, including the MFA, the Children’s Museum, and the Sackler collection at Harvard. Taught in English.
E. Teng

21F.036J Advertising and Media: Comparative Perspectives
(Same subject as CMS.356J)
(Subject meets with 21F.190, CMS.888)
Prereq: None
U (Spring)
3-0-9 HASS-H

Compares modern and contemporary advertising culture in China, the US, and other emerging markets. First half focuses on branding in the old media environment; second half introduces the changing practice of advertising in the new media environment. Topics include branding and positioning, media planning, social media campaigns, cause marketing 2.0, social TV, and mobility marketing. Required lab work includes interactive sessions in branding a team product for the US (or a European country) and China markets. Taught in English. Students taking graduate version complete additional assignments.
J. Wang
COURSE 21F

21F.038 China in the News: The Untold Stories (Subject meets with 21F.194)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-H

Examines issues and debates crucial to understanding contemporary Chinese society, culture, and politics. Discusses how cultural politics frames the way in which China is viewed by mass media around the world and by China scholars in the West. Topics include the Beijing Olympic Games; Mao in post-Mao China; the new patriotism; leisure and consumer culture; the rise of the internet and web culture in urban China; media censorship, remix, and creative online culture. Analyzes the central debate over progress and the role played by the state, the market, and citizen activists in engineering social change. Uses documentaries and feature films to illustrate the cultural, social and political changes that have taken place in China since the 1980s. Taught in English.

J. Wang

21F.039J Japanese Popular Culture (Same subject as 21A.143J)
(Subject meets with 21F.591)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

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.

L. Condry

21F.040 A Passage to India: Introduction to Modern Indian Culture and Society
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Introduction to Indian culture through films, short-stories, novels, essays, newspaper articles. Examines some major social and political controversies of contemporary India through discussions centered on India’s history, politics and religion. Focuses on issues such as ethnic tension and terrorism, poverty and inequality, caste conflict, the missing women, and the effects of globalization on popular and folk cultures. Particular emphasis on the IT revolution, outsourcing, the new global India and the enormous regional and subcultural differences. Taught in English.

A. Banerjee

21F.043J Introduction to Asian American Studies: Historical and Contemporary Issues (Same subject as 21H.107J)
Prereq: None
U (Fall)
3-0-9 HASS-H; 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 (Same subject as 21L.044J, WGS.235J)
(Subject meets with 21F.195)
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-H

Introduction to some of the major genres of traditional Chinese poetry, fiction, and drama. Intended to give students a basic understanding of the central features of traditional Chinese literary genres, as well as to introduce students to the classic works of the Chinese literary tradition. Works read include Journey to the West, Outlaws of the Margin, Dream of the Red Chamber, and the poetry of the major Tang dynasty poets. Literature read in translation. Taught in English.

E. Teng

21F.046 Modern Chinese Fiction and Cinema (Subject meets with 21F.192)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H; CI-H

Covers major works of Chinese fiction and film, from mainland China, Taiwan, and Hong Kong.

J. Wang

21F.047J Cultures of East Asia (Same subject as 21A.140J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

See description under subject 21A.140J.

M. Buyandelger

21F.048J Images of Asian Women: Dragon Ladies and Lotus Blossoms (Same subject as 21A.141J, WGS.274J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S

See description under subject 21A.141J.

M. Buyandelger

21F.049 French Photography (New)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-A; CI-H

Introduces students to the world of French photography from its invention in the 1820s to the present. Provides exposure to major photographers and images of the French tradition, and encourages students to explore the social and cultural roles and meanings of photographs. Designed to help students navigate their own photo-saturated worlds; provides opportunity to gain practical experience in photography. Taught in English. Enrollment limited.

C. Clark

21F.052 French Film Classics
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
2-2-8 HASS-H

History and aesthetics of French cinema from the advent of sound to present-day. Treats films in the context of technical processes, the art of narration, directorial style, role of the scriptwriter, the development of schools and movements, the impact of political events and ideologies, and the relation between French and other national cinemas. Films shown with English subtitles. Taught in English.

C. Clark
21F.053 Understanding Contemporary French Politics
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-S; CI-H

Examines the changes in contemporary French society through the study of political debates, reforms and institutions since 1958. Analyzes the deep influence of politics on cultural and social life, despite a decline in political participation. Revisits public controversies and political cleavages, from the Algerian war to postcolonial issues, from the birth of the European Union to the recent financial crisis, and from the moral “revolution” of the seventies to the recognition of new families. Course taught in English. Enrollment limited.
B. Perreau

21F.054J France 1660–1815: Enlightenment, Revolution, Napoleon
(Same subject as 21H.241J)
Prereq: None
U (Fall)
3-0-9 HASS-H
See description under subject 21H.241J.
J. Ravel

21F.055J Media in Weimar and Nazi Germany
(Same subject as CMS.311J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-2-8 HASS-H; CI-H

Debates over national and media identity in Weimar and Nazi Germany. Production and use of media under extreme political and social conditions with a focus on films (such as Nosferatu, Berlin, M, and Triumph des Willens) and other media. Media approached as both texts and systems. Considers the legacy of the period, in terms of stylistic influence (e.g. film noir), techniques of persuasion, and media’s relationship to social and economic conditions. Taught in English. Enrollment limited.
W. Uricchio

21F.059 Paragons of European Thought and Culture
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H; CI-H

Subject surveys the main currents of European cultural and intellectual history in the modern period. Introduces a set of ideas and arguments that have played a formative role in European culture, and acquaints students with exemplars of critical thought. Readings begin with the Protestant Reformation and move through the French Revolution up to the post-WWII period. Figures to be considered include Luther, Descartes, Kant, Hegel, Rousseau, Smith, Marx, Freud, Beauvoir, and Foucault. Class discussions set these texts into the context of European culture. Topics to be considered are artworks by Goya, David, and Duchamp; the architecture of Schinkel; the music of Bach; and the literature of Goethe. Taught in English.

21F.063 Anime: Transnational Media and Culture
(Subject meets with 21F.596)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Explores anime (Japanese animated films and TV shows) as a study in flows among media and cultures. Discusses Japan’s substantial share of the TV cartoon market and the reasons for anime’s worldwide success. Focuses on cultural production and the ways anime cultures are created through the interactive efforts of studios, sponsors, fans, broadcasters, and distributors. Uses anime scholarship and media examples as a means to examine leading theories in media and cultural studies, gender and sexuality, technology and identity, and post-industrial globalization. Taught in English.
I. Condry

21F.064 Introduction to Japanese Culture
(Subject meets with 21F.592)
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H

Examines the major aesthetic, social, and political elements which have shaped modern Japanese culture and society. Readings on contemporary Japan and historical evolution of the culture are coordinated with study of literary texts, film, and art, along with an analysis of everyday life and leisure activities. Taught in English.
I. Condry

21F.065J Japanese Literature and Cinema
(Same subject as 21A.142J)
(Subject meets with 21F.593)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

Surveys both cinematic and literary representations of diverse eras and aspects of Japanese culture such as the classical era, the samurai age, wartime Japan and the atomic bombings, social change in the postwar period, and the appropriation of foreign cultural themes, with an emphasis on the modern period. Directors include Akira Kurosawa and Hiroshi Teshigahara. Authors include Kobo Abe and Yukio Mishima. Films shown with subtitles in English. Taught in English. Enrollment limited.
J. Cullen

21F.068J The Invention of French Theory: A History of Transatlantic Intellectual Life since 1945
(Same subject as WGS.234J)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Examines post-WWII French theory. Discusses how theorists such as Lacan, Cixous, Derrida, and Debord were perceived in France and the US. Explores transatlantic intellectual debates since 1989 and the “new” French theory. Topics include: communism, decolonization, neo-liberalism, gender and mass media. Taught in English.
B. Perreau

21F.074 Topics in Portuguese Popular Culture
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H
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.
A. Igrejas

21F.075J The Global Chinese: Chinese Migration, 1567–Present
(Same subject as 21H.253J)
(Subject meets with 21F.196)
Prereq: None
U (Spring)
3-0-9 HASS-H

Examines Chinese migration in historical and comparative perspective, beginning in 1567 with the lifting of the imperial ban on private maritime trade. Covers migration to diverse venues across the globe, including tropical colonies, settler societies, Chinese frontiers, and postcolonial metropoles. Topics include the varied roles of Chinese migrants in these diverse venues, the coolie trade and anti-Chinese movements, overseas students, transnational
networks, cultural adaptation, and the creolization of Chinese food in migrant communities. Critically examines the degree to which this transnational migration has produced a “Global Chinese” identity. Taught in English.

**E. Teng**

**21F.076J Globalization: The Good, the Bad and the In-Between**

(Same subject as 21L.020J)


U (Fall)

3-0-6 HASS-H; CI-H

See description under subject 21L.020J. 

**M. Resnick**

See description under subject 17.55J.

**R. Bateson**

**CHINESE**

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in Chinese. These first-year 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.076J.

**Undergraduate Language Subjects**

**21F.101 Chinese I (Regular)**

(Subject meets with 21F.151, 21F.171)

Prereq: None

U (Fall, IAP)

4-0-8 HASS-H

Introduction to modern standard Chinese (Mandarin) with emphasis on developing conversational skills by using fundamental grammatical patterns and vocabulary in functional and culturally suitable contexts. Basic reading and writing are also taught. For graduate credit, see 21F.151. Placement interview with instructors required of students who have had prior exposure to Chinese before or on Reg Day. Limited to 16 per section. No listeners.

Consult H. Liao

**21F.171 Chinese I (Regular)—Globalization**

(Subject meets with 21F.101, 21F.151)

Prereq: None. Coreq: 21F.076

U (Fall)

4-0-5 HASS-H

In conjunction with 21F.076J, covers same material as 21F.101. See description under 21F.101. Students cannot receive credit without simultaneous completion of 21F.076J. Limited to 16 per section.

Consult H. Liao

**21F.102 Chinese II (Regular)**

(Subject meets with 21F.152)

Prereq: 21F.101, 21F.171, or permission of instructor

U (Spring)

4-0-8 HASS-H

Credit cannot also be received for 21F.142, 21F.162

Continuation of 21F.101. For full description, see 21F.101. For graduate credit see 21F.152. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.

Consult H. Liao

**21F.142 Intermediate Chinese I: Very Fast Track**

(Subject meets with 21F.162)

Prereq: 21F.101, 21F.171, or permission of instructor

U (Spring; first half of term)

4-0-5 HASS-H

Credit cannot also be received for 21F.102, 21F.152

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.102 as well as complete the first half of the material in 21F.103 in half the time. Placement interview on or before Registration Day required of students who have had prior exposure to Chinese elsewhere. For graduate credit, see 21F.162. Limited to 12. No listeners.

Consult H. Liao

**21F.103 Chinese III (Regular)**

(Subject meets with 21F.173)

Prereq: 21F.102 or permission of instructor

U (Fall)

4-0-8 HASS-H

Continuing instruction in spoken and written Chinese, with particular emphasis on consolidating basic conversational skills and improving reading confidence and depth. Lab work required. Placement interview with instructors before or on Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.

Consult H. Liao

**21F.173 Chinese III (Regular)—Globalization**

(Subject meets with 21F.103)

Prereq: 21F.102 or permission of instructor; Coreq: 21F.076

U (Fall)

4-0-5 HASS-H

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. Limited to 16 per section.

Consult H. Liao

**21F.143 Intermediate Chinese II: Very Fast Track**

(Subject meets with 21F.163)

Prereq: 21F.142 or permission of instructor

U (Spring; second half of term)

4-0-8 HASS-H

Credit cannot also be received for 21F.104

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 second half material of 21F.103 as well as all of 21F.104 in half the time. Placement interview on or before first day of class required of students who have had prior exposure to Chinese elsewhere. Limited to 12. No listeners.

Consult H. Liao

**21F.104 Chinese IV (Regular)**

Prereq: 21F.103, 21F.173, or permission of instructor

U (Spring)

4-0-8 HASS-H

Credit cannot also be received for 21F.143, 21F.163

Continuation of 21F.103. For full description, see 21F.103. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.

Consult H. Liao
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

Students develop more sophisticated conversational and reading skills by combining traditional textbook material with their own explorations of Chinese speaking societies, using the human, literary, and electronic resources available at MIT and in the Boston area. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult T. Chen

21F.175 Chinese V (Regular)—Globalization
(Subject meets with 21F.105)
Prereq: 21F.104 or permission of instructor;
Coreq: 21F.076
U (Fall)
3-0-6 HASS-H

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. Limited to 16 per section.
Consult 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

Continuation of 21F.105. For full description see 21F.105. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult T. Chen

21F.107 Chinese I (Streamlined)
(Subject meets with 21F.157, 21F.181)
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS-H

The first term streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. For graduate credit see 21F.157. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult M. Liang

21F.157 Chinese I (Streamlined)—Globalization
(Subject meets with 21F.107, 21F.157)
Prereq: Permission of instructor; Coreq: 21F.076
U (Fall)
3-0-6 HASS-H

In conjunction with 21F.076J, covers same material as 21F.157. See description under 21F.107. Students cannot receive credit without simultaneous completion of 21F.076J. Limited to 16 per section.
Consult M. Liang

21F.108 Chinese II (Streamlined)
(Subject meets with 21F.158)
Prereq: 21F.107, 21F.181, or permission of instructor
U (Spring)
3-0-9 HASS-H

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. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult M. Liang

21F.158 Chinese II (Streamlined)—Globalization
(Subject meets with 21F.108)
Prereq: 21F.107, 21F.181
Coreq: 21F.076
U (Spring)
3-0-6 HASS-H

In conjunction with 21F.076J, covers same material as 21F.158. See description under 21F.108. Limited to 16 per section. No listeners.
Consult M. Liang

21F.109 Chinese III (Streamlined)
(Subject meets with 21F.183)
Prereq: 21F.108 or permission of instructor
U (Fall)
3-0-9 HASS-H

Intermediate level subject in streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. Students conduct their own explorations of modern China using online and print materials, as well as interviews with Chinese in the Boston area. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult J. Zhang

21F.183 Chinese III (Streamlined)—Globalization
(Subject meets with 21F.109)
Prereq: Permission of instructor; Coreq: 21F.076
U (Fall)
3-0-6 HASS-H

In conjunction with 21F.076J, covers same material as 21F.109. See description under 21F.109. Limited to 16 per section.
Consult M. Liang

21F.110 Chinese IV (Streamlined)
Prereq: 21F.109, 21F.183, or permission of instructor
U (Spring)
3-0-9 HASS-H

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. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult J. Zhang

21F.113 Chinese V (Streamlined)
(Subject meets with 21F.118)
Prereq: 21F.110 or permission of instructor
U (Fall)
3-0-9 HASS-H

Advanced level subject in streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Chinese speaking environment) without a corresponding level of literacy. Students conduct their own explorations of modern China using online and print materials, as well as interviews with Chinese in the Boston area. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. Limited to 16 per section. No listeners.
Consult J. Zhang

21F.185 Chinese V (Streamlined)—Globalization
(Subject meets with 21F.113)
Prereq: 21F.110 or permission of instructor;
Coreq: 21F.076
U (Fall)
3-0-6 HASS-H

In conjunction with 21F.076J, covers same material as 21F.113. See description under
Graduate Language Subjects

21F.151 Chinese I (Regular)
(Subject meets with 21F.101, 21F.171)
Prereq: None
G (Fall, IAP)
4-0-5
Introduction to modern standard Chinese (Mandarin). For a full description, see 21F.101. For undergraduate credit see 21F.101. Limited to 16 per section.

Consult H. Liao

21F.152 Chinese II (Regular)
(Subject meets with 21F.102)
Prereq: 21F.151 or permission of instructor
G (Spring)
4-0-5
Continuation of 21F.151. For a description, see 21F.102. For undergraduate credit see 21F.102.

Consult H. Liao

21F.157 Chinese I (Streamlined)
(Subject meets with 21F.107, 21F.181)
Prereq: Permission of instructor
G (Fall)
3-0-6
Introduction to modern standard Chinese (Mandarin) for students with some speaking ability but little reading ability. For full description, see 21F.107. For undergraduate credit see 21F.107. Limited to 16 per section.

Consult M. Liang

21F.158 Chinese II (Streamlined)
(Subject meets with 21F.108)
Prereq: 21F.157 or permission of instructor
G (Spring)
3-0-6
Continuation of 21F.157. For a description see 21F.157. For undergraduate credit see 21F.108.

Consult M. Liang

21F.162 Intermediate Chinese I: Very Fast Track
(Subject meets with 21F.142)
Prereq: 21F.151 or permission of instructor
G (Spring; first half of term)
4-0-5
Credit cannot also be received for 21F.102, 21F.152

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 as well as complete the first half of the material in 21F.103 in half the time. Placement interview on or before Reg. Day required of students who have had prior exposure to Chinese elsewhere. For undergraduate credit, see 21F.142. Students cannot also receive credit for 21F.152. Limited to 12. No listeners.

Consult H. Liao

21F.163 Intermediate Chinese II: Very Fast Track
(Subject meets with 21F.143)
Prereq: 21F.162 or permission of instructor
G (Spring; second half of term)
4-0-5
Credit cannot also be received for 21F.104

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 second half material of 21F.103 as well as all of 21F.104 in half the time. Placement interviews on or before first day of class required of students who have had prior exposure to Chinese elsewhere. Limited to 12. No listeners.

Consult H. Liao

Chinese Language Option Subjects

21F.190 Advertising and Media: Comparative Perspectives
(Subject meets with 21F.036J, CMS.356J, CMS.888)
Prereq: 21F.104, 21F.110, or permission of instructor
U (Spring)
3-0-10 HASS-H

Compares modern and contemporary advertising culture in China, the US, and other emerging markets. First half focuses on branding in the old media environment; second half introduces the changing practice of advertising in the new media environment. Topics include branding and positioning, media planning, social media campaigns, cause marketing 2.0, social TV, and mobility marketing. Required lab work includes interactive sessions in branding a team product for the US (or a European country) and China markets. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.

E. Teng

21F.192 Modern Chinese Fiction and Cinema
(Subject meets with 21F.046)
Prereq: 21F.104, 21F.110, or permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-10 HASS-H, CI-H

Covers major works of Chinese fiction and film, from mainland China, Taiwan, and Hong Kong. Focusing on the modern period, examines how Chinese intellectuals, writers, and filmmakers have used artistic works to critically explore major issues in modern Chinese culture and society. Literature read in translation. Taught in English with a project that requires research in Chinese. Enrollment limited; preference to Chinese minors.

J. Wang

21F.193 Introduction to East Asian Cultures: From Zen to K-Pop
(Subject meets with 21F.030J, WGS.236J)
Prereq: 21F.104, 21F.110, or permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-10 HASS-H

Examines traditional forms of East Asian culture (including literature, art, performance, food, and religion) as well as contemporary forms of popular culture (film, pop music, karaoke, and manga). Covers China, Japan, Korea, Taiwan, and Hong Kong, with an emphasis on China. Considerers women’s culture, as well as the influence and presence of Asian cultural expressions in the US. Uses resources in the Boston area, including the MFA, the Children’s Museum, and the Sackler collection at Harvard. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.

J. Wang
21F.194 China in the News: The Untold Stories
(Subject meets with 21F.038)
Prereq: 21F.104, 21F.110, or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-10 HASS-H
Examines issues and debates crucial to understanding contemporary Chinese society, culture, and politics. Discusses how cultural politics frames the way in which China is viewed by mass media around the world and by China scholars in the West. Topics include the Beijing Olympic Games; Mao in post-Mao China; the new patriotism; leisure and consumer culture; the rise of the internet and web culture in urban China; media censorship, remix, and creative online culture. Analyzes the central debate over progress and the role played by the state, the market, and citizen activists in engineering social change. Uses documentaries and feature films to illustrate the cultural, social and political changes that have taken place in China since the 1980s. Taught in English with a project that requires research in Chinese. Preference to Chinese minors. 
E. Teng

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 (Spring)
Not offered regularly; consult department
3-0-10 HASS-H
Introduction to some of the major genres of traditional Chinese poetry, fiction, and drama. Intended to give students a basic understanding of the central features of traditional Chinese literary genres, as well as to introduce students to the classic works of the Chinese literary tradition. Works read include Journey to the West, Outlaws of the Margin, Dream of the Red Chamber, and the poetry of the major Tang dynasty poets. Literature read in translation. Taught in English with a project that requires research in Chinese. Preference to Chinese minors.
J. Wang

21F.196 The Global Chinese: Chinese Migration, 1567–Present (New)
(Subject meets with 21F.075J, 21H.253J)
Prereq: 21F.104, 21F.110, or permission of instructor
U (Spring)
3-0-10 HASS-H
Examines Chinese migration in historical and comparative perspective, beginning in 1567 with the lifting of the imperial ban on private maritime trade. Covers migration to diverse venues across the globe, including tropical colonies, settler societies, Chinese frontiers, and postcolonial metropoles. Topics include the varied roles of Chinese migrants in these diverse venues, the coolie trade and anti-Chinese movements, overseas students, transnational networks, cultural adaptation, and the creolization of Chinese food in migrant communities. Critically examines the degree to which this transnational migration has produced a “Global Chinese” identity. Taught in English with a project that requires research in Chinese. Preference to students in the Chinese minor.
E. Teng

21F.199 Chinese Youths and Web Culture
Prereq: 21F.113, permission of instructor
U (Spring)
3-0-9 HASS-H
Introduces the cultural trends and media habits of Chinese Generation X and the post-1990s generation, and its context of the rise of Web culture. Topics include the influence of the global Web culture on China; the cross-fertilization of Chinese culture on China; the cross-fertilization of Chinese culture with the 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

For Chinese Literature and Culture subjects offered in English, see 21F.030J, 21F.036J, 21F.038, 21F.043J, 21F.044J, 21F.046, and 21F.075J.

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. Limited to 14. No listeners.
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
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. Limited to 18. No listeners.
Staff

21F.222 Expository Writing for Bilingual Students
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-0-9 HASS-H; CI-HW
Can be repeated for credit
Formulating, organizing, and presenting ideas clearly in writing. Reviews basic principles of rhetoric. Focuses on development of a topic, thesis, choice of appropriate vocabulary, and sentence structure to achieve purpose. Develops idiomatic prose style. Gives attention to grammar and vocabulary usage. Special focus on strengthening skills of bilingual students. Intended to be taken during the student’s first year at MIT. Limited to 18; undergraduates only.
A. C. Kemp
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
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. Limited to 18 per section. No listeners.

E. Grunwald

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; CI-H
Can be repeated for credit

Analysis and practice of various forms of scientific and technical writing, from memos to journal articles. Strategies for conveying technical information to specialist and non-specialist audiences. Comparable to 21W.780, but methods designed to deal with special problems of advanced ELS or bilingual students. The goal of the workshop is to develop effective writing skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. Enrollment limited to 18 per section. No listeners.

A. C. Kemp

21F.223 Advanced Speaking and Critical Listening Skills (ELS)
(Subject meets with 21F.232)
Prereq: Placement test and permission of instructor
U (Fall, Spring)
3-3-6 HASS-H
Can be repeated for credit

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. Placement test or permission of instructor required in all cases. Limited to 15 per section. No listeners.

Fall: J. Dunphy
Spring: A. C. Kemp

Graduate Subjects

21F.217 Workshop in Strategies for Effective Teaching (ELS)
(Subject meets with 21F.218)
Prereq: None
G (IAP)
1-0-2

A mini-module for international teaching assistants. Covers special problems in teaching when English is a second language and the USA a second culture. Videotaping of practice sessions for feedback. Individualized programs to meet different needs. Graduate TA’s have priority. Limited to 14. No listeners.

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

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. Limited to 18. No listeners.

J. Dunphy

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

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. Limited to 18 per section. No listeners.

E. Grunwald

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

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. Limited to 18 per section. No listeners.

A. C. Kemp

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

Focuses on techniques, format, and prose used in academic and professional life. Emphasis on writing required in fields such as economics,
political science, and architecture. Short assignments include business letters, memos, and proposals that lead toward a written term project. Methods designed to accommodate those whose first language is not English. Develops effective writing skills for academic and professional contexts. Models, materials, topics and assignments vary from term to term. Placement test or permission of instructor required. Limited to 18 per section. No listeners.

A. C. Kemp

21F.232 Advanced Speaking and Critical Listening Skills (ELS)  
(Subject meets with 21F.233) 
Prereq: Placement test and permission of instructor 
G (Fall, Spring) 
3-3-6 
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. Placement test or permission of instructor required in all cases. Limited to 15 per section. No listeners.

Fall: J. Dunphy  
Spring: A. C. Kemp

FRENCH

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in French. These first-year 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 
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. Limited to 18 per section. 

S. Goyette  

21F.371 French I—Globalization  
Prereq: None. Coreq: 21F.076 
U (Fall) 
4-0-5 HASS-H 
Credit cannot also be received for 21F.301, 21F.351 

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. Limited to 18 per section. 

S. Goyette  

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 
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. Limited to 18 per section. 

L. Rezvani  

21F.372 French II—Globalization  
Prereq: 21F.301 or permission of instructor; Coreq: 21F.076 
U (Fall) 
4-0-5 HASS-H 
Credit cannot also be received for 21F.302, 21F.352 

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. Limited to 18 per section. 

L. Rezvani  

21F.303 French III  
Prereq: 21F.302, 21F.372, or permission of instructor 
U (Fall, Spring) 
4-0-8 HASS-H 
Credit cannot also be received for 21F.373 

Third subject in the French language sequence, with focus on intercultural understanding. Students work with a variety of materials available online such as intercultural questionnaires, surveys, newspapers, commercials, films and music. Systematic work on grammar and vocabulary expands students’ skills in understanding, speaking, reading, and writing. Meets with 21F.373 when offered concurrently. Limited to 18 per section. 

S. Levet  

21F.373 French III—Globalization  
Prereq: 21F.302 or permission of instructor; Coreq: 21F.076 
U (Fall) 
4-0-5 HASS-H 
Credit cannot also be received for 21F.303 

In conjunction with 21F.076, covers same material as 21F.303. See description under 21F.303. Students cannot receive credit without simultaneous completion of 21F.076. Meets with 21F.303 when offered concurrently. Limited to 18 per section. 

S. Levet  

21F.304 French IV  
Prereq: 21F.303, 21F.373, or permission of instructor 
U (Fall, Spring) 
4-0-8 HASS-H 
Credit cannot also be received for 21F.374 

Final subject in the French language sequence before taking intermediate subjects in French literature and culture. Further develops linguistic skills for improving the overall quality of writing and oral fluency. Uses literary texts, films, and
the Internet. Meets with 21F.374 when offered concurrently. Limited to 18 per section.

L. Rezvani

21F.374 French IV—Globalization
Prereq: 21F.303 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H
Credit cannot also be received for 21F.304

In conjunction with 21F.076J, covers same material as 21F.304. Final subject in the French language sequence before taking intermediate subjects in French literature and culture. Further develops 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.076J. Meets with 21F.304 when offered concurrently. Limited to 18 per section.

L. Rezvani

21F.306 French: Communication Intensive I
Prereq: Permission of instructor; Coreq: 21F.308, 21F.310, 21F.311, 21F.312, 21F.315, 21F.320, 21F.321, 21F.322, 21F.325j, 21F.341, 21F.346, or 21F.347
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.321, 21F.322, 21F.325j, 21F.341, 21F.346, or 21F.347
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.

C. Clark

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

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

Training in oral expression including communication skills, fluency, idiomatic French and pronunciation. Discussion materials include short literary and sociological texts, recent films, varied audio and digitized video interviews and the Internet. Taught in French. Limited to 16.

L. Rezvani

21F.311 Introduction to French Culture
Prereq: 21F.304, 21F.374, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Examines major social and political trends, events, debates and personalities which help place various aspects of contemporary French culture in their historical perspective. Topics include the heritage of the French Revolution, the growth and consequences of colonialism, the role of intellectuals in public debates, the impact of the Occupation, the modernization of the economy and of social structures. Also studied are the sources and meanings of national symbols, monuments, myths and manifestoes. Documents include fiction, films, essays, newspaper articles, and television shows. Recommended for students planning to study abroad. Taught in French.

C. Clark

21F.312 Basic Themes in French Literature and Culture
Prereq: 21F.304, 21F.374, or permission of instructor
U (Spring)
3-0-9 HASS-H
Can be repeated for credit

Introduction to literary and cultural analysis through the close reading and discussion of texts united by a common theme. Taught in French.

C. Clark

21F.315 Cross-cultural Perspectives on Contemporary French Society
Prereq: 21F.304, 21F.374, or permission of instructor
U (Spring)
3-0-9 HASS-H

Intermediate subject designed to help students gradually build an in-depth understanding of France. Focuses on French attitudes and values regarding education, work, family, and institutions. Deals with the differing notions that underlie interpersonal interactions and communication styles, such as politeness, friendship, and formality. Using a Web comparative, cross-cultural approach, students explore a variety of French and American materials, then analyze and compare using questionnaires, opinion polls, news reports (in different media), as well as a variety of historical, anthropological and literary texts. Students involved in team research projects. Attention given to the development of relevant linguistics skills. Recommended for students planning to study and work in France. Taught in French.

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 the instructor.

21F.320 Introduction to French Literature
Prereq: 21F.304, 21F.374, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

A basic study of major French literary genres — poetry, drama, and fiction — and an introduction to methods of literary analysis. Authors include: Voltaire, Balzac, Sand, Baudelaire, Apollinaire,
Camus, Sartre, Ionesco, Duras, and Tournier. Special attention devoted to the improvement of French language skills. Taught in French.
B. Perreau

21F.321 Childhood and Youth in French and Francophone Cultures
Prereq: One intermediate subject in French
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Studies the transformation of childhood and youth since the 18th century in France, as well as the development of sentimentality within the family in a francophone context. Examines the personification of children, both as a source of inspiration for artistic creation and a political ideal aimed at protecting future generations. Considers various representations of childhood and youth in literature (e.g., Pagnol, Proust, Sarraute, Lave, Morgièvre), movies (e.g., Truffaut), and songs (e.g., Brel, Barbara). Taught in French.
B. Perreau

21F.322 Frenchness in an Era of Globalization (New)
(Same subject as 21H.242J)
Prereq: One intermediate subject in French or permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Approaches the question of what constitutes Frenchness in today’s era of globalization through issues of memory, belonging, and cultural production. Explores the role of timeless traditions—common technologies, an internationally-spoken language, monuments open to the world, and foods such as wine and cheese—remain quintessentially French. Also covers recent scandals about France’s role in the world, such as its colonial identity and Dominique Strauss-Kahn’s New York debacle. Taught in French. Limited to 18.
C. Clark

21F.325 New Culture of Gender: Queer France
(Same subject as WGS.233J)
Prereq: One intermediate subject in French
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Can be repeated for credit

Addresses the place of contemporary queer identities in French discourse. Discusses the new generation of queer authors and their principal concerns. Introduces students to the main classical references of queer subcultures, from Proust and Vivien to Hocquenghem and Wittig. Examines current debates on post-colonial and globalized queer identities through essays, songs, movies, and novels. Authors include Didier Eribon, Anne Garrêta, Abdelah Taïa, Anne Scott, and Nina Bouraoui. Taught in French.
B. Perreau

21F.341 Contemporary French Film and Social Issues
Prereq: 21F.304, 21F.374, or permission of instructor
U (Spring)
Not offered regularly; consult department
2-2-8 HASS-H

Issues in contemporary French society as expressed through movies made in the 1990s. Topics include France’s national self-image, the women’s movement, sexuality and gender, family life and class structure, post-colonialism and immigration, and American cultural imperialism. Films by Lelouch, Audiard, Doillon, Denis, Klapisch, Resnais, Rouan, Balasko, Collard, Dridi, Kassovitz, and others. Readings from French periodicals. Films shown with English subtitles. Taught in French.
C. Clark

21F.346 Topics in Modern French Literature and Culture
Prereq: One intermediate subject in French
U (Fall, Spring)
3-0-9 HASS-H
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.
C. Clark

21F.347 Social and Literary Trends in Contemporary Short French Fiction
Prereq: One intermediate subject in French or permission of instructor
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-H

Examines short stories and short novels published in France during the past 20 years, with emphasis on texts related to the dominant social and cultural trends. Themes include the legacy of France’s colonial experience, the re-examination of its wartime past, memory and the Holocaust, the specter of AIDS, changing gender relationships, new families, the quest for personal identity, and immigration narratives. Covers a wide variety of authors, including Christine Angot, Nina Bouraoui, Herve Guibert, and Patrick Modiano. Taught in French.
B. Perreau

Graduate Language Subjects

21F.351 French I
(Subject meets with 21F.301)
Prereq: None
G (Fall, IAP, Spring)
4-0-5
Credit cannot also be received for 21F.371

Introduction to the French language and culture with emphasis on acquisition of vocabulary and grammatical concepts through active communication. Conducted entirely in French. Exposure to the language via a variety of authentic sources such as the Internet, audio, video and printed materials which help develop cultural awareness and linguistic proficiency. Coordinated language lab program. Meets with 21F.371 when offered concurrently. Limited to 18 per section.
L. Rezvani

21F.352 French II
(Subject meets with 21F.302)
Prereq: 21F.351
G (Fall, Spring)
4-0-5
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. Same as 21F.302, but for graduate credit. Meets with 21F.372 when offered concurrently. Limited to 18 per section.
L. Rezvani

For French Literature and Culture subjects offered in English, see 21F.049, 21F.052, 21F.053, 21F.054J, and 21F.068J.
GERMAN

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in German. These first-year 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
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. For graduate credit see 21F.451. Meets with 21F.471 when offered concurrently. Limited to 18 per section.

D. Jaeger

21F.471 German I—Globalization
Prereq: None. Coreq: 21F.076
U (Fall)
4-0-5 HASS-H
Credit cannot also be received for 21F.401, 21F.451
In conjunction with 21F.076I, covers same material as 21F.401. See description under 21F.401. Students cannot receive credit without simultaneous completion of 21F.076I. Meets with 21F.401 and 21F.451 when offered concurrently. Limited to 18 per section.

P. Weise

21F.402 German II
(Subject meets with 21F.452)
Prereq: 21F.401, 21F.471, or permission of instructor
U (Fall, IAP, Spring)
4-0-8 HASS-H
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. Limited to 18 per section.

D. Jaeger

21F.472 German II—Globalization
Prereq: 21F.401 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H
Credit cannot also be received for 21F.402, 21F.452
In conjunction with 21F.076I, covers same material as 21F.402. See description under 21F.402. Students cannot receive credit without simultaneous completion of 21F.076I. Meets with 21F.402 and 21F.452 when offered concurrently. Limited to 18 per section.

D. Jaeger

21F.403 German III
Prereq: 21F.402, 21F.472, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-H
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, Boll, Borchert, and others) and through media selections on contemporary issues in German-speaking cultures. Discussions and compositions based on these texts. Review of grammar and development of vocabulary-building strategies. Recommended for students with two years of high school German. Meets with 21F.473 when offered concurrently. Limited to 18 per section.

E. Crocker

21F.473 German III—Globalization
Prereq: 21F.402 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H
Credit cannot also be received for 21F.403
In conjunction with 21F.076I, covers same material as 21F.403. See description under 21F.403. Students cannot receive credit without simultaneous completion of 21F.076I. Meets with 21F.403 when offered concurrently. Limited to 18 per section.

E. Crocker

21F.404 German IV
Prereq: 21F.403, 21F.473, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-H
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. Limited to 18 per section.

Fall: D. Jaeger
Spring: E. Crocker

21F.474 German IV—Globalization
Prereq: 21F.403 or permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H
Credit cannot also be received for 21F.404
In conjunction with 21F.076I, covers same material as 21F.404. See description under 21F.404. Students cannot receive credit without simultaneous completion of 21F.076I. Meets with 21F.404 when offered concurrently. Limited to 18 per section.

D. Jaeger
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.
E. Crocker

Intermediate Subjects in Language, Literature, and Culture

21F.405 Intermediate German: Intensive Study of Language and Culture
Prereq: 21F.403, 21F.473, or permission of instructor
Acad Year 2014–2015: U (IAP)
Acad Year 2015–2016: Not offered
4-0-8 HASS-H

Prepares students for working and living in German-speaking countries. Focuses on current political, social, and cultural issues, using newspapers, TV, radio broadcasts, podcasts, and Web sources from Germany, Austria, and Switzerland. Emphasizes speaking and listening skills for professional contexts. Project-based course includes oral presentations, group discussions, guest lectures, and live interviews with German speakers. Progress tracked with student portfolios. Taught in German. No listeners.
E. Crocker

21F.409 Advanced German: Visual Arts, Media, Creative Expression
Prereq: 21F.404 or 21F.474
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Students develop their spoken and written language skills via storytelling, drama, interpretative speaking, poetry slam, writing short, creative texts; and by reading contemporary prose, plays, and poetry. Explores different art forms such as short film, photography, installation and digital art, and commercials. Discusses works by Yoko Tawada, Ernst Jandl, and Babak Saed, among others. Students create their own mini-film, commercial, or multimedia work. Taught in German.
D. Jaeger

21F.410 Advanced German: Communication for Professionals
Prereq: 21F.404 or 21F.474
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Exposés students to current issues and language use in German technology, business, and international industrial relations; discusses ramifications of these issues in a larger social and cultural context. Prepares students who wish to work or study in a German-speaking country. Focuses on specialized vocabulary and systematic training in speaking and writing skills to improve fluency and style. Emphasizes communicative strategies that are crucial in a working environment. Includes discussion and analysis of newspaper and magazine articles, modern expository prose, and extensive use of online material. Taught in German.
P. Weise

21F.412 Advanced German: Literature and Culture
Prereq: 21F.404, 21F.474, or permission of instructor
U (Fall)
3-0-9 HASS-H

Can be repeated for credit with permission of instructor

Provides the opportunity to discuss, orally and in writing, cultural, ethical, and social issues on a stylistically sophisticated level. Explores representative and influential works from the 19th century to the present, through literary texts (prose, drama, poetry), radio plays, art, film, and architecture. Investigates topics such as the human and the machine, science and ethics, representation of memory, and issues of good and evil. Includes works by E.T.A. Hoffmann, Kafka, Brecht, Dürrenmatt, Süskind, and W.G. Sebald. Topics and authors vary from term to term. Taught in German.
P. Weise

21F.414 German Culture, Media, and Society
Prereq: 21F.404 or 21F.474
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Can be repeated for credit

Investigates current trends and topics in German literature, theater, film, television, radio, and other media arts productions. Analyzes media texts in the context of their production, reception, and distribution as well as the public debates initiated by these works. Students have the opportunity to discuss topics with a writer, filmmaker, and/or media artist from Germany. Taught in German. Topics vary from term to term.
K. Fendt

21F.415 Germany and Its European Context
Prereq: 21F.404 or 21F.474
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Can be repeated for credit

Examines the historical, political, and sociological forces that shape present-day Germany. Topics vary and may include: value changes in postwar society, coping with the legacy of the past, multiculturalism in Germany, change of gender roles, cultural differences between East and West after the unification, the role of environmentalism, the process of European integration, and Germany and its neighbors. Draws on current articles, texts and videos from newspapers, journals, the Web, and German TV. Integrates and contextualizes the first-hand experiences of German society. Taught in German.
E. Crocker

21F.416 20th- and 21st-Century German Literature
Prereq: 21F.404 or 21F.474
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

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.
D. Jaeger
JAPANESE

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in Japanese. These first-year 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.076.

Fundamental Language Subjects

21F.501 Japanese I (Subject meets with 21F.551)
Prereq: None
U (Fall, IAP)
4-0-5 HASS-H
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. Limited to 16 per section.
Y. Nagaya

21F.502 Japanese II (Subject meets with 21F.572)
Prereq: 21F.501 or permission of instructor
G (Fall, IAP, Spring)
4-0-5
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. Same as 21F.402, but for graduate credit. Meets with 21F.472 when offered concurrently. Limited to 18 per section.
D. Jaeger

21F.503 Japanese III (Subject meets with 21F.573)
Prereq: 21F.502; or placement test and permission of instructor
U (Fall)
4-0-8 HASS-H
Students further develop their skills in speaking, listening, reading and writing. Involves continued vocabulary and kanji building. Coordinated language lab. Limited to 16 per section.
T. Aikawa

21F.504 Japanese IV (Subject meets with 21F.503)
Prereq: 21F.502 or 21F.573; or placement test and permission of instructor; Coreq: 21F.076
U (Fall)
4-0-5 HASS-H
In conjunction with 21F.076, covers same material as 21F.503. Students further develop their skills in speaking, listening, reading and writing. Involves continued vocabulary and kanji building. Limited to 16 per section.
Y. Nagaya

21F.505 Japanese V (Subject meets with 21F.575)
Prereq: 21F.504; or placement test and permission of instructor
U (Spring)
4-0-8 HASS-H
Systematic development of reading, writing, and oral communication skills. Introduction to advanced grammar that deepens the understanding of Japanese culture and society through reading and discussion. Lab work required. Limited to 16 per section.
M. Ikeda-Lamm

For German Literature and Culture subjects offered in English, see 21F.055 and 21F.059.
21F.575 Japanese V—Globalization
(Subject meets with 21F.505)
Prereq: 21F.504; or placement test and permission of instructor; Coreq: 21F.076
G (Fall) 4-0-5 HASS-H

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. Limited to 16 per section.

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

Continuation of 21F.505. Further development of reading, writing, and oral communication skills. Extension of advanced grammar and further enhancement of advanced vocabulary. Variety of cultural elements studied through readings, video, and discussion. Lab work required.

M. Ikeda-Lamm

Japanese Language Option Subjects

21F.590 Visualizing Japan in the Modern World
(Subject meets with 21F.027), CMS.874J)
Prereq: 21F.504 or permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-10 HASS-H; CI-H

Studies how visual images shape the identity of peoples, cultures, and events in Japan. Uses prototype digital projects as case studies to introduce the conceptual and practical issues involved in “visualizing cultures.” Projects look at American and Japanese graphics depicting contacts between Japan and the West in the 19th and early 20th centuries. Taught in English with a project that requires research in Japanese. Enrollment limited; preference to Japanese minors.

S. Miyagawa

21F.591 Japanese Popular Culture
(Subject meets with 21A.143), 21F.039J)
Prereq: 21F.504 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-10 HASS-H

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. Emphasis on 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 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) 3-0-10 HASS-H; CI-H

Examines the major aesthetic, social, and political elements that have shaped modern Japanese culture and society. Includes readings on contemporary Japan and the historical evolution of the culture. Students study literary texts, film and art, and analyze everyday life and leisure activities. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.

I. Condry

21F.593 Japanese Literature and Cinema
(Subject meets with 21A.142J, 21F.065J)
Prereq: 21F.504 or permission of instructor
U (Spring) 3-0-10 HASS-H; CI-H

Surveys both cinematic and literary representations of diverse eras and aspects of Japanese culture, with emphasis on the modern period. Includes topics such as the classical era, the samurai age, wartime Japan and the atomic bombings, social change in the postwar period, and the appropriation of foreign cultural themes. Directors include Akira Kurosawa and Hiroshi Teshigahara. Authors include Kobo Abe and Yukio Mishima. Films shown with subtitles in English. Taught in English with a project that requires research in Japanese. Preference to Japanese minors.

J. Cullen

21F.594 Anime: Transnational Media and Culture
(Subject meets with 21F.063)
Prereq: 21F.504 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-10 HASS-H

Explores anime (Japanese animated films and TV shows) as a study in flows among media and cultures. Discusses Japan’s substantial share of the TV cartoon market and the reasons for anime’s worldwide success. Focuses on cultural production and the ways anime cultures are created through the interactive efforts of studios, sponsors, fans, broadcasters, and distributors. Uses anime scholarship and media examples as a means to examine leading theories in media and cultural studies, gender and sexuality, technology and identity, and post-industrial globalization. Taught in English with a project

I. Condry

For Japanese Literature and Culture subjects offered in English, see 21F.027J, 21F.039J, 21F.063, 21F.064, and 21F.065J.

ITALIAN

The subjects listed below include language, literature, and cultural studies subjects, all of which are taught in Italian. These first-year 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

Focus on basic oral expression, listening comprehension, and elementary reading and writing. Emphasis on the acquisition of vocabulary and grammatical concepts through active communication. Designed for students with no knowledge of Italian. Audio, video, and printed materials provide direct exposure to authentic Italian language and culture.

Staff

21F.651 Italian I
(Subject meets with 21F.601)
Prereq: None
G (IAP)
4-0-5

Focus on basic oral expression, listening comprehension, and elementary reading and writing. Emphasis on the acquisition of vocabulary and grammatical concepts through active communication. Designed for students with no knowledge of Italian. Audio, video, and printed materials provide direct exposure to authentic Italian language and culture.

Staff

21F.801 Portuguese I
(Subject meets with 21F.851)
Prereq: None
U (Fall, IAP)
4-0-8 HASS-H

Introduction to the language and culture of the Portuguese-speaking world, with special attention to Brazilian Portuguese. Focuses on basic oral expression, listening comprehension, and elementary reading and writing. Students develop their vocabulary and understanding of grammatical concepts through active communication. Coordinated language lab program. Designed for students with no knowledge of Portuguese. Conducted entirely in Portuguese. For graduate credit, see 21F.851. Limited to 18.

A. Igrejas

21F.871 Portuguese I—Globalization
Prereq: None. Coreq: 21F.076J
U (Fall)
4-0-5 HASS-H

In conjunction with 21F.076J, covers same material as 21F.801. See description under 21F.801. Students cannot receive credit without simultaneous completion of 21F.076J. Meets with 21F.801 and 21F.851 when offered concurrently. Limited to 18.

A. Igrejas

21F.802 Portuguese II
(Subject meets with 21F.852)
Prereq: 21F.801, 21F.871, or permission of instructor
U (Spring)
4-0-8 HASS-H

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. Conferred entirely in Portuguese. For graduate credit, see 21F.852. Limited to 18.

N. Dominique

21F.880 Accelerated Introductory Portuguese for Spanish Speakers
(Subject meets with 21F.855)
Prereq: 21F.704, 21F.774, or permission of instructor
U (Fall, Spring)
4-0-8 HASS-H

Credit cannot also be received for 21F.870

Accelerated introduction to the language and culture of the Portuguese-speaking world, with a focus on Brazil. Designed for speakers of Spanish (native or bilingual, or those who have completed two college years or the equivalent). Covers essential content of complete first-year Portuguese in one term. Builds on the similarities and differences between both languages in grammar, vocabulary and pronunciation for speaking, listening, reading and writing skills. Conducted entirely in Portuguese. For graduate credit, see 21F.855. Limited to 18.

Fall: N. Dominique
Spring: A. Igrejas

21F.870 Accelerated Introductory Portuguese for Spanish Speakers—Globalization
Prereq: None. Coreq: 21F.076J
U (Fall)
4-0-5 HASS-H

Credit cannot also be received for 21F.855, 21F.880

In conjunction with 21F.076J, covers same material as 21F.880. See description under 21F.880. Students cannot receive credit without simultaneous completion of 21F.076J. Meets with 21F.880 and 21F.855 when offered concurrently. Limited to 18.

N. Dominique

21F.803 Portuguese III
Prereq: 21F.802, 21F.870, 21F.880, or permission of instructor
U (Fall, IAP)
4-0-8 HASS-H

Expands the breadth and depth of students' skills in understanding, speaking, reading, and writing Portuguese while continuing to provide exposure to the history and cultures of the Portuguese-speaking world. Uses short stories, films and music to study issues of historical and
current interest. Conducted entirely in Portuguese. Limited to 18.
N. Dominique

21F.804 Portuguese IV
Prereq: 21F.803 or permission of instructor
U (Spring)
4-0-8 HASS-H
Continued study of the language and culture to improve fluency, accuracy and style in both oral and written communication. Students discuss current news articles, short literary texts, films, music and web-based materials dealing with issues relevant to the Portuguese-speaking world. Coursework also includes grammar review. Conducted entirely in Portuguese. Limited to 18.
N. Dominique

Intermediate Subjects in Language, Literature, and Culture

21F.820 Topics in Modern Portuguese Literature and Culture
Prereq: 21F.804 or permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H
Can be repeated for credit with permission of instructor
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.
N. Dominique

Graduate Language Subjects

21F.851 Portuguese I
(Subject meets with 21F.801)
Prereq: None
G (Fall, IAP)
4-0-5
Credit cannot also be received for 21F.871
Introduction to the language and culture of the Portuguese-speaking world, with special attention to Brazilian Portuguese. Focuses on basic oral expression, listening comprehension, and elementary reading and writing. Students develop their vocabulary and understanding of grammatical concepts through active communication. Coordinated language lab program. Designed for students with no knowledge of Portuguese. Conducted entirely in Portuguese.
For undergraduate credit, see 21F.801. Enrollment limited.
A. Igrejas

21F.852 Portuguese II
(Subject meets with 21F.802)
Prereq: 21F.851 or permission of instructor
G (Spring)
4-0-5
Continuation of 21F.851. Focuses on expanding communication skills and further development of linguistic competency. Uses a variety of authentic sources, such as the Internet, audio, video, and printed materials, to help develop cultural awareness and linguistic proficiency. Coordinated language lab. Conducted entirely in Portuguese. For undergraduate credit, see 21F.802. Enrollment limited.
N. Dominique

21F.855 Accelerated Introductory Portuguese for Spanish Speakers
(Subject meets with 21F.880)
Prereq: 21F.704 or permission of instructor
G (Fall, Spring)
4-0-5
Credit cannot also be received for 21F.870
Accelerated introduction to the language and culture of the Portuguese-speaking world, with a focus on Brazil. Designed for speakers of Spanish (native or bilingual, or those who have completed two college years or the equivalent). Covers essential content of complete first-year Portuguese in one term. Builds on the similarities and differences between both languages in grammar, vocabulary and pronunciation for speaking, listening, reading and writing skills. Conducted entirely in Portuguese. For undergraduate credit, see 21F.880. Limited to 18.
Fall: N. Dominique
Spring: A. Igrejas

For Portuguese Literature and Culture subjects offered in English, see 21F.074.

RUSSIAN

21F.611 Russian I (Regular)
Prereq: None
U (Fall, IAP)
4-0-8 HASS-H
Emphasizes the development of communicative and cultural competence, as well as mastery of the foundations of Russian grammar and vocabulary. Using video, internet resources, and varied cultural materials, students work on developing speaking, reading, and writing skills. Conducted in both Russian and English. Designed for students with no knowledge of Russian. Limited to 18.
M. Khotimsky

21F.612 Russian II (Regular)
Prereq: 21F.611 or permission of instructor
U (Spring)
4-0-8 HASS-H
Continuing instruction in Russian language and culture with emphasis on acquisition of vocabulary and grammatical concepts through active communication. Conducted in both Russian and English. Provides exposure to the language via a video program, internet resources, and literary texts that are integrated in grammar instruction and conversation tasks. Limited to 18.
M. Khotimsky

21F.613 Russian III (Regular)
Prereq: 21F.612; permission of instructor
U (Fall)
4-0-8 HASS-H
Includes comprehensive review and expansion of grammar and vocabulary. Emphasizes the development of speaking, reading, and writing skills. Examines adapted and authentic literary texts, media resources, and film. Develops communicative skills necessary for personal and professional interaction in a Russian-language environment. Limited to 18.
M. Khotimsky

21F.614 Russian IV (Regular)
Prereq: 21F.613; permission of instructor
U (Spring)
4-0-8 HASS-H
Features intermediate to advanced study of Russian with a comprehensive review of grammar, and emphasis on more complex communicative topics. Reading and writing skills developed through study of various topics in Russian culture and society. Uses a variety of authentic literary and non-fiction texts, media resources, and film. Limited to 18.
M. Khotimsky

21F.615 Russian I (Streamlined)
Prereq: Placement test and permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
4-0-8 HASS-H
The first term streamlined sequence. Designed for students who have conversational skills (typically gained from growing up in a Russian
Fundamental Language Subjects

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Credits</th>
<th>Department</th>
<th>Time</th>
<th>Corequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>21F.701</td>
<td>Spanish I</td>
<td>(Subject meets with 21F.751)</td>
<td>None</td>
<td>U (Fall, IAP, Spring)</td>
<td>4-0-8</td>
<td>Coreq: 21F.076</td>
</tr>
<tr>
<td>21F.771</td>
<td>Spanish I—Globalization</td>
<td>Prerequisite: None</td>
<td>Coreq: 21F.076</td>
<td>U (Fall)</td>
<td>4-0-5</td>
<td>HASS-H</td>
</tr>
<tr>
<td>21F.702</td>
<td>Spanish II</td>
<td>(Subject meets with 21F.752)</td>
<td>Prerequisite: 21F.701, 21F.771, or permission of instructor</td>
<td>U (Fall, Spring)</td>
<td>4-0-8</td>
<td>HASS-H</td>
</tr>
</tbody>
</table>

In conjunction with 21F.076J, covers the same material as 21F.701. See the description under 21F.701. Students cannot receive credit without simultaneous completion of 21F.076J. Meets with 21F.701 and 21F.751 when offered concurrently. Limited to 18 per section. 

L. Soto

21F.772 Spanish II—Globalization
| Prerequisite: 21F.701 or permission of instructor; Coreq: 21F.076 | U (Fall) | 4-0-5 | HASS-H |

In conjunction with 21F.076J, covers the same material as 21F.702. See the description under 21F.702. Students cannot receive credit without simultaneous completion of 21F.076J. Meets with 21F.702 and 21F.752 when offered concurrently. Limited to 18 per section. 

R. Rey Agudo

21F.782 Spanish II (Study Abroad)
| Prerequisite: 21F.701, 21F.771, or permission of instructor; Coreq: 21F.076 | U (IAP) | 4-0-8 | HASS-H |

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. For graduate credit, see 21F.783. Enrollment limited by lottery. 

A. Yáñez, R. Rey Agudo

21F.700 Refresher Spanish
| Prerequisite: Permission of instructor | Acad Year 2014–2015: Not offered | | | | | |

Credit cannot also be received for 21F.700, 21F.772, 21F.782, 21F.783

Reviews vocabulary and grammar structures covered in introductory Spanish through classroom activities, readings, and writing. Develops fluency in speaking through communicative classroom activities and oral presentations, as well as audio and video podcasts. Readings include online newspapers and short literary selections. Writing expression practiced through a daily online journal/blog and short compositions. Intended for students who have taken two or more years of Spanish in high school, but who lack the communicative skills, grammar foundation and confidence required for an intermediate level of Spanish. Enrollment limited by lottery. 

R. Rey Agudo
**21F.703 Spanish III**  
Prereq: 21F.702, 21F.772, or permission of instructor  
U (Fall, Spring)  
4-0-8 HASS-H  
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. Limited to 18 per section.  
A. Yáñez

**21F.773 Spanish III—Globalization**  
Prereq: 21F.702 or permission of instructor;  
Coreq: 21F.076  
U (Fall)  
4-0-5 HASS-H  
Credit cannot also be received for 21F.703  
In conjunction with 21F.076J, covers same material as 21F.703. See description under 21F.703. Students cannot receive credit without simultaneous completion of 21F.076J. Meets with 21F.704 when offered concurrently. Limited to 18 per section.  
A. Yáñez

**21F.704 Spanish IV**  
Prereq: 21F.703, 21F.773, or permission of instructor  
U (Fall, Spring)  
4-0-8 HASS-H  
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. Students cannot receive credit without simultaneous completion of 21F.076J. Meets with 21F.704 when offered concurrently. Limited to 18 per section.  
A. Yáñez

**21F.774 Spanish IV—Globalization**  
Prereq: 21F.703 or permission of instructor;  
Coreq: 21F.076  
U (Fall)  
4-0-5 HASS-H  
Credit cannot also be received for 21F.704  
In conjunction with 21F.076J, covers same material as 21F.704. 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. Students cannot receive credit without simultaneous completion of 21F.076J. Meets with 21F.704 when offered concurrently. Limited to 18 per section.  
M. Ribas Groeger

**21F.708 Spanish: Communication Intensive I**  
Prereq: Permission of instructor; Coreq: 21F.716, 21F.717, 21F.730, 21F.735, 21F.738, 21F.739, 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. Conducted entirely in Spanish. Preference to Spanish majors.  
P. Duong

**21F.709 Spanish: Communication Intensive II**  
Prereq: 21F.708, permission of instructor; Coreq: 21F.716J, 21F.717J, 21F.730, 21F.735, 21F.738J, 21F.739, or 21F.740J  
U (Fall, Spring)  
3-0-0  
Further development of spoken and written communication. Introduces students to individual topics and group Web-based and video projects. Analyses of selected literary texts, films and popular music. Taught in Spanish. Enrollment limited.  
M. Ribas Groeger

**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  
Further development of spoken and written skills to improve fluency and style. Oral reports by participants on individual topics and group simulations, interviews, guided compositions, regular journal writing, and participation on an online forum. Readings include: journalistic reports, essays, and literary selections offering diverse perspectives. Taught in Spanish. Enrollment limited.  
M. Ribas Groeger

**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  
Can be repeated for credit  
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.  
M. Ribas Groeger

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.

It is required that all students take one of the intermediate-level subjects 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  
Focuses on expository and journalistic writing that examines the social and cultural impact of science and technology in Hispanic societies. Topics considered are: family structure and community, personal identity, gender relations, relationship to natural world, value systems and religion, education and work-life. Ethical implications of technological decision-making also discussed. Improves oral and written skills through discussions of audiovisual materials, simulations, interviews, guided compositions, regular journal writing, and participation on an online forum. Readings include: journalistic reports, essays, and literary selections offering diverse perspectives. Taught in Spanish. Enrollment limited.  
M. Ribas Groeger

**21F.717 Advanced Communication in Spanish: Film, Visual Arts, and Fiction**  
Prereq: 21F.704, 21F.774, or permission of instructor  
U (Spring)  
3-0-9 HASS-H  
Can be repeated for credit  
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.  
M. Ribas Groeger
Essays receive both peer and instructor review before final submission. Taught in Spanish.
A. Yáñez

21F.714 Spanish for Bilingual Students
Prereq: Fluency in a Spanish dialect
U (Spring)
3-0-9 HASS-H

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. Enrollment limited.
M. Ribas Groeger

Advanced Subjects in Literature and Culture

It is strongly advised that all students take one of the intermediate-level subjects before enrolling in an advanced subject. Otherwise students are required to obtain permission of the instructor of the advanced subject.

21F.716J Introduction to Contemporary Hispanic Literature and Film (Same subject as 21L.616J)
Prereq: One intermediate subject in Spanish or permission of instructor
U (Spring)
3-0-9 HASS-H

See description under subject 21L.616J.
Staff

21F.717J Introduction to Spanish Culture (New) (Same subject as 21L.617J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

See description under subject 21L.617J.
M. Resnick

21F.730 Hispanic America: One Hundred Years of Literature and Film
Prereq: One intermediate subject in Spanish or permission of instructor
U (Spring)
3-0-9 HASS-H

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. Limited to 18.
Staff

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

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. Limited to 18.
P. Duong

21F.738J Literature and Social Conflict: Perspectives on Modern Spain (Same subject as 21L.638J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

See description under subject 21L.638J.
Staff

21F.739J Globalization and its Discontents: Spanish-speaking Nations (Same subject as 21L.639J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

See description under subject 21L.639J.
Staff

21F.740J The New Spain: 1977–Present (Same subject as 21L.640J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

See description under subject 21L.640J.
M. Resnick

Graduate Language Subjects

21F.751 Spanish I
(Subject meets with 21F.701)
Prereq: None
G (Fall, IAP, Spring)
4-0-5
Credit cannot also be received for 21F.771

For students with no previous knowledge of Spanish. Introduction to understanding, speaking, reading, and writing Spanish. Maximal use of fundamentals of grammar in active communication. Audio- and video-based language laboratory program coordinated with and supplementary to class work. Same as 21F.701, but for graduate credit. Meets with 21F.771 when offered concurrently. Limited to 18 per section.
L. Soto

21F.752 Spanish II
(Subject meets with 21F.702)
Prereq: 21F.751 or permission of instructor
G (Fall, Spring)
4-0-5
Credit cannot also be received for 21F.700, 21F.772, 21F.782, 21F.783

Introductory subject that continues the study of Spanish language and culture using audio, video and print materials, feature films and popular music from Latin America and Spain. Emphasizes writing, vocabulary acquisition, and the study of more complex grammatical structures. Group interaction and short oral presentations develop students’ oral skills. Meets with 21F.772 when offered concurrently. Limited to 18 per section.
R. Rey Agudo

21F.783 Spanish II (Study Abroad)
(Subject meets with 21F.782)
Prereq: 21F.751 or permission of instructor
G (IAP)
4-0-5
Credit cannot also be received for 21F.700, 21F.702, 21F.752, 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. Same as 21F.782, but for graduate credit. Enrollment limited by lottery.
A. Yáñez, R. Rey Agudo

For Spanish Literature and Culture subjects taught in English, see 21F.084J.
INDEPENDENT STUDY AND SPECIAL SUBJECTS

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 Global Studies and Languages Headquarters

21F.S01–21F.S02 Special Subject: Global Studies and Languages
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.
Consult Global Studies and Languages Headquarters

21F.S03 Special Subject: Global Studies and Languages
Prereq: None
U (Spring; first half of term)
Not offered regularly; consult department
Units arranged
Can be repeated for credit

21F.S04 Special Subject: Global Studies and Languages
Prereq: None
U (Spring; second half of term)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.
Consult Global Studies and Languages Headquarters

21F.S05–21F.S08 Special Subject: Global Studies and Languages (New)
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Opportunity for undergraduate study of subject matter that is not covered in the regular curriculum.
Consult Global Studies and Languages Headquarters

21F.THT Pre-Thesis Tutorial: Global Studies and Languages
Prereq: Permission of instructor
U (Fall, Spring)
1-0-5
Can be repeated for credit
Definition of and early-stage work on thesis project leading to 21F.ThU Global Studies and Languages Thesis. Taken during the first term of the student’s two-term commitment to the thesis project. Student works closely with an individual faculty tutor.
Consult Global Studies and Languages Headquarters

21F.THU Global Studies and Languages Thesis
Prereq: 21F.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.
Consult Global Studies and Languages Headquarters

21F.UR Undergraduate Research
Prereq: None
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Credit cannot also be received for 21F.URG

21F.URG Undergraduate Research
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Credit cannot also be received for 21F.UR
Consult Global Studies and Languages Headquarters

For individual research in Global Studies and Languages, register for 21F.UR or 21F.URG. For Global Studies and Languages 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.
Bachelor of Science in Foreign Languages and Literatures/Course 21F

General Institute Requirements (GIRs) Subjects
Science Requirement 6
Humanities, Arts, and Social Sciences Requirement [three subjects may be satisfied by subjects in the Departmental Program] 8
Restricted Electives in Science and Technology (REST) Requirement 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).

Program 1: French Studies
Prerequisite subjects: 21F.301, 21F.302
(24)
Required Subjects 42
21F.304 French IV, 12, HASS-H, 21F.303*
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.321, 21F.322, 21F.325J, 21F.341, 21F.346 or 21F.347.
Restricted Electives 90
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
(24)
Required Subjects 42
21F.704 Spanish IV, 12, HASS-H, 21F.703*
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.716J, 21F.717J, 21F.730, 21F.735, 21F.738J, 21F.739 or 21F.740J.
Restricted Electives 90
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 (36)
Unrestricted Electives (for Each Program) 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.
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; CI-H
Explores fundamental questions about the causes and nature of revolutions by looking at how people overthrow their rulers and establish new governments. Considers a set of major political transformations throughout the world and across centuries to understand the meaning of revolution and evaluate its impact. Examines how revolutionaries have attempted to establish their ideals and realize their goals. Asks whether radical upheavals require bloodshed, violence, or even terror. Seeks to explain why some revolutions succeed and others fail. Materials include the writings of revolutionaries, declarations and constitutions, music, films, art, novels, memoirs, and newspapers.
S. Aiyar, L. Ekmekcioglu, C. Leighton

21H.007J Empire: Introduction to Ancient and Medieval Studies
(Same subject as 21L.014J)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H
Interdisciplinary and comparative investigation of the Roman empire of Augustus and the Frankish empire of Charlemagne. Focuses on how large, multi-ethnic empires were created, sustained, legitimated, and contested through conquest, government, literature, art, and economic organization. Students examine different types of evidence, read across a variety of disciplines, and develop skills to identify continuities and changes in ancient and medieval societies.
W. Broadhead, S. Frampton, E. Goldberg

21H.009 The World: 1400–Present
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H
Surveys the increasing interaction between communities, as the barrier of distance succumbed to both curiosity and new transport technologies. Explores Western Europe and the United States’ rise to world dominance, as well as the great divergence in material, political, and technological development between Western Europe and East Asia post-1750, and its impact on the rest of the world. Examines a series of evolving relationships, including human beings and their physical environment; religious and political systems; and sub-groups within communities, sorted by race, class, and gender. Introduces historical and other interpretive methodologies using both primary and secondary source materials.
H. Nagahara, J. Ravel

21H.101 American History to 1865
Prereq: None
U (Fall)
3-0-9 HASS-H
A basic history of American social, economic, and political development from the colonial period through the Civil War. Examines the colonial heritages of Spanish and British America; the American Revolution and its impact; the establishment and growth of the new nation; and the Civil War, its background, character, and impact. Readings include writings of the period by Winthrop, Paine, Jefferson, Madison, W. H. Garrison, G. Fitzhugh, H. B. Stowe, and Lincoln.
J. Cullin

21H.102 American History since 1865
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H; 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.125J, 21L.008J, 21W.741J, WGS.190J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-A, HASS-H; CI-H
See description under subject 24.912J.
Staff

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; CI-H
See description under subject 21F.043J.
E. Teng

21H.130 The Ancient World: Greece
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H
History of Ancient Greece from the Bronze Age to the death of Alexander. Major social, economic, political, and religious trends. Homer, heroism, and the Greek identity; the hoplite revolution and the rise of the city-state; Herodotus, Persia, and the (re)birth of history; Empire, Thucydidean rationalism, and the Peloponnesian War; Aristotle, Macedonia, and Hellenism. Emphasis on use of primary sources in translation.
S. Ostrow

21H.132 The Ancient World: Rome
Prereq: None
U (Spring)
3-0-9 HASS-H; 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. Enrollment limited.
W. Broadhead
21H.133 The Medieval World: CE 200–1500
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Investigates the dynamic history of Europe and its relations with the wider world between the late Roman empire and voyages of discovery. Examines the rise of Christianity, the cult of the saints, and monasticism; the decline of the Roman empire, the barbarian invasions, and the foundation of post-Roman kingdoms; the meteoric rise of Islam; the formation of the Carolingian, Byzantine, and Islamic empires; the Vikings and Mongols; castles, knights, and crusades; religious thinkers, reformers, and heretics; changes in art, architecture, and literature; the Black Death and the fall of Constantinople; the Italian Renaissance and the voyages of discovery.

E. Goldberg

21H.134j Medieval Economic History in Comparative Perspective
(Same subject as 14.70j)
Prereq: None
U (Spring)
3-0-9 HASS-S; CI-H

Surveys the conditions of material life and changing social and economic relations in medieval Europe using the comparative context of contemporary Islamic, Chinese, and Japanese experiences. Covers the emergence and decline of feudal institutions, the transformation of peasant agriculture, living standards and the course of epidemic disease, and the ebb and flow of long-distance trade across the Eurasian system. Particular emphasis placed on the study of those factors, both institutional and technological, which contributed to the emergence of capitalist organization and economic growth in western Europe in contrast to the trajectories followed by the other major medieval economies.

A. McCants, S. Ostrow

21H.141 Renaissance to Revolution: Europe, 1300–1800
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

Provides an introduction to major political, social, cultural and intellectual changes in Europe from the beginnings of the Renaissance in Italy around 1300 to the outbreak of the French Revolution at the end of the 1700s. Focuses on the porous boundaries between categories of theology, magic and science. Examines how developments in these areas altered European political institutions, social structures, and cultural practices. Studies men and women, nobles and commoners, as well as Europeans and some non-Europeans with whom they came into contact.

J. Ravel

21H.151 Traditional China: Earliest Times to 1644
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Examines how traditional China originated a civilization of universal meaning and persistent influence, including ideologies, technologies, and culture. Explains how this unique civilization and the Chinese state at its center developed, considers its patterns, and assesses its impact. Emphasizes analysis of structures as well as knowledge of events.

C. Leighton

21H.152 Modern China: 1644 to the Present
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Surveys China from its last empire through its reemergence as a power in modern times. Examines how China’s contemporary transformation has lifted hundreds of millions from poverty, refashioned social relations, and altered international politics. Students debate the causes and consequences of these major events and speculate on China’s future in the light of its past.

C. Leighton

21H.154 Pre-modern Japan: Earliest Times to 1868
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

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
Prereq: None
U (Spring)
3-0-9 HASS-H

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.157 The Making of Modern South Asia
Prereq: None
U (Spring)
3-0-9 HASS-S

Explores the political, social, and economic history of South Asia from the 18th century to the present day. Topics include colonial rule; anti-colonial movements; nationalism and the creation of modern India, Pakistan, and Bangladesh; the post-colonial nation state; social movements; religious identity; involvement of the United States in the region; and economic development. Students develop an understanding of the current successes, failures, and challenges facing the people and states of contemporary South Asia from a historical perspective.

S. Aiyar

21H.160 Islam, the Middle East, and the West
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Provides students with an overview of basic themes and issues in Middle Eastern history from the rise of Islam to the present, with an emphasis on exchanges and encounters between the Middle East and Europe/North America. Examines the history of the notion of “East” and “West”; the emergence of Islam and the Christianization of Europe; Ottoman, Sufavid, 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.

A. Jacobson
21H.161 The Middle East in the Twentieth Century
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H
Surveys major political, socio-economic, and cultural changes in the Middle East after 1900. Examines 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.
A. Jacobson

21H.171 Latin America: Revolution, Dictatorship, and Democracy, 1850 to Present
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Selective survey of Latin American history from the mid-19th century to the present. Issues studied include: dictators and democracies in the 20th century, revolution in Mexico, Cuba, and Central America, Latin America in the global economy, relations between Latin America and the US, indigenismo, feminism, and the varieties of religion in Latin America.
J. Ravel

21H.181J Libertarianism in History
(Same subject as 17.035J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Explores the history of the ideal of personal freedom with an eye towards contemporary debates over the pros and cons of the regulatory state. The first part of the course surveys the sociological and theological sources of the concepts of freedom and civil society, and introduces liberty's leading relatives or competitors: property, equality, community, and republicanism. Second part consists of a series of case studies in the rise of modern liberty and libertarianism: the abolition of slavery, the struggle for religious freedom, and the twentieth-century American civil liberties movement.
M. Ghachem

21H.185 Introduction to Environmental History
Prereq: None
U (Spring)
3-0-9 HASS-S; 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. Enrollment limited.
H. Ritvo

INTERMEDIATE

21H.201 The American Revolution
Prereq: None
U (Spring)
3-0-9 HASS-H
English and American background of the Revolution; issues and arguments in the Anglo-American conflict; colonial resistance and the beginnings of republicanism; the Revolutionary War; constitution writing for the states and nation; and effects of the American Revolution. Concerned primarily with the revolutionary origins of American government and laws. Readings emphasize documents from the period—pamphlets, correspondence, the minutes or resolutions of resistance organizations, constitutional documents and debates.
J. Cullon

21H.205J The Civil War and the Emergence of Modern America: 1861–1890
(Same subject as STS.027J)
Prereq: Permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H
See description under subject STS.027J.
M. R. Smith

21H.209 America in Depression and War
Prereq: None
U (Fall)
3-0-9 HASS-H
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.

21H.211 The United States in the Nuclear Age: Politics, Culture, and Society Since 1941
Prereq: None
U (Fall)
3-0-9 HASS-H
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, suburbanization, and popular culture.
Staff

21H.213J The War at Home: American Politics and Society in Wartime
(Same subject as 17.28J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
See description under subject 17.28J.
A. Berinsky, C. Capozzola

21H.214 War and American Society
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
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
(Same subject as 11.013J)
Prereq: None
U (Spring)
2-0-7 HASS-H; CI-H
See description under subject 11.013J.
R. M. Fogelson

21H.218J American Urban History II
(Same subject as 11.014J)
Prereq: None
U (Fall)
2-0-7 HASS-H; CI-H
See description under subject 11.014J.
R. M. Fogelson
21H.220J Metropolis: A Comparative History of New York City
(Same subject as 11.150J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Examines the evolution of New York City from 1607 to the present. Readings focus on the city’s social and physical histories. Discussions compare New York’s development to patterns in other cities.
C. Wilder

21H.226J Riots, Strikes, and Conspiracies in American History
(Same subject as 11.015J)
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H
Focuses on a series of short, complicated, traumatic events that shed light on American politics, culture, and society. Events studied may include the rendition of Anthony Burns in 1854, the most famous fugitive slave controversy in US history; the Homestead strike/lockout of 1892; the student uprisings at Columbia University in 1968; and the Attica prison uprising of 1971. Emphasis on finding ways to make sense of these events and on using them to understand larger processes of change in American history.
R. M. Fogelson

21H.227 Constitutional Law in US History
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
Introduces major themes and patterns of change in American constitutional law since 1787, including federal-state relations, racial and gender equality, economic regulation, and civil liberties. Readings consist of original court cases, especially from the US Supreme Court, including cases of the current term. Emphasis on the historical development of constitutional law and on the relationship between the Supreme Court and broader social, political, and cultural trends.
C. Capozzola

21H.228 American Classics
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H; CI-H
Students read, discuss, and write about critical works in American history from the 17th through the 20th centuries. Includes writings by early Puritan writers, Franklin, Paine, Jefferson, and Madison; Lewis and Clark; Frederick Douglass; Harriet Beecher Stowe; the Lincoln-Douglas debates; U. S. Grant, W. E. B. 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. Enrollment limited
C. Wilder

21H.229 The Black Radical Tradition in America
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Focuses on American history from the African-American perspective. Includes alternative visions of the nation’s future, and definitions of its progress, that have called for a fundamental restructuring of political, economic and social relations. Introduces events, figures and institutions that have shaped African-American history, from the struggles to dominate the African coast and the emergence of a modern slave trade, through the fall of the Western slave societies. Also examines the experiences of Africans in other parts of North America, as well as South America and the Caribbean.
C. Wilder

21H.236 The Making of a Roman Emperor
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Through close examination of the emperor Augustus and his Julio-Claudian successors, this subject investigates how Roman emperors used art, architecture, coinage, and other media to create and project an image of themselves, how the surviving literary sources from the Roman period reinforced or subverted that image, and how both phenomena have contributed to post-classical perceptions of Roman emperors. Also considers works of Suetonius and Tacitus, and modern representations of the emperors such as those found in the films I, Claudius, Quo Vadis, and HBO’s Rome series.
W. Broadhead

21H.239 The City of Rome in the Age of the Caesars (New)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Historical topography of Ancient Rome. Investigates the relationship between urban architecture and the political, social, and cultural history of Rome from the 1st century BC to the 2nd century AD. Surveys and analyzes archaeological and literary evidence, including the Roman Forum, the Imperial fora, the palace of the emperors, the atrium houses of Roman Pompeii, the Colosseum, the Pantheon, Polybius’ history, Martial’s Epigrams, and Vitruvius’ treatise on architecture. Not open to students who completed 21H.233 prior to Fall 2014.
W. Broadhead

21H.238 The Vikings
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Explores the complex relationship of the Vikings with the medieval world. Investigates the complexity of the Viking expansion, not only in terms of raiding and conflict, but also as a process of diplomacy, settlement, assimilation, and colonization. Examines developments within Scandinavian society such as state formation, social structures, trade, shipbuilding, slavery, urban growth, and Christianization. Considers the methodological difficulties presented by the diverse and often contradictory historical sources for information about the Vikings, such as chronicles, archaeology, coin hoards, stone inscriptions, and sagas.
E. Goldberg

21H.237 The City of Athens in the Age of Pericles (New)
Prereq: None
U (Fall)
3-0-9 HASS-H
Historical topography of ancient Athens. Investigates the relationship between urban architecture and political, social, and cultural history of Athens in the 5th and 4th centuries BC. Surveys and analyzes archeological and literary evidence, including the sanctuary of Athena on the Acropolis, the Agora, Greek houses, the histories of Herodotus and Thucydides, plays of Sophocles and Aristophanes, and the panhellenic sanctuaries of Delphi and Olympia. Not open to students who completed 21H.233 prior to Fall 2014.
W. Broadhead
21H.241J Franci 1660–1815: Enlightenment, Revolution, Napoleon
(Same subject as 21F.054J)
Prereq: None
U (Fall)
3-0-9 HASS-H

French politics, culture, and society from Louis XIV to Napoleon Bonaparte. Attention given to the growth of the central state, the beginnings of a modern consumer society, the Enlightenment, the origins and course of the French Revolution, and the rise and fall of Napoleon.

J. Ravel

21H.242J Frenchness in an Era of Globalization (New)
(Same subject as 21F.322J)
Prereq: One intermediate subject in French or permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

See description under subject 21F.322J.

C. Clark

21H.244 Imperial and Revolutionary Russia: Culture and Politics, 1700–1917
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Analyzes Russia's social, cultural, and political heritage in the 18th and 19th centuries, up to and including the Russian Revolution of 1917. Compares reforming and revolutionary impulses in the context of serfdom, the rise of the intelligentsia, and debates over capitalism. Focuses on historical and literary texts, especially the intersections between the two.

E. Wood

21H.245J Soviet and Post-Soviet Politics and Society: 1917 to the Present
(Same subject as 17.57J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S; CI-H

Explores the political and historical evolution of the Soviet state and society from the 1917 Revolution to the present. Covers the creation of a revolutionary regime, causes and nature of the Stalin revolution, post-Stalinist efforts to achieve political and social reform, and causes of the Soviet collapse. Also examines current developments in Russia in light of Soviet history. Enrollment limited

Staff

21H.253J The Global Chinese: Chinese Migration, 1567–Present
(Same subject as 21F.075J)
(Subject meets with 21F.196)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

See description under subject 21F.075J.

E. Teng

21H.260 Cities in the Middle East: History, Politics and Society
Prereq: None
U (Fall)
3-0-9 HASS-S

Examines the role and centrality of cities in the history of the modern Middle East, through political, social, cultural and urban interactions. Begins with a theoretical introduction of the different approaches for investigating urban spaces, and follows with discussions of case studies that demonstrate the diversity of urban centers in the Middle East, including Beirut, Istanbul, Jerusalem, Mecca, Algiers, and Cairo.

A. Jacobson

21H.262 Palestine and the Arab-Israeli Conflict
Prereq: None
U (Spring)
3-0-9 HASS-H

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. Limited to 15.

A. Jacobson

21H.285J Making the Modern World: The Industrial Revolution in Global Perspective
(Same subject as STS.025J)
Prereq: None
U (Fall)
3-0-9 HASS-H

Not offered regularly; consult department

SEMINARS

21H.310J Migration and Immigration in US History
(Same subject as 11.019J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S

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. Capozola

21H.315 American Consumer Culture
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-0-10 HASS-H

Examines how and why 20th-century Americans came to define the “good life” through consumption, leisure, and material abundance. Explores how such things as department stores, advertising, mass-produced cars, and suburbs transformed the American economy, society, and politics.

Staff

21H.318 The Energy Crisis: Past and Present
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-0-10 HASS-H

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.

Staff

21H.319 Race, Crime, and Citizenship in American Law (New)
Prereq: None
U (Fall)
3-0-9 HASS-S

Surveys the history of modern American criminal justice, with emphasis on its relationship to American ideas about citizenship, nationhood, and race/ethnicity/religion. Begins with a sampling of perspectives on the rise of mass
incarceration and the debates over the role of race, poverty, and procedure in criminal punishment. Continues with a series of case studies, including racial disparities in the war on drugs, illegal immigration, and the regulation of police investigations. Concludes by addressing the development of a constitutional law governing the intersection of ethnicity, religion, and counter-terrorism before and (especially) after 9/11. M. Ghachem

21H.320J Gender and the Law in US History
(Same subject as WGS.161J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Explores the legal history of the US as a gendered system. Examines how women have shaped the meanings of American citizenship through pursuit of political rights such as suffrage, jury duty, and military service, as well as how the legal system has shaped gender relations 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
(Same subject as 11.026J)
(Same subject as 11.339)
Prereq: None
U (Spring)
2-0-7 HASS-H

Seminar on downtown in US cities from the late 19th century to the late 20th. Emphasis on downtown as an idea, place, and cluster of interests, on the changing character of downtown, and on recent efforts to rebuild it. Considers subways, skyscrapers, highways, urban renewal, and retail centers. Focus on readings, discussions, and individual research projects. Students taking graduate version complete additional assignments. R. M. Fogelson

21H.322 Christianity in America
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Examines Christian encounters with Judaism, Islam, and the indigenous religions of Africa and America. Explores the intellectual and social consequences of Christian imperialism and the transformations of Christianity during its American encounters. C. Wilder

21H.331 Julius Caesar and the Fall of the Roman Republic
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Ancient Rome from 133 to 27 BC. Explores political, social, and economic factors commonly offered to explain the fall of the Roman Republic: growth of the territorial empire, increased intensity of aristocratic competition, transformation of the Italian economy, growth of the city of Rome and dependence of the urban plebs, changes in military recruitment and dependence of soldiers on their generals. Emphasis on the reading of ancient sources in translation, including Cicero, Sallust, Caesar, Augustus, Appian, Plutarch, and Suetonius. Instruction and practice in oral and written communication provided. Taught in seminar format with emphasis on class participation. W. Broadhead

21H.333 Early Christianity
Prereq: None
U (Spring)
3-0-9 HASS-H

Introduction to the history of early Christianity, from Jesus to Muhammad. Investigates the origins and spread of the Jesus movement within the ancient Jewish and Roman worlds, the emergence of the Church, and the diversity of early Christian thought, spirituality, literature, and art. Examines such topics as the historical Jesus and Paul, relations among Jews, Romans, and Christians, debates over orthodoxy and heresy, the conversion of the Roman empire, the rise of bishops and monasticism, the Church Fathers, and the cult of the saints. E. Goldberg

21H.334 The World of Charlemagne
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H

Investigates the world of the first medieval emperor, Charles the Great, or Charlemagne (768-814). Focuses on how Charlemagne and his dynasty, the Carolingians (ruled 751-888), forged a vast empire out of the diverse peoples and territories of Europe—not only through conquests and military might, but through Christianity and the Church, education and literacy, government and law, art and architecture, and a fundamental reorganization of the economy and society. Considers the enduring contributions of Charlemagne and his family to the formation of Europe as well as the shortcomings and failures of their empire. E. Goldberg

21H.343 From Print to Digital: Technologies of the Word, 1450–Present
(Subject meets with CMS.880)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

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. Students taking graduate version complete additional assignments. J. Ravel

21H.351J Shanghai and China’s Modernization
(Same subject as 11.153J)
Prereq: None
U (Spring)
2-0-10 HASS-H

Considers the history and function of Shanghai, from 1840 to the present, and its rise from provincial backwater to international metropolis. Examines its role as a primary point of economic, political, and social contact between China and the world, and the strong grip Shanghai holds on both the Chinese and foreign imagination. Students discuss the major events and figures of Shanghai, critique the classic historiography, and complete an independent project on Shanghai history. C. Leighton

21H.354 World War II in Asia
Prereq: None
U (Fall)
3-0-9 HASS-H

Examines World War II in the Asia-Pacific region, starting with the rise of the Japanese Empire after World War I and ending with the Allied occupation of Japan from 1945 to 1952. Highlights the diverse and, at times, contradictory forces in politics, society, and culture that shaped the wartime experiences of the empire’s inhabitants. H. Nagahara

21H.357 South Asians in the British Empire: Trade, Labor, Literature, Politics (New)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

Provides a comparative and connected transregional history of identity, colonialism, migration, and multiculturalism from the perspective of the South Asian diaspora in the British Empire.
Topics include Indian traders in East Africa and Southeast Asia; Indian indentured laborers in Fiji, Mauritius, and the Caribbean; Indian political activism and the making of a mahatma (Gandhi) in South Africa; African and Indian political collaboration in Kenya; and the post-colonial expulsion of South Asians from East Africa to Britain in the late 1960s to early 1970s.

21H.365 Cultural Plurality in Modern Middle East

Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Seminar considers "difference" and "sameness" as they have been conceived, experienced, and regulated by peoples of the Middle East, with a focus on the 19th and 20th centuries. First half discusses the Ottoman Empire. Explores how this multiethnic, polyglot empire survived for several relatively peaceful centuries and what happened when its formula for existence was challenged by politics based on mono-ethnic states. Second half focuses on post-Ottoman nation-states, such as Turkey and Egypt, and Western-mandated Arab states, such as Syria, Lebanon, Palestine, and Iraq. Concludes with a case analysis of Israel.

L. Ekmekcioglu

21H.380 People and Other Animals
(Same subject as 21A.411)
(Subject meets with 21A.419J, 21H.980J)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
2-0-10 HASS-S

Historical exploration of the ways that people have interacted with their closest animal relatives, for example: hunting, domestication of livestock, exploitation of animal labor, scientific study of animals, display of exotic and performing animals, and pet-keeping. Themes include changing ideas about animal agency and intelligence, our moral obligations to animals, and the limits imposed on the use of animals. Students taking the graduate version complete additional assignments.

H. Ritvo

21H.381J Women and War
(Same subject as WGS.222J)
Prereq: None
U (Fall)
3-0-9 HASS-S

Examines women's experiences during and after war and genocide, covering the first half of the 20th century in Europe and the Middle East. Addresses ways in which women's wartime suffering has been used to further a variety of political and social agendas. Discussions focus on a different topic each week, such as sexual violence, women survivors, female perpetrators of genocide, nurses, children of genocidal rape, and the memory of war.

L. Ekmekcioglu

21H.382 Finance and Fraud in the Revolutionary Atlantic

Prereq: None
U (Fall)
3-0-9 HASS-H

Seminar focuses on a period of Atlantic history when financial power and republican norms first began to conflict in a sustained and direct manner and considers the lessons that emerged from such events. Examines the eighteenth century through two lenses: as a period of recurring financial crisis, and one that generated powerful and enduring norms of the model just society. Beginning with the first major stock market crashes in 1719–1720 (the South Sea and Mississippi Bubbles), discusses the unprecedented opportunities the North Atlantic provided for colonial joint-stock companies, banks and land speculators to wreak havoc on society at large through the creation of novel instruments of credit, debt, and investment.

M. Ghachem

21H.385J The Ghetto: From Venice to Harlem
(Same subject as 11.152J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
2-0-10 HASS-S

Provides an in-depth look at a modern institution of oppression: the ghetto. Uses literature to examine ghettoization over time and across a wide geographical area, from Jews in Medieval Europe to African-Americans in the 20th-century United States. Also explores segregation and poverty in the urban "Third World."

C. Wilder

21H.390 Seminar in Historical Methods

Prereq: Two History subjects or permission of instructor
U (Spring)
2-0-10 HASS-H

Examines the distinctive ways in which historians in different parts of the world have approached the task of writing history. Explores methodologies used, such as political, social, economic, cultural, and popular histories through the reading and discussion of relevant and innovative texts. 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.

C. Wilder

21H.391 Undergraduate Independent Study

Prereq: None
U (Fall, IAP)
Units arranged
Can be repeated for credit

Individual supervised work for students who wish to explore an area of interest in history. Before registering, a student must plan a course of study with a member of the History Faculty and secure approval from the Head of the History Faculty. Normal maximum is 6 units; exceptional 9-unit projects occasionally approved. 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
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

G R A D U A T E S U B J E C T S

21H.902 Reading Seminar in American History:
1877 to the Present
Prereq: 21H.991
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.

Staff

21H.980J People and Other Animals
(Same subject as 21A.419J)
(Subject meets with 21A.411J, 21H.380J)
Prereq: None
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
2-0-10

Historical exploration of the ways that people have interacted with their closest animal relatives, for example: hunting, domestication of livestock, exploitation of animal labor, scientific study of animals, display of exotic and performing animals, and pet-keeping. Themes include changing ideas about animal agency and intelligence, our moral obligations to animals, and the limits imposed on the use of animals. Students taking the graduate version complete additional assignments.

H. Ritvo

21H.981 Seminar in Nature, Environment, and Empire
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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

Explores the range of approaches available to historians. Readings include examples of agrarian history, historical demography, environmental history, microhistory, among other fields. Topics drawn from European, American, and Asian history.

A. McCants

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

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</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><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).

**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>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>
</tr>
<tr>
<td>21H.ThT History Pre-Thesis Tutorial, 12</td>
<td></td>
</tr>
<tr>
<td>21H.ThU History Thesis, 12, CI-M *</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A coherent program of seven subjects from the history curriculum; and three related subjects from a second HASS discipline.</td>
<td>84–114</td>
</tr>
</tbody>
</table>

**Departmental Program Units That Also Satisfy the GIRs**

<table>
<thead>
<tr>
<th>Unrestricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(27–33)</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Total Units Beyond the GIRs Required for SB Degree</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**
*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).
Note that topics for some of the intermediate subjects vary from term to term. Please contact Literature Headquarters (14N–407), or consult the Literature Supplement to the Bulletin, for specific term descriptions.

1) Introductory subjects (21L.000–21L.048) all carry HASS Distribution and Communications Intensive (CI-H or CI-HW) credit.

2) Samplings (21L.310–21L.339, 21L.345–21L.355) are 6-unit subjects that provide both an alternative route into literary study and a less intensive means for students to sustain a commitment to reading and textual interpretation. Their focus is on critical exploration, comprehension, and group discussion, with less sustained attention to analytic writing skills. Students can combine most two 6-unit Samplings subjects to count as a HASS subject in the Humanities category and the equivalent of a subject in the Intermediate tier. (Students who began their studies prior to Fall 2010 may combine Sampling subjects, by petition to the Subcommittee on the HASS Requirement, for HASS Elective credit.) No more than four 6-unit subjects may be combined in this manner. See http://web.mit.edu/hassreq/ and contact Literature Headquarters for details.

3) Intermediate subjects (21L.430–21L.512) explore literary and visual forms in greater depth and center on historical periods, literary themes, or genres; others focus on media studies, comparative cultural studies, or national literatures. Students are encouraged to consult individual instructors about prerequisite requirements.

4) Seminars (21L.616–21L.715), usually 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 online and from the Literature Section offices, offers more detailed descriptions of all literature subjects and includes specific information about required texts, writing assignments, and examinations.

INTRODUCTORY SUBJECTS

21L.000 Writing About Literature
(Same subject as 21W.041J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-HW

Intensive focus on the reading and writing skills used to analyze literary texts such as poems by Emily Dickinson, Shakespeare or Langston Hughes; short stories by Chekhov, Joyce, or Alice Walker; and a short novel by Melville or Toni Morrison. Designed not only to prepare students for further work in writing and literary and media study, but also to provide increased confidence and pleasure in their reading, writing, and analytical skills. Students write or revise essays weekly. Enrollment limited.
Fall: S. Alexandre
Spring: W. Kelley

21L.001 Foundations of Western Literature: Homer to Dante
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-H

Studies a broad range of texts essential to understanding the two great sources of Western conceptions of the world and humanity’s place within it: the ancient world of Greece and Rome and the Judeo-Christian world that challenged and absorbed it. Readings vary but usually include works by Homer, Sophocles, Aristotle, Plato, Virgil, St. Augustine, and Dante. Enrollment limited.
Fall: S. Frampton
Spring: Staff

21L.002 Foundations of Western Literature: From Shakespeare to the Present
Prereq: None
U (Spring)
3-0-9 HASS-H; 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; CI-H

Introduces prose fiction, both stories and novels. Emphasizes historical context, narrative structure and close reading. Enrollment limited.
Fall: M. Gubar, I. Lipkowitz
Spring: R. Perry, I. Lipkowitz

21L.004 Reading Poetry
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-H

Fall: N. Jackson, S. Tapscott
Spring: N. Jackson

21L.005 Introduction to Drama
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; 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.
Staff

21L.006 American Literature
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-H

Studies the national literature of the United States since the early 19th century. Considers a range of texts—including, novels, essays, films, and electronic media—and their efforts to define the notion of American identity. Readings usually include works by such authors as Nathaniel

Fall: W. Kelley
Spring: S. Tapscott

21L.007 World Literatures
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H
Introduces students to a coherent set of textual and visual materials drawn from different geographical regions, languages, artistic genres, and historical periods. The focus may vary but usually cuts across national boundaries. Includes non-English works read in translation and examines different kinds of writing, both fiction and nonfiction. Pays special attention to such issues as identity formation, cultural contact, exploration, and exile. Previously taught topics include contemporary writing from Africa and South Asia, the impact of the discovery of the New World, and Caribbean literature.

W. Donaldson

21L.008 Black Matters: Introduction to Black Studies
(Same subject as 2A.912J, 21A.125J, 21H.106J, 21W.741J, WGS.190J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-A, HASS-H; CI-H
See description under subject 24.912J.

Staff

21L.009 Shakespeare
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-H
Focuses on the close reading of six to eight Shakespeare plays, as well as their adaptation for stage and/or film. Selected texts cover the range of genres in which Shakespeare wrote (i.e., history, comedy, tragedy, and romance). Special emphasis in some terms on performances and adaptions of Shakespearean drama around the world. Plays studied vary across sections and from term to term, and have recently included Henry IV Part 1, Hamlet, A Midsummer Night’s Dream, King Lear, Othello, and The Tempest. Enrollment limited.

P. Donaldson, S. Raman

21L.010 Writing with Shakespeare
(Same subject as 21W.042J)
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H
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; CI-H
Concentrates on close analysis and criticism of a wide range of films, including works from the early silent period, documentary and avant-garde films, European art cinema, and contemporary Hollywood fare. Through comparative reading of films from different eras and countries, students develop the skills to turn their in-depth analyses into interpretations and explore theoretical issues related to spectatorship. Syllabus varies from term to term, but usually includes such directors as Coppola, Eisenstein, Fellini, Godard, Griffith, Hawks, Hitchcock, Kubrick, Kurosawa, Tarantino, Welles, Wiseman, and Zhang.

Fall: E. Brinkema
Spring: D. Thorburn

21L.012 Forms of Western Narrative
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H
Examines a wide assortment of narrative forms, from Homer to the present, and considers why and how stories are told. Focuses on the close reading of literary and cultural issues, the emergence of different narrative genres, and how different media affect the construction and interpretation of narratives. Syllabus varies by term, but usually includes materials such as epics, novels, tales, short stories, films, television programs, graphic novels, and interactive games.

D. Thorburn

21L.013 The Supernatural in Music, Literature and Culture
(Same subject as 21A.201J, 21M.013J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A, HASS-H; CI-H
See description under subject 21M.013J.

C. Shadle, M. Fuller

21L.014 Empire: Introduction to Ancient and Medieval Studies
(Same subject as 21H.007J)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H
See description under subject 21H.007J.

W. Broadhead, S. Frampton, E. Goldberg

21L.015 The Art of the Probable
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H; CI-H
Examines literary texts and/or films in relation to the history of the idea of probability. Traces the growing importance of probability as a basic property of things and the world, as well as a measure of the reliability of our ideas and beliefs. Connects the development and use of probabilistic reasoning (e.g., in the lottery and in statistics) with literary and cultural concerns regarding the rationality of belief, risk and uncertainty, free will and determinism, chance and fate. Discussion of the work of scientific and philosophical pioneers of probabilistic thought (e.g., Pascal, Leibniz, Bernoulli, Laplace) in conjunction with works by Shakespeare, Voltaire, H. G. Wells, Pynchon and Stoppard, among others.

N. Jackson, A. Kibel, S. Raman

21L.016 Introduction to English Literature
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H; CI-H
Examines the rich heritage of English literature across genre and historical period. Designed for students who want to know more about English literature or about English culture and history. Studies the relationships between literary themes, forms, and conventions and the times in which they were produced. Explores (for instance) Renaissance lyrics and drama, Enlightenment satires in word image, the 19th-century novel, and modern and contemporary stories, poems and film.

S. Tapscott
21L.019 Introduction to European and Latin American Fiction
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H; CI-H

Studies great works of European and Latin American fiction. Attention to a variety of forms including: the picaresque, epistolary, realist, naturalist, and magical realist fiction. Emphasizes ways in which the unique history of each country shaped the imaginative responses of its writers. Authors include Cervantes, Laclos, Goethe, Mann, Dostoevsky, Flaubert, Zola, Unamuno, Wolf, García Márquez, and Allende. Taught in English.
M. Resnick

21L.020J Globalization: The Good, the Bad and the In-Between
(Same subject as 21F.076J)
U (Fall)
3-0-6 HASS-H; 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.021 Comedy
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

Surveys a range of comic texts in different media, the cultures that produced them, and various theories of comedy. Authors and directors studied may include Aristophanes, Shakespeare, Molière, Austen, Wilde and Chaplin.
A. Kibel

21L.022J Darwin and Design
(Same subject as 21W.739J)
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H

In The Origin of Species, Darwin provided a model for understanding the existence of objects and systems manifesting evidence of design without positing a designer, and of purpose and mechanism without intelligent agency. Texts deal with pre-Darwinian and later treatment of this topic within literature and speculative thought since the 18th century, with some attention to the modern study of feedback mechanism in artificial intelligence. Readings in Hume, Voltaire, Malthus, Darwin, Butler, Hardy, H. G. Wells, and Freud.
A. Kibel

21L.023J Folk Music of the British Isles and North America
(Same subject as 21M.223J)
Prereq: None
U (Fall)
3-1-8 HASS-A; CI-H

See description under subject 21M.223J.
G. Ruckert, R. Perry

21L.044J Classics of Chinese Literature in Translation
(Same subject as 21F.044J, WGS.235J)
(Subject meets with 21F.195)
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-H

See description under subject 21F.044J.
E. Teng

21L.048J International Women’s Voices
(Same subject as 21F.022J, WGS.141J)
Prereq: None
U (Spring)
3-0-9 HASS-H; 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 Ba, Isabel Allende, Anita Desai, Maxine Hong Kingston, Toni Morrison, Doris Lessing, Alifa Rijaat, Yang Jiang, Nawal Al-Saadawi, and Sawako Ariyoshi. Taught in English.
M. Resnick

21L.285 Modern Fiction
Prereq: One subject in Literature
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-6 HASS-H
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.
H. Eiland

21L.286 Modern Drama
Prereq: One subject in Literature
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-6 HASS-H

Credit cannot also be received for 21L.486

Students analyze major modern plays. Typically features the works of Beckett and Brecht. Additional writers may include Churchill, Friel, Kushner, O’Neill, Shaw, Devere Smith, Stoppard, Soyinka, Williams, and Wilson. Special consideration of performance, sociopolitical and aesthetic contexts, and the role of theater in the world of modern multimedia. Meets with 21L.486 when offered concurrently. Students taking the 12-unit version complete additional assignments.
S. Tapscott

21L.301J Doing Right
(Same subject as 24.190J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
2-0-4 [P/D/F]

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
LITERATURE 2014–2015

SAMPLINGS

21L.310 Bestsellers
Prereq: None
U (Fall; first half of term)
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.
S. Raman

21L.315 Prizewinners
Prereq: None
U (Spring; first half of term)
2-0-4
Can be repeated once for credit if the specific works studied differ
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. Enrollment limited.
W. Kelley

21L.320 Big Books
Prereq: None
U (Spring)
2-0-4
Can be repeated once for credit if works studied differ
Intensive study of a single major literary work or a very small set of related literary works. Emphasizes texts that encourage close analysis in a way that cannot easily be integrated into the regular literature curriculum. The Big Books taught in previous terms include Moby-Dick, Canterbury Tales, and the Faerie Queene. Enrollment limited.
M. Fuller

21L.325 Small Wonders
Prereq: None
U (Fall)
2-0-4
Can be repeated once for credit if works studied differ
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.
N. Jackson

21L.338 Reading in the Original
Prereq: Permission of instructor
U (Spring)
2-0-4
Can be repeated once for credit if content differs
Close examination of literary texts in their original languages. Language and texts studied vary from term to term.
S. Faramont

21L.339 Literary Translation
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, Spring)
2-0-4
Can be repeated once for credit if content differs
Studies the practices and theory of moving literary texts from one language to another. Student proficiency in other language(s) welcome but not required.
Staff

21L.345 On the Screen
Prereq: Permission of instructor
U (IAP, Spring)
2-0-4
Can be repeated for credit with permission of instructor
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. Meets first half of term during fall.
E. Brinkema

21L.350 Science and Literature
Prereq: None
U (Fall, Spring)
2-0-4
Can be repeated once for credit if content differs
Examines intersections and channels of influence between the sciences and forms of imaginative literature. Topics, historical periods, and syllabi will vary.
Fall: M. Fuller
Spring: S. Raman

21L.355 Literature in the Digital Age
Prereq: None
U (Spring; second half of term)
2-0-4
Can be repeated for credit if content differs
Examines how emerging computational methods and tools are transforming practices of reading and writing in the present. Topics may include the exploration of experimental literary forms and digital media practices (hypertext, Twitter fiction, etc.) or focus on the use of digital tools for analyzing literature (GIS mapping, data mining, etc.).
W. Kelley

INTERMEDIATE SUBJECTS

Genres and Themes

21L.430 Popular Culture and Narrative
(Subject meets with CMS.920)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Can be repeated for credit with permission of instructor
Examines relationships between popular culture and art, focusing on problems of evaluation and audience, and the uses of different media within a broader social context. Typically treats a range of narrative and dramatic works as well as films. Previously taught topics include Elements of Style; Gender, Sexuality and Popular Narrative. Students taking graduate version complete additional assignments. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program.
K. Delaney

21L.431 Shakespeare on Film and Media (New)
Prereq: None
U (Spring)
3-0-9 HASS-H
Examines the adaptation, performance and interpretation of Shakespearean plays on film and video. Focus varies from term to term to include films such as the Olivier and Almereyda versions of Hamlet and Baz Luhrmann’s Romeo + Juliet; “spin-offs” such as Kurosawa’s Throne of Blood and Shakespeare in Love; or theatrical videos of English language and international productions.
P. Donaldson
21L.432 Understanding Television
(Subject meets with CMS.915)
Prereq: One subject in Literature or Comparative Media Studies
U (Spring)
3-0-9 HASS-H
Can be repeated for credit

A cultural approach to television’s evolution as a technology and system of representation. Considers television as a system of storytelling and mythmaking, and as a cultural practice studied from anthropological, literary, and cinematic perspectives. Focuses on prime-time commercial broadcasting, the medium’s technological and economic history, and theoretical perspectives. Considerable television viewing and readings in media theory and cultural interpretation are required. Previously taught topics include American Television: A Cultural History. Students taking graduate version complete additional assignments.
D. Thorburn

21L.433 Film Styles and Genres
Prereq: 21L.011 or permission of instructor
U (Fall)
3-0-9 HASS-H
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.
A. Kibel

21L.434 Science Fiction and Fantasy
Prereq: None
U (Spring)
3-0-9 HASS-H

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.
M. Gubar

21L.435 Literature and Film
(Subject meets with CMS.840)
Prereq: One subject in Literature or Comparative Media Studies
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-3-6 HASS-H
Can be repeated for credit

Investigates relationships between the two media, including film adaptations as well as works linked by genre, topic, and style. Explores how artworks challenge and cross cultural, political, and aesthetic boundaries. Students taking graduate version complete additional assignments.
E. Brinkema

21L.449 Literature and the Environment
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

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 (Spring)
3-0-9 HASS-H

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, Shakespeare, Swift, Ibsen, Shaw, Dostoyevsky, and Conrad, as well as some Biblical materials.
A. Kibel

21L.451 Literary Theory
Prereq: None
U (Fall)
3-0-9 HASS-H

Examines how we read texts and the questions that we, as readers, ask of them. Introduces different critical approaches to literature by examining the relationship between readers and text, between different texts, and between text and context. Topics vary but usually include reader-response theory, structuralism and semiotics, post-structuralism and post-modernism, historicism, psychoanalysis, intertextuality, cultural criticism, and media theory.
S. Raman

21L.455 Classical Literature
Prereq: None
U (Fall)
3-0-9 HASS-H
Can be repeated once for credit as long as 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.
S. Frampton

21L.458 The Bible
Prereq: None
U (Fall)
3-0-9 HASS-H

An introduction to major books from both the Hebrew Bible and the New Testament. Particular attention given to literary techniques, issues resulting from translation from the original Hebrew and Greek, and the different historical periods that produced and are reflected in the Bible.
I. Lipkowitz

21L.460 Medieval Literature
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H
Can be repeated for credit with instructor’s permission when subject content differs

Covers readings in European literature between the years 800 and 1500, with particular focus on the English and French literary traditions. Addresses themes such as the complex relationship between love and war; the differences between the medieval and modern understandings of character, psychology, and authorship; and the particular role of women (as both characters and authors) in the Middle Ages. Previous topics include Arthurian legends and Geoffrey Chaucer. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Enrollment limited.
Staff
21L.471 Major Novels
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H
Can be repeated for credit with permission of instructor
Studies important examples of the literary form that, from the beginning of the 18th century to the present day, has become an indispensable instrument for representing modern life, in the hands of such writers as Cervantes, Defoe, Richardson, Sterne, Burney, Austen, Scott, Dickens, the Brontes, Eliot, Balzac, Stendhal, Flaubert, Hardy, Conrad, Woolf, Dostoievsky, Tolstoy, Proust, and others.
I. Lipkowitz

21L.473 Jane Austen
(Same subject as WGS.240J)
Prereq: One subject in Literature
U (Fall)
3-0-9 HASS-H
An examination of Jane Austen’s satire in her seven complete novels, several fragments, and juvenilia. Students read these texts in relation to her letters and other biographical and historical information.
R. Perry

21L.475 Enlightenment and Modernity
Prereq: One subject in Literature
U (Spring)
3-0-9 HASS-H
Can be repeated for credit with permission of instructor
Examines selected topics in 18th- and 19th-century English/European literature and culture from the restoration of the English monarchy in 1660 to the end of Queen Victoria’s reign in 1901. Topics vary by term; authors may include Jonathan Swift, Laurence Sterne, William Blake, William Wordsworth, Jane Austen, Charles Dickens, George Eliot, Lewis Carroll, Oscar Wilde, and Arthur Conan Doyle, among others.
J. Buzard

21L.485 Modern Fiction
Prereq: One subject in Literature
U (Fall)
3-0-9 HASS-H
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.
D. Thorburn

21L.486 Modern Drama
Prereq: One subject in Literature
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Credit cannot also be received for 21L.286
Students analyze major modern plays. Typically features the works of Beckett and Brecht. Additional writers may include Churchill, Friel, Kushner, O’Neill, Shaw, Devere Smith, Stoppard, Soyinka, Williams, and Wilson. Special consideration of performance, sociopolitical and aesthetic contexts, and the role of theater in the world of modern multimedia. Meets with 21L.286 when offered concurrently. Students taking the 12-unit version complete additional assignments.
S. Tapscott

21L.487 Modern Poetry
Prereq: One subject in Literature
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Study of major modern texts and manifestos from the late 19th century through the 20th century. Examines works written in English, with attention to Modernist texts from other cultures and other languages as well. Poems by T.S. Eliot, W.C. Williams, Langston Hughes, Robert Frost, Pablo Neruda, Hilda Doolittle, Charles Baudelaire, and others.
S. Tapscott

21L.488 Contemporary Literature
Prereq: One subject in Literature
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
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.
Staff

21L.489 Interactive Narrative
(Same subject as 21W.765J)
Prereq: None
U (Fall)
3-0-9 HASS-A
See description under subject 21W.765J.
N. Montfort

American Literature
See also 21L.006.

21L.501 The American Novel
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS-H
Can be repeated for credit with permission of instructor if content differs
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”).
S. Alexandre

21L.504 Race and Identity in American Literature
(Same subject as WGS.140J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Can be repeated for credit with permission of instructor if content differs
Questions posed by the literature of the Americas about the relationship of race and gender to authorship, audience, culture, ethnicity, and aesthetics. Social conditions and literary histories that shape the politics of identity in American literature. Specific focus varies each term. Previously taught topics include Immigrant Stories, African American Literature, and Asian American Literature.
Staff
21L.512 American Authors
Prereq: One subject in Literature, permission of instructor
U (Fall)
3-0-9 HASS-H
Can be repeated for credit with permission of instructor so long as the content differs
Examines in detail the works of several American authors selected according to a theme, period, genre, or set of issues. Through close readings of poetry, novels, or plays, subject addresses such issues as literary influence, cultural diversity, and the writer’s career. Previously taught topics include American Women Writers, American Autobiography, American Political Writing, and American Short Fiction. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program.
W. Kelley

21L.518 Literature from Anywhere (New)
Prereq: Permission of instructor
U (IAP, Spring)
2-0-7 HASS-E
Provides students studying abroad the opportunity to study a literature topic and interact with their peers on campus through feedback and discussion. Begins with an on-campus seminar during IAP that introduces tools, background, and context for the readings; covers goals, methods, and logistics for the work students will conduct independently over the spring; and discusses the assigned text, films, etc. During the spring term, students synthesize and record their questions and understandings of the literature, producing materials for use and comment by peers enrolled in a six-unit, on-campus class that covers the same content (e.g., 21L.320 Big Books). Topics vary from year to year.
M. Fuller

International Literatures

See also 21L.007 and 21L.020J.

21L.611 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. Aided 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.612 Latin II
Prereq: 21L.611 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.
Staff

21L.616 Introduction to Contemporary Hispanic Literature and Film
(Same subject as 21F.716J)
Prereq: One intermediate subject in Spanish or permission of instructor
U (Spring)
3-0-9 HASS-H
Studies important 20th- and 21st-century texts and films from both Spain and Latin America. Readings include short stories, theater, the novel, and poetry, as well as some non-fiction. Students acquire skills necessary for a serious examination of literacy and cultural issues in the Spanish-speaking world. Conducted entirely in Spanish. Emphasis on active participation of students in class discussion.
Staff

21L.617 Introduction to Spanish Culture
(Same subject as 21F.717J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H
Studies the major social, political, and aesthetic modes which have shaped Spanish civilization. Coordinates the study of literature, film, art, and architecture with the historical evolution of Spain. Readings and discussions focus on such topics as: the coexistence of Christians, Moors, and Jews; Imperial Spain; the First and Second Republics; and the contemporary period as background for the emergence of distinctively Spanish literary and artistic movements. Taught in Spanish. Limited to 18.
M. Resnick

21L.638 Literature and Social Conflict: Perspectives on Modern Spain
(Same subject as 21F.738J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Considers how major literary texts illuminate principal issues in the evolution of modern Spanish society. Emphasizes the treatment of such major questions as the exile of liberals in 1820, the concept of progress, the place of religion, urbanization, rural conservatism and changing gender roles, and the Spanish Civil War. Authors include Pérez Galdos, Pardo Bazan, Unamuno, Ortega y Gasset, Salinas, Lorca, La Pasionaria, and Falcond. Taught in Spanish.
Staff

21L.639 Globalization and its Discontents: Spanish-speaking Nations
(Same subject as 21F.739J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Studies new paradigms of cultural exchange that have shaped Latin America in the 20th and 21st centuries. Examines how globalization is rapidly changing the identity of peoples and cultures in Spanish-speaking nations. Spotlights debates about human rights. Materials studied include film, fiction, essay, architectural archives, music and art. Students complete a research project about a specific aspect of Hispanic culture that has been shaped by contemporary forces in the global economy. Taught in Spanish with required readings and writing in Spanish.
Staff

SEMINARS

(Same subject as 21F.740J)
Prereq: One intermediate subject in Spanish or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Deals with the vast changes in Spanish social, political and cultural life that have taken place since the death of Franco. Topics include new freedom from censorship, the re-emergence of strong movements for regional autonomy (the Basque region and Catalonia), the new cinema
including Almodóvar and Saura, educational reforms instituted by the socialist government, and the fiction of Carme Riera and Terenci Moix. Special emphasis on the emergence of mass media as a vehicle for expression in Spain. Considers the changes wrought by Spain's acceptance into the European Community. Materials include magazines, newspapers, films, fiction, and Amando de Miguel's Los Españoles. Taught in Spanish.

M. Resnick

21L.701 Literary Methods
Prereq: Two subjects in Literature
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall) 3-0-9 HASS-H
Can be repeated for credit

Introduces practice and theory of literary criticism. Seminar focuses on topics such as the history of critical methods and techniques, and the continuity of certain subjects in literary history. Instruction and practice in oral and written communication. Previously taught topics include Virginia Woolf’s Shakespeare, Theory and Use of Figurative Language, and Text, Context, Subtext, Pretext. Approved for credit in the Women’s and Gender Studies when content meets requirements for subjects in that program. Limited to 12.

A. Kibel

21L.702 Studies in Fiction
Prereq: Two subjects in Literature
U (Spring) 3-0-9 HASS-H
Can be repeated for credit

Intensive study of a range of texts by a single author or by a limited group of authors whose achievements are mutually illuminating. Some attention to narrative theory and biographical and cultural backgrounds. Instruction and practice in oral and written communication. Previously taught topics include Stowe, Twain, and the Transformation of 19th-century America, and Joyce and the Legacy of Modernism. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Limited to 12.

S. Alexandre

21L.703 Studies in Drama
Prereq: Two subjects in Literature
U (Spring) 3-0-9 HASS-H
Can be repeated for credit

Intensive study of an important topic or period in drama. Close analysis of major plays, enriched by critical readings and attention to historical and theatrical contexts. Instruction and practice in oral and written communication through student presentations and research essays. Previously taught topics include: Renaissance Drama; Shakespeare with his Contemporaries; Oscar Wilde; and Stoppard and Company. Limited to 12.

D. Henderson

21L.704 Studies in Poetry
Prereq: Two subjects in Literature
U (Fall, Spring) 3-0-9 HASS-H
Can be repeated for credit

Intensive study of a body of poetry, raising questions of form, authorship, poetic influence, social context, and literary tradition. Instruction and practice in oral and written communication. Previously taught topics include: Does poetry Matter?, Poetry and the Science of Mind; Songs, Sonnets and the Story of English; Virgil, Spenser, Milton; and The Image: Poetry, Photography, and Technologies of Vision. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Limited to 12.

Fall: S. Tapscott
Spring: N. Jackson

21L.705 Major Authors
Prereq: Two subjects in Literature
U (Fall, Spring) 3-0-9 HASS-H
Can be repeated for credit

Close study of a limited group of writers. Instruction and practice in oral and written communication. Previously taught topics include John Milton and his Age, Chaucer, Herman Melville, Toni Morrison, and Oscar Wilde and the ’90s. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Limited to 12.

Fall: W. Kelley
Spring: S. Tapscott

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) 3-3-6 HASS-H
Can be repeated for credit

Intensive study of films from particular periods, genres, or directors. Instruction and practice in oral and written communication provided. Previously taught topics include Film Analysis, Remixes, Film Narrative, and Heroic Cinema. Students taking graduate version complete additional assignments. Approved for
credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Limited to 12.
M. Marks

SPECIAL SUBJECTS AND TOPICS IN LITERATURE

21L.340 Pleasures of Poetry
Prereq: Permission of instructor
U (IAP)
3-0-3
Can be repeated for credit with permission of instructor

Strengthens writing and reading comprehension skills. Students attend all public sessions of the Pleasures of Poetry readings and discussions as well as several additional classes. The poems chosen by the various moderators range across the history of literature, from ancient Chinese lyrics to contemporary texts.
Staff

21L.900 Independent Study
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit with permission of instructor

21L.901 Independent Study
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.S88 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

21L.S89 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

21L.S90 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

21L.S91, 21L.S92 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit if the subjects are different

21L.S93, 21L.S94 Special Subject in Literature
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit if the subjects are different

21L.S95 Special Subject in Literature
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.S96 Special Subject in Film and Media
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

21L.S97 Special Subject in Film and Media
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 permission of 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

21L.URG Undergraduate Research
Prereq: None
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.
Consult with Section UROP Coordinator

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></th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [all but two subjects can be from 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>

**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**
Four of the 10 subjects from the required subjects and restricted electives taken to satisfy the major 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).

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three advanced seminar level subjects in Literature</td>
<td>36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>A coherent program of seven additional subjects from the literature curriculum.</td>
<td>63–84</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(60–72)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unrestricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>132–141</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Units Beyond the GIRs Required for SB Degree</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td></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**
*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.701, 21L.702, 21L.703, 21L.704, 21L.705, 21L.706, 21L.707, 21L.709.

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 five areas: Introductory, History/Culture, Composition/Theory, Performance, Advanced/ Special Subjects, and Music and Media.

Although most students start with introductory subjects, those who have vocal or instrumental training or extensive exposure to music are encouraged to begin at a higher starting level.

Introductory Subjects

21M.011 Introduction to Western Music
Prereq: None
U (Fall, Spring)
4-0-8 HASS-A; CI-H
Provides a broad overview of Western music from the Middle Ages to the 20th century, with emphasis on late baroque, classical, romantic, and modernist styles. Designed to enhance the musical experience by developing listening skills and an understanding of diverse forms and genres. Major composers and works placed in social and cultural contexts. Weekly lectures feature demonstrations by professional performers and introduce topics to be discussed in sections. Enrollment limited.
Fall: E. Pollock, T. Neff, A. Boyles
Spring: M. Marks, T. Neff

21M.013J The Supernatural in Music, Literature, and Culture
(Same subject as 21A.201J, 21L.013J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A; HASS-H; CI-H
Explores the relationship between music and the supernatural, focusing on the social history and context of supernatural beliefs as reflected in key literary and musical works from 1600 to the present. Provides an understanding of the place of ambiguity and the role of interpretation in culture, science and art. Explores great works of art by Shakespeare, Verdi, Goethe (in translation), Gounod, Henry James and Benjamin Britten. Readings also include selections from the most recent scholarship on magic and the supernatural. Writing assignments range from web-based projects to analytic essays. No previous experience in music is necessary. Projected guest lectures, musical performances, field trips. Limited to 36.
C. Shadle, M. Fuller

21M.030 Introduction to World Music
Prereq: None
U (Fall, Spring)
3-0-9 HASS-A; CI-H
An introduction to diverse musical traditions of the world. Music from a wide range of geographical areas is studied in terms of structure, performance practice, social use, aesthetics, and cross-cultural contact. Includes hands-on music making, live demonstrations by guest artists, and ethnographic research projects. Enrollment limited by lottery.
Fall: P. Tang, M. Schweig
Spring: E. Ziporyn

21M.051 Fundamentals of Music
Prereq: None
U (Fall, Spring)
3-3-6 HASS-A
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.
M. Cuthbert, E. Kwon

21M.065 Introduction to Musical Composition
Prereq: None
U (Spring)
3-0-9 HASS-A
Through a progressive series of composition projects, students investigate the sonic organization of musical works and performances, focusing on fundamental questions of unity and variety. Aesthetic issues are considered in the pragmatic context of the instructions that composers provide to achieve a desired musical result, whether these instructions are notated in prose, as graphic images, or in symbolic notation. 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 18.
K. Makan, F. Hollerweger

History/Culture

21M.215 Music of the Americas
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-A
A survey of the music of North and South America from the Renaissance to the present, with emphasis on the cross-fertilizations of indigenous and European traditions. Listening assignments will focus on composers as varied as Copland and Still, Revueltas and Chihara. C. Shadle

21M.220 Early Music
Prereq: None. Coreq: 21M.301
U (Spring)
3-0-9 HASS-A
Examines European music from the early Middle Ages until the end of the Renaissance. Includes a chronological survey and intensive study of three topics: chant and its development, music in Italy 1340–1420, and music in Elizabethan England. Focuses on methods and pitfalls in studying music of the distant past. Students' papers, problem sets, and presentations explore lives, genres, and works in depth. Works studied in facsimile of original notation, and from original manuscripts at MIT, where possible.
M. Cuthbert

21M.223J Folk Music of the British Isles and North America
(Same subject as 21L.023J)
Prereq: None
U (Fall)
3-1-8 HASS-A; CI-H
Examines the production, transmission, preservation and the qualities of folk music in the British Isles and North America from the 18th century to the folk revival of the 1960s and the present. Special emphasis on balladry, fiddle styles, and African-American influences. Enrollment limited.
G. Ruckert, R. Perry
21M.226 Jazz
Prereq: None
U (Fall, Spring)
3-0-9 HASS-A
Surveys Baroque and Classical genres: opera, cantata, oratorio, sonata, concerto, quartet and symphony. Includes the composers Monteverdi, Schutz, Purcell, Vivaldi, Bach, Handel, Haydn, and Mozart. Bases written essays, projects, and oral presentations on live performances as well as listening and reading assignments. Basic music score-reading ability required.
T. Neff

21M.235 Monteverdi to Mozart: 1600–1800
Prereq: 21M.301 or permission of instructor
U (Fall)
3-0-9 HASS-A
Surveys Baroque and Classical genres: opera, cantata, oratorio, sonata, concerto, quartet and symphony. Includes the composers Monteverdi, Schutz, Purcell, Vivaldi, Bach, Handel, Haydn and Mozart. Bases written essays, projects and oral presentations on live performances as well as listening and reading assignments. Basic music score-reading ability required.

21M.236 Beethoven to Mahler: 1800–1910
Prereq: 21M.301 or permission of instructor
U (Spring)
3-0-9 HASS-A
Surveys Romantic genres including Lied/song, choral music, opera, piano sonata/character cycle, concerto, and symphony/symphonic poem. Includes the composers Beethoven, Schubert, Berlioz, Chopin, Brahms, Wagner, Verdi, Rachmaninoff, and Mahler. Bases written essays and oral presentations on live performances as well as listening and reading assignments. Basic music score-reading ability recommended.

21M.250 Stravinsky to the Present
Prereq: 21M.301 or permission of instructor
U (Fall)
3-0-9 HASS-A
Surveys musical works drawn from many genres, representing stylistic movements that have transformed classical music over the past hundred years. Focal topics include musical modernism, serialism, neoclassicism, nationalism and ideology, minimalism, and aleatoric and noise composition experiments. Discusses electronic and computer music, and new media and the postmodern present. Begins with Stravinsky’s early ballets and ends with music by current MIT composers and other important figures active today. Ability to read music required. Instruction and practice in oral and written communication provided.

21M.256 Studies in Western Music History
Prereq: 21M.301 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-A
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.

21M.273 Opera
Prereq: None
U (Fall)
3-0-9 HASS-A
Focuses on the different styles and dramatic approaches exhibited by a range of operas. Central questions include the process of adaptation from source material, the conventions of different operatic eras, and how the works are staged in contrasting productions. Basic score-reading ability required.

M. Marks

21M.271 Symphony and Concerto
Prereq: None
U (Fall)
3-0-9 HASS-A
Explores the style, form, and history of approximately two dozen pieces of canonical symphonic repertoire. Students write short reviews of musicological articles on the rich cultural history of selected works and complete one project about the state of classical music in contemporary society. Basic score-reading ability required.

E. Pollock

21M.274 Musicals of Stage and Screen
Prereq: One subject in film, music, or theater; or permission of instructor
U (Spring)
3-0-9 HASS-A
Covers Broadway works and Hollywood films in depth. Proceeds chronologically, exploring three stage musicals and three films at a time, within four historical categories: breakthrough musicals of the 1920s and ’30s; classic “book musicals” of the ’40s and ’50s; modernist and concept musicals of the ’60s and ’70s; and post modern and cutting-edge works of the ’80s and ’90s. Attention given to the role of music in relation to script, characterization, and dramatic structure. Final papers involve comparison of one stage and one film work, selected in consultation with the instructor. Oral presentations required and in-class performances encouraged.
M. Marks

21M.284 Film Music
(Subject meets with CMS.925)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-3-6 HASS-A
Surveys styles and dramatic functions of music for silent films of the 1910s-20s, and music in sound films from the 1930s to the present. Close attention given to landmark scores by American and European composers, including Korngold, Steiner, Rozsa, Prokofiev, Copland, Herrmann, Rota, Morricone, and Williams. Subsidiary topics include new trends in contemporary film-scoring, pop scores, the impact of electronics, and specialized genres (e.g., animation). Students taking the graduate version complete different assignments. Some background in the study of film and/or music is expected.
M. Marks

21M.289 Studies in Western Classical Genres
Prereq: 21M.301 or Permission of instructor
U (Spring)
3-0-9 HASS-A
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 and may require additional prerequisites or specialized skills such as score-reading or playing an instrument. Examples include the English madrigal, Baroque chamber music, Beethoven’s symphonies, French art song, Wagner’s ‘Ring’ cycle, American choral music, Stravinsky’s theater works, and the Hollywood film score.
P. McMurray
21M.291 Music of India
Prereq: None
U (Spring)
3-0-9 HASS-A
Focuses on Hindustani classical music of North India, and also involves learning about the ancient foundations of the rich classical traditions of music and dance of all Indian art and culture. Practice of the ragas and talas through the learning of songs, dance, and drumming compositions. Develops insights through listening, readings, and concert attendance.
G. Ruckert

21M.293 Music of Africa
Prereq: None
U (Fall)
3-0-9 HASS-A
Studies musical traditions of sub-Saharan Africa, with focus on West Africa. Explores a variety of musical practices and their cultural contexts through listening, reading and writing assignments with an emphasis on class discussion. Includes in-class instruction in drumming, song and dance of Senegal, Ghana, and South Africa, as well as live lecture-demonstrations by guest performers from throughout sub-Saharan Africa. Limited to 15; preference to majors, minors, concentrators. Admittance may be controlled by lottery.
P. Tang

21M.294 Popular Musics of the World
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-A
Focuses on popular music created for and transmitted by mass media. Studies various popular music genres from around the world through listening and reading assignments, while considering issues of musical change, syncretism, Westernization, globalization, the impact of recording industries, and the post-colonial era. Case studies include bhangra, Afro-pop, reggae, and global hip-hop. Limited to 25; preference to majors, minors, concentrators. Admittance may be controlled by lottery.
P. Tang

21M.295 American Popular Music
Prereq: None
U (Fall)
3-0-9 HASS-A
Surveys the development of popular music in the US, and in a cross-cultural milieu, relative to the history and sociology of the last two hundred years. Examines the ethnic mixture that characterizes modern music, and how it reflects many rich traditions and styles (minstrelsy, music-hall, operetta, Tin Pan Alley, blues, rock, electronic media, etc.). Provides a background for understanding the musical vocabulary of current popular music styles.
T. Neff

21M.299 Studies in World, Traditional, and Popular Music
Prereq: 21M.030 or permission of instructor
U (Spring)
3-0-9 HASS-A
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 music and crisis, fieldwork methodologies, Asian classical traditions, Senegalese Mbalax, Hindustani Khyal, Brazilian Samba, or Duke Ellington.
M. Schweig

Composition/Theory

21M.301 Harmony and Counterpoint I
Prereq: None
U (Fall, Spring)
3-3-6 HASS-A
Covers basic writing skills in music of the common-practice period (Bach to Brahms). Regular written assignments lead to the composition of short pieces. Analyzes representative works from the literature, keyboard laboratory, and sight-singing choir. Students should have experience reading music. Enrollment limited.
Fall: M. Harvey, J. Casinghino
Spring: E. Ruehr, J. Casinghino

21M.302 Harmony and Counterpoint II
Prereq: 21M.301 or permission of instructor
U (Fall, Spring)
3-2-7 HASS-A
A continuation of 21M.301, including chromatic harmony and modulation, a more extensive composition project, keyboard laboratory, and musicianship laboratory. Limited to 20 per section.
Fall: W. Cutter, J. Casinghino
Spring: K. Makan, J. Casinghino

21M.303 Writing in Tonal Forms I
Prereq: 21M.302
U (Fall, Spring)
3-1-8 HASS-A
Written and analytic exercises based on 18th- and 19th-century small forms and harmonic practice found in music such as the chorale preludes of Bach; minuets and trios of Haydn, Mozart, and Beethoven; and the songs and character pieces of Schubert and Schumann. Musicianship laboratory is required. Limited to 20.
Fall: J. Rohwein
Spring: C. Shadle

21M.304 Writing in Tonal Forms II
Prereq: 21M.303
U (Spring)
3-1-8 HASS-A
Further written and analytic exercises in tonal music, focusing on larger or more challenging forms. For example, students might compose a sonata-form movement for piano or a two-part invention in the style of Bach. Students have opportunities to write short works that experiment with the expanded tonal techniques of the late 19th and early 20th centuries. Musicianship laboratory is required. Limited to 20.
C. Shadle

21M.310 Techniques of 20th-Century Composition
Prereq: 21M.302, 21M.260, or permission of instructor
U (Fall)
3-0-9 HASS-A
Students complete written and analytical exercises based on compositional forms and practices from the first half of the 20th century. Areas covered include compositions based upon artificial scales and modes, as in Debussy, Bartok, and Stravinsky; compositions based on atonal pitch organizations, as with Schoenberg and Webern; compositions based on rhythmic processes, timbral exploration, and/or non-Western influences. Basic instrumentation will be taught, and compositions will be performed in class.
K. Makan

21M.340 Jazz Harmony and Arranging
Prereq: 21M.051, 21M.226, or permission of instructor
U (Spring)
3-0-9 HASS-A
Basic harmony and theory of mainstream jazz and blues; includes required listening in jazz, writing and analysis work, and two full-scale arrangements. Serves as preparation for more advanced work in jazz with application to rock and pop music. Performance of student arrangements. Limited to 20.
M. Harvey
21M.341 Jazz Composition
Prereq: 21M.226, 21M.340, or permission of instructor
U (Fall) 3-0-9 HASS-A
Jazz writing using tonal, modal, and extended compositional approaches as applied to the blues, the 32-bar song form, and post-bop structural designs. Consideration given to a variety of styles and to the ways improvisation informs the compositional process. Study of works by Ellington, Mingus, Parker, Russell, 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 2014–2015: Not offered
Acad Year 2015–2016: U (Fall) 3-0-9 HASS-A
Explores composition and arrangement for the large jazz ensembles from 1920s foundations to current postmodern practice. Consideration given to a variety of styles and to the interaction of improvisation and composition. Study of works by Basie, Ellington, Evans, Gillespie, Golson, Mingus, Morris, Nelson, Williams, and others. Open rehearsals, workshops, and performances of student compositions by the MIT Festival Jazz Ensemble and the Aardvark Jazz Orchestra. Limited to 20.  
M. Harvey

21M.351 Music Composition
(Subject meets with 21M.505)
Prereq: 21M.304, 21M.310, or permission of instructor
U (Spring) 3-0-9 HASS-A
Can be repeated for credit
Directed composition of original writing involving voices and/or instruments. Includes a weekly seminar in composition for the presentation and discussion of work in progress. Students are expected to produce at least one substantive work and perform it in public by the end of the term. Contemporary compositions and major works from 20th-century music literature are studied. Students taking the graduate version complete different assignments.  
P. Child

21M.355 Musical Improvisation
Prereq: Permission of instructor
U (Fall, Spring) 3-1-8 HASS-A
Students study concepts and practice techniques of improvisation in solo and ensemble contexts. Examines relationships between improvisation, composition, and performance based in traditional and experimental approaches. Topics, with occasional guest lectures, may include jazz, non-western music, and western concert music, as well as improvisation with film, spoken word, theater, and dance. Enrollment may be limited; open by audition to instrumental or vocal performers.  
Fall: E. Ziporyn  
Spring: M. Harvey

21M.359 Studies in Musical Composition, Theory, and Analysis
Prereq: 21M.302 or permission of instructor
U (Fall, Spring) 3-0-9 HASS-A
Can be repeated for credit with permission of instructor
Explores techniques associated with musical composition and/or analysis. Written exercises in the form of music (composition) and/or prose (papers) may be required, depending on the topic. Topics vary each year; examples include fugue, contemporary aesthetics of composition, orchestration, music analysis, or music and mathematics.  
Fall: A. Dreyblatt  
Spring: E. Egozy

21M.361 Electronic Music Composition I
Prereq: None
U (Fall, Spring) 2-1-9 HASS-A
Students develop basic skills in composition through weekly assignments focusing on sampling and audio processing. Source materials include samples of urban/natural environments, electronically generated sounds, inherent studio/recording noise, and pre-existing recordings. Audio processing includes digital signal processing (DSP) and analog devices. Covers compositional techniques, including mixing, algorithms, studio improvisation, and interaction. Students critique each other’s work and give informal presentations on recordings drawn from sound art, experimental electronica, conventional and non-conventional classical electronic works, and popular music. Covers technology, math, and acoustics in varying detail. Limited to 10 per section; preference to Music majors, minors, and concentrators.  
P. Whincop

21M.362 Electronic Music Composition II
Prereq: 21M.361 or permission of instructor
U (Spring) 2-2-8 HASS-A
Explores sophisticated synthesis techniques, from finely tuned additive to noise filtering and distortion, granular synthesis to vintage emulation. Incorporates production techniques and use of multimedia, with guest lecturers/performers. Considers composing environments such as Max/MSP/Jitter, SPEAR, SoundHack, and Mathematica. Assignments include diverse listening sessions, followed by oral or written presentations, weekly sound studies, critiques, and modular compositions/soundscapes. Prior significant computer music experience preferred. Consult instructor for technical requirements. Limited to 8.  
P. Whincop

21M.380 Music and Technology
Prereq: Permission of instructor
U (Fall, Spring) 3-0-9 HASS-A
Can be repeated for credit
Explores various technologies in relation to musical analysis, composition, performance, culture, and quantitative methods. Topics vary each term and may include development and impact on society, generative and algorithmic music, or recording techniques. May involve hands-on components such as laptop music ensemble, new instrument building, or comparing the theory and practice of audio recording.  
F. Hollerweger

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.

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 oratorios of our own time. Open to graduate and undergraduate students by audition.  
W. Cutter
21M.405 MIT Chamber Chorus
Prereq: None
U (Fall, Spring)
3-0-3
Can be repeated for credit

Rehearsal and performance of choral repertoire for small chorus, involving literature from the Renaissance to contemporary periods. Limited to 32 by audition.
W. Cutter

21M.410 Vocal Repertoire and Performance
(Subject meets with 21M.515)
Prereq: None. Coreq: Participation in ensemble for vocalists
U (Spring)
3-0-3
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

Rehearsals prepare works for concerts and recordings. Analyses of musical style, structure, and performance practice are integrated into rehearsals as a means of enriching musical conception and the approach to performance. Likewise, additional scores of particular structural or stylistic interest are read whenever time permits. Admission by audition.
A. Boyles

21M.423 Conducting and Score-Reading
Prereq: 21M.302 or permission of instructor
U (Spring)
3-0-3
Can be repeated for credit once with permission of instructor

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

Designed for advanced instrumentalists who are committed to the analysis, performance, and recording of woodwind, brass, and percussion literature from the Renaissance through the 21st century. The repertoire consists primarily of music for small and large wind ensembles. May include ensemble music from Gabrieli to Grainger, Schuller, Mozart, Dvorak, and various mixed media including strings. Performance of newly commissioned works. Opportunities for solo work and work with recognized professional artists and composers. Admission by audition.
F. Harris

21M.442 MIT Festival Jazz Ensemble
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit

Designed for instrumentalists dedicated to the analysis, performance, and recording of traditional and contemporary jazz ensemble compositions. Instrumentation includes saxophones, trumpets, trombones, piano, guitar or vibraphone, bass, percussion and occasionally French horn, double reeds, and strings. Provides opportunities to work with professional jazz artists and perform commissioned works by recognized jazz composers. Experience in improvisation preferred but not required. Admission by audition.
F. Harris

21M.445 Chamber Music Society
Prereq: None
U (Fall, Spring)
0-4-2
Can be repeated for credit

Study of chamber music literature through analysis, rehearsal, and performance. Weekly seminars and coaching. Open to string, piano, brass, woodwind players, and singers. Admission by audition.
Fall: M. Thompson, J. Rife
Spring: M. Thompson, D. Deveau, J. Rife

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 Tik. No previous experience necessary, but prior enrollment in 21M.030 is strongly recommended. Limited to 25 by audition.
Fall: C. Southworth
Spring: D. Alit

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.
Fall: Staff
Spring: D. Deveau

21M.460 MIT Senegalese Drum Ensemble
Prereq: None
U (Fall, Spring)
0-3-3
Can be repeated for credit

A performing ensemble focusing on the sabar drumming tradition of Senegal, West Africa. Study and rehearse Senegalese drumming techniques and spoken word. Perform in conjunction with MIT Rambax drumming group. No previous experience necessary, but prior enrollment in 21M.030 or 21M.293 strongly recommended. Limited to 30 by audition.
L. Toure
MUSIC AND THEATER ARTS

Advanced/Special Subjects

21M.480 Advanced Music Performance
(Subject meets with 21M.512)
Prereq: None
U (Fall, Spring)
1-2-3
Can be repeated for credit

Directed for students who demonstrate considerable technical and musical skills and who wish to develop them through intensive private study. Students must take a weekly lesson, attend a regular performance seminar, and participate in a departmental performing group. Full-year commitment required. Information about lesson fees, scholarships, and auditions available in Music Section Office. Students taking the graduate version complete different assignments. Admission by audition.

Fall: M. Thompson
Spring: M. Thompson, D. Deveau

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 Advanced Seminar in Music
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS-A
Can be repeated for credit with permission of instructor

Seminar that develops analytic and research skills in music history/culture or theory/composition. Topics vary, but are organized around a particular methodology, musical topic, or collection of works, that allow for application to a variety of interests and genres. Strong emphasis on student presentations, discussion, and a substantial writing project.

P. Child

21M.505 Music Composition
(Subject meets with 21M.351)
Prereq: 21M.304, 21M.310, or permission of instructor
G (Spring)
3-0-9
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.

P. Child

21M.512 Advanced Music Performance
(Subject meets with 21M.480)
Prereq: None
G (Fall, Spring)
1-2-3
Can be repeated for credit

Directed for students who demonstrate considerable technical and musical skills and who wish to develop them through intensive private study. Students must take a weekly lesson, attend a regular performance seminar, and participate in a departmental performing group. Full-year commitment required. Information about lesson fees, scholarships, and auditions available in Music Section Office. Students taking the graduate version complete different assignments. Admission by audition.

D. Deveau, M. Thompson

21M.515 Vocal Repertoire and Performance
(Subject meets with 21M.410)
Prereq: None
G (Spring)
3-0-3
Can be repeated for credit

For the singer and/or pianist interested in collaborative study of solo vocal performance. Historical study of the repertoire includes listening assignments of representative French, German, Italian, and English works as sung by noted vocal artists of the genre. Topics include diction as facilitated by the study of the International Phonetic Alphabet; performance and audition techniques; and study of body awareness and alignment through the Alexander Technique and yoga. Admission by audition. Emerson Vocal Scholars contact department.

A. Boyles

21M.525 Emerson Scholars Solo Recital
(Subject meets with 21M.490)
Prereq: None
G (Spring)
1-2-3
Can be repeated for credit

Emerson Scholars may receive credit for a solo spring recital that has been prepared with and approved by the private teacher and the Emerson Private Studies Committee. Approval based on evidence of readiness shown in first term master classes. Restricted to Emerson Scholars.

M. Thompson, D. Deveau

21M.531 Independent Study in Music
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged
Can be repeated for credit

Open to qualified students who wish to pursue independent studies or projects with members of the Music Section. Projects require prior approval by the Music and Theater Arts Chair.

Consult Music Section Office

21M.533 Independent Study in Music
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Open to qualified students who wish to pursue independent studies or projects with members of the Music Section. Projects require prior approval by the Music and Theater Arts Chair.

Consult Music Section Office

21M.553, 21M.554 Special Subject in Music
Prereq: Permission of instructor
U (Fall, IAP, 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

Music and Media

21M.580J Musical Aesthetics and Media Technology
(Same subject as MAS.825J)
Prereq: Permission of instructor
G (Fall)
3-3-3 H-LEVEL Grad Credit
See description under subject MAS.825J.

T. Machover
THEATER ARTS

The subjects listed below are arranged in three sections: Introductory, Intermediate, and Advanced Subjects.

Introductory Subjects

21M.600 Introduction to Acting
Prereq: None
U (fall, spring)
4-0-5 HASS-A
Explores the actor’s tools: body, voice, mind, imagination, and the essential self. Through studio exercises, students address issues of honesty and creativity in the theatrical moment, and begin to have a sense of their strengths and limitations as communicating theatrical artists. Provides an opportunity for students to discover their relationship to “the other” in the acting partner, the group, the environment, and the audience. Limited to 20 per section.
K. Mancuso, J. Sonenberg, O. D’Ambrosio

21M.603 Introduction to Design for the Theater
Prereq: None
U (spring)
3-0-6 HASS-A
Focuses on the process of designing for the play. 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. Enrollment may be limited.
S. L. Brown

21M.604| Playwriting I
(Same subject as 21W.754j)
Prereq: None
U (fall)
3-0-9 HASS-A
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
Can be repeated for credit
Concentrates upon freeing the natural voice through awareness of physical, vocal and, at times, emotional habits and the willingness and desire to experience change. Teaches progression of contemporary approaches to voice through in-class vocal exercises. Students use sonnets or poems as vehicles to explore the components of language and the need to communicate and reveal oneself through the voice. Designed for students interested in theater or developing their voices for presentations and professional speaking. Limited to 14; preference to Theater majors, minors, and concentrators who have pre-registered.
K. Eastley

21M.606 Introduction to Stagecraft
Prereq: None
U (fall, spring)
4-0-5 HASS-A
Introduces students to an array of production techniques in areas of scenery, costume, rigging, lighting, video, and sound design. Provides multiple opportunities to apply these techniques ranging from theoretical discussions and scenographic sketches to the precision execution of design elements for a series of studio performance exercises. Concentrating on a disciplined approach to creative problem solving, small groups collaborate on short performances for a live audience in which the scenography plays the leading role. Reading assignments and screenings provide a historical and theoretical context for this studio-driven class. Limited to 18.
K. Barrett, S. Brown, B. Karasu

21M.611 Foundations of Theater Practice
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (fall)
3-3-6 HASS-A
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.624 Acting with the Camera
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. Instruction in written and oral communication provided. Limited to 20.
A. Kohler

21M.645 Motion Theater
Prereq: None
U (fall)
3-0-6 HASS-A
Examines the theatrical event from the perspective of composition in a performance workshop. Studio exercises address the process of developing a theatrical work through an internalized understanding of compositional principles in theater. Examines physical action in time and space. Includes outside readings, videos, short essays, and in-class discussions. Provides the performer, director, choreographer, designer or writer opportunities to engage with large and small group ensembles in creation of theatrical events. Topics include image, motion, shape, repetition, gesture, and spatial relationship. Preference to majors, minors, concentrators. Admittance may be controlled by lottery.
J. Scheib
Intermediate Subjects

21M.703J Media and Methods: Performing (Same subject as CMS.403J)
Prereq: CMS.100, 21L.011, or permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H
See description under subject CMS.403J.
J. Scheib

21M.704 Musical Theater Workshop
Prereq: 21M.600 or permission of instructor
U (Fall)
3-0-6 HASS-A
Introduces applications of music in theater and performance. Encourages experimentation with different genres of singing, acting, and movement by exploring an array of historical and contemporary styles and techniques. Students develop and perform their own original songs and textual materials, gaining a theoretical and practical understanding of the actor’s contribution to the dynamic form of musical theater. Previous experience in musical theater not required.
A. Kohler

21M.705 The Actor and the Text
Prereq: 21M.600 or permission of instructor
U (Fall, Spring)
4-0-5 HASS-A
Can be repeated for credit
Gives students who have begun the process of bringing themselves to a dramatic moment the opportunity to apply their skills to scripted material. Studio work in this class further develops the completeness, spontaneity, and honesty of expression of the actor’s body, imagination, and voice; and introduces written material and the problems of synthesizing the self, the moment, and the scripted word. Weekly rehearsals with a scene partner. Enrollment may be limited.
A. Brody

21M.710 Script Analysis
Prereq: None
U (Fall)
3-0-9 HASS-A; 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
U (Fall, Spring)
3-0-6 HASS-A
Pursues detailed study of a particular playtext or theme and is related to some planned production activity during the following IAP. Seminar activities may include guest speakers from various disciplines who approach some aspect of the playtext or theme from the perspective of their fields; various theatrical practitioners; and critical and scholarly presentations by seminar members. Participation in the IAP production is not required.
A. Kohler

21M.715 Topics in Theater Arts
Prereq: Permission of instructor
(U, IAP, Spring)
3-0-6
Can be repeated for credit if content differs
Multidisciplinary studio seminar provides opportunity for study in performance theory and practice. Topics vary from term to term; may be taught by visiting faculty.
Staff

21M.732 Costume Design for the Theater
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-A
Intermediate workshop designed for students with a basic understanding of the principles of theatrical design who want a more intensive study of costume. Students develop designs within a creative process that incorporates production dramaturgy, character, script analysis, and directorial concept. Fosters period research, conceptual design, and rendering skills through practical exercises in the studio. Instruction in basic costume construction, including drafting and draping, provides tools for students to apply their acquired conceptual design skills to the costume production process.
O. Botez

21M.733 Scenic Design
Prereq: 21M.603 or permission of instructor
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-3-6 HASS-A
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. Instruction and practice in oral and written communication provided.
S. Brown

21M.734 Lighting Design for the Theater
Prereq: Permission of instructor
U (Spring)
4-0-5 HASS-A
Explores the history, concepts and techniques of sculpting space with light within a contemporary context. Students experiment with a wide range of approaches, tools, and skills to develop their own creative vision. Focuses on discrete forms that include live performance, installation, architecture, and developments in applied technologies. Studio projects alternate between conceptual studies and realized designs reflective of students’ own unique interests and talents. Limited to 15.
K. Barrett

21M.735 Technical Design for Performance
Prereq: 21M.606 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-3-6 HASS-A
Studio examines the role of the technical designer as an integral member of an ensemble. Focusing on the artistic process, students develop their own unique approaches to stage design, lighting, sound, video design and other new media applications for the performing arts. They also explore an array of pre-production research and rehearsal techniques and analyze dramatic texts. Introduces theoretical and practical aspects of technical design, from the budgeting of time and selection of materials, to use of new technologies. Culminates in a public showing of final design projects for an invited audience.
B. Karasu

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
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. Students taking graduate version complete additional assignments. Enrollment may be limited.

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

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. Students taking graduate version complete additional assignments.

A. Brody

21M.790 Directing

(Subject meets with 21M.791)

Prereq: 21M.600; 21M.710 or permission of instructor

U (Spring)

3-0-6 HASS-A

21M.791 Directing

(Subject meets with 21M.790)

Prereq: 21M.600; 21M.710 or permission of instructor

G (Spring)

3-0-6

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. Scheib

Advanced Topics and Practica

21M.805 Performance and Design Practicum

Prereq: Permission of instructor

U (Fall, Spring; second half of term)

0-3-3

Can be repeated for credit

Provides directed practice in the disciplines of performance, including stage design, projection and new media design, acting, directing, lighting design, costume design, and other creative fields. Students test and refine their skills in the presentation of plays, dance, film, music theater, opera, and other performing arts events by participating in research and the rehearsal/performance process. Students seeking to design an individual project with a particular faculty member must obtain the approval of the Director of Theater Arts.

Staff

21M.815 Technical Theater Practicum

Prereq: Permission of instructor

U (Fall, IAP, Spring; second half of term)

0-3-3

Can be repeated for credit

Provides directed practice in the disciplines of stage management, technical direction, and technical production for performance. Students test and refine their skills in the presentation of plays, dance, films, music theater, opera, concerts, and other performing arts events by participating in research and the rehearsal/production process. Students seeking to design an individual project with a particular faculty member must obtain the approval of the Director of Theater Arts.

Consult Theater Arts Staff

21M.830 Acting: Techniques and Style

(Subject meets with 21M.835)

Prereq: 21M.600

U (Fall, Spring)

4-0-8 HASS-A

Can be repeated for credit

Refines the student actor's use of the language of the stage with work on text and physical presentation. Explores issues of style, including the understanding and honoring, in performance, of the specific requirements from several different periods of the Western theatrical tradition. Periods may differ from term to term. Students taking graduate version complete additional assignments.

J. Sonenberg

21M.835 Acting: Techniques and Style

(Subject meets with 21M.830)

Prereq: 21M.600

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 from several different periods of the Western theatrical tradition. Periods may differ from term to term. Students taking graduate version complete additional assignments.

O. D’Ambrosio

21M.840 Performance Media

(Subject meets with 21M.841)

Prereq: None

U (Fall, Spring)

3-2-7 HASS-A

Integrates media and communication technologies in performing arts. Studio exercises provide a forum for experimentation. Contemporary and historical techniques for media integration examined through readings, viewing videos and short written essays. Technologies examined include digital imaging, composite and live feed digital video, and web-based performance. Engages the designer, director, choreographer, performer, visual artist or programmer in the practice of integrating media into live art events. Equipment is provided. Students taking graduate version complete additional assignments.

B. Karasu

21M.841 Performance Media

(Subject meets with 21M.840)

Prereq: None

G (Fall, Spring)

3-2-7

Meets with 21M.840 but assignments differ. Graduate students are expected to complete additional assignments. See description under 21M.840.

B. Karasu

21M.846 Topics in Performance Studies

(Subject meets with 21M.847)

Prereq: None

U (Fall, Spring)

3-0-9 HASS-A

Can be repeated for credit

Multidisciplinary lecture/workshop engages students in a variety of approaches to the study and practice of performance as an area of aesthetic and social interaction. Special attention
paid to the use of diverse media in performance. Interdisciplinary approaches to study encourage students to seek out material histories of performance and practice. New topics are discussed each year.  
*Fall*: C. Braithwaite  
*Spring*: Staff

**21M.847 Topics in Performance Studies**  
(Subject meets with 21M.846)  
*Prereq*: None  
G (Fall, Spring)  
3-0-9  
Can be repeated for credit  
See description under 21M.846. Assignments differ.  
*Fall*: C. Braithwaite  
*Spring*: Staff

**21M.851 Independent Study in Production and Performance**  
*Prereq*: Permission of instructor  
U (Fall, IAP, Spring; second half of term)  
Units arranged  
Can be repeated for credit  
Multidisciplinary independent study provides opportunity for individual practica in the performing arts. While opportunities may include directed theoretical research and practice in production and performance with permanent and visiting faculty, students are encouraged to propose independent programs of study. Approval may be obtained from the Director of Theater Arts.  
*Theater Arts Staff*

**21M.863 Advanced Topics in Theater Arts**  
*Prereq*: Permission of instructor  
U (Fall, IAP, Spring)  
4-2-6  
Can be repeated for credit if content differs  
Advanced multidisciplinary studio workshop provides opportunity for advanced study in the performing arts. Topics vary from term to term; may be taught by visiting faculty.  
*Staff*

**21M.865 Research in Theater**  
*Prereq*: Permission of instructor  
G (Fall, Spring)  
Units arranged  
Can be repeated for credit with permission of instructor  
Offers directed research of advanced theatrical subjects occurring in either the performance or theoretical spheres.  
*Staff*

**Note that thesis is not a requirement of the music program.**

**Theater 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 21.ThT and 21.ThU. They should also register for 21.UR or 21.URG when doing UROP projects.**

**21M.THT Music or Theater Arts Pre-Thesis Tutorial**  
*Prereq*: Permission of instructor  
U (Fall, IAP, 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 or Theater Arts. Taken during the first term, or during IAP, of the student's two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Limited to Music or Theater Arts Majors.  
*Consult Music Headquarters*

**21M.THU Undergraduate Thesis in Music or Theater Arts**  
*Prereq*: 21M.THT  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit  
Completion of work on senior major thesis in Music or Theater Arts under supervision of a faculty tutor. Includes oral presentation of thesis project early in the term, assembling and revising final text and meeting at the close with a committee of Music or Theater Arts faculty evaluators to discuss successes and limitations of the project. Limited to Music or Theater Arts majors.  
*Consult Music and Theater Arts Headquarters*

**21M.UR Undergraduate Research in Music and Theater Arts**  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit  
**21M.URG Undergraduate 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*
Bachelor of Science in Music/Course 21M

**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 [all but two subjects can be from 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).

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Subjects</strong></td>
<td>72</td>
</tr>
<tr>
<td>21M.011 Introduction to Western Music, 12, HASS-A, CI-H</td>
<td></td>
</tr>
<tr>
<td>21M.030 Introduction to World Music, 12, HASS-A, CI-H</td>
<td></td>
</tr>
<tr>
<td>21M.301 Harmony and Counterpoint I, 12, HASS-A</td>
<td></td>
</tr>
<tr>
<td>Two terms of Performance subjects, 21M.401–21M.499 (6 units each)</td>
<td></td>
</tr>
<tr>
<td>21M.500 Advanced Seminar in Music, 12, HASS-A, CI-M; permission of instructor</td>
<td></td>
</tr>
</tbody>
</table>

To satisfy the requirement that students complete two Communication Intensive subjects in the major, students must take one subject from this list of approved CI-M subjects for Course 21M in addition to 21M.500:
- 21M.220
- 21M.235
- 21M.260

**Restricted Electives**

A coherent program of five subjects from the music curriculum chosen in consultation with faculty advisor(s).

60

**Departmental Program Units That Also Satisfy the GIRs**

(72)

**Unrestricted Electives**

120

**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 in the MIT Subject Listing & Schedule, [http://student.mit.edu/catalog/index.cgi](http://student.mit.edu/catalog/index.cgi).
The Program in Comparative Media Studies/Writing has three undergraduate subject options: Creative Writing, Science Writing, and 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.012 Writing and Rhetoric: Food for Thought
Prereq: None
U (Fall)
3-0-9 HASS-H; 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.

A. Walsh

21W.015 Writing and Rhetoric: Writing about Sports
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.011, 21W.012, 21W.013, 21W.014, 21W.730

Examines the role of sports in our individual lives and American culture at large. Considers a broad range of issues, such as heroism and ethical conundrums, gender equality, steroids, and the proper role of sports in college life. Examples of high-quality, descriptive and analytic sports writing serve as the focus for class discussion and as models for student essays. Limited to 18.

K. Boiko

analytical, persuasive, and research-based essays, as well as oral presentations, group discussions, and debates. Readings drawn from political speeches, scientific arguments, and popular media. Limited to 18.

L. Harrison-Lepera

21W.014 Writing and Rhetoric: Exploring Visual Media
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.011, 21W.012, 21W.013, 21W.015, 21W.730

Explores the rhetoric of visual media and the meaning of the digital revolution. Students analyze readings and films and discuss the power of media in defining social issues and shaping ideas of self, family, and community. They also write essays that sharpen skills in analyzing visual rhetoric, developing and supporting arguments, and using sources. Limited to 18.

A. Walsh

21W.013 Writing and Rhetoric: Introduction to Contemporary Rhetoric
Prereq: None
U (Fall)
3-0-9 HASS-H; 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
21W.021 Writing and Experience: MIT Inside, Live
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.022, 21W.023, 21W.024, 21W.025, 21W.026, 21W.731
Acting as participant-observers, students investigate MIT’s history and culture through visits to the Institute’s archives and museums, relevant readings, and depictions of MIT in popular culture. Students chronicle their experiences and insights through a variety of writing projects, culminating in the completion of a portfolio. Limited to 18.
L. Marx

21W.022 Writing and Experience: Reading and Writing Autobiography
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.021, 21W.023, 21W.024, 21W.025, 21W.026, 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.
L. Marx, N. Jackson

21W.026 Writing and Experience: The Hero in the Postmodern World
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.021, 21W.022, 21W.023, 21W.024, 21W.025, 21W.731
Students examine and analyze concepts of the hero—from ancient Greece through the writings of Jung and Joseph Campbell—using the lens of postmodernist thought and critical theory, which largely reject the concept of a hero as role model or ideal. Studies the flaws of the great leaders of earlier times and discusses how the image of the hero influences world view, informs choices, and functions as metaphor in ethical dilemmas. Explores the characteristics that define a hero and how they have changed over time. Considers whether or not certain figures meet the definition of a hero, whether their deeds remain compelling, and whether they still deserve a place in cultural dialog. Students read essays, fiction, and plays depicting heroes in both literature and history, and use workshops and revision to turn ideas and experience into powerful written communication. Limited to 18.
S. Lewitt

21W.031 Science Writing and New Media: Explorations in Communicating about Science and Technology
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.032, 21W.034, 21W.035, 21W.036, 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. Meivold

21W.032 Science Writing and New Media: Introduction to Digital Media
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.034, 21W.035, 21W.036, 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.034 Science Writing and New Media: Perspectives on Medicine and Public Health
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.032, 21W.034, 21W.036, 21W.732
Public health topics, such as AIDS, asthma, malaria control, obesity, and sleep deprivation, provide a unifying focus as students explore diverse modes of science writing. Readings include essays by such writers as Atul Gawande, Danielle Offir, Jerome Groopman, and William Carlos Williams, as well as peer-reviewed journal articles. Assignments include a critical review, a scientific literature review, a brochure suitable for general distribution, an autobiographical narrative, a resume, a job application letter, and oral presentations. Limited to 18.
C. Taft

21W.035 Science Writing and New Media: Elements of Science Writing for the Public
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.032, 21W.034, 21W.036, 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 news article, interview, essay, and short feature. Limited to 18.
Fall: T. Singer, J. Berezin
Spring: K. Boiko

21W.036 Science Writing and New Media: Writing and the Environment
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-HW
Credit cannot also be received for 21W.031, 21W.032, 21W.034, 21W.035, 21W.732
Develops written and oral communication skills through the study and practice of environmental science writing. Covers a wide range of genres, including such standard forms as the scientific literature review. Students adapt the content of their papers and oral presentations to the distinctive needs of specific audiences. Assignments provide thematic coherence and a basis for independent student research. Limited to 18.
C. Taft
**WRITING**

21W.041J Writing about Literature  
(Same subject as 21L.000J)  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-H; CI-H  
See description under subject 21L.000J.  
*Fall: S. Alexandre  
Spring: W. Kelley*

21W.042J Writing with Shakespeare  
(Same subject as 21L.010J)  
Prereq: None  
U (Fall)  
3-0-9 HASS-H; CI-H  
See description under subject 21L.010J.  
*D. Henderson*

**CREATIVE WRITING**

**Introductory**


**Advanced**

21W.735 Writing and Reading the Essay  
Prereq: Writing sample and permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-0-9 HASS-H; CI-H  
Exploration of formal and informal modes of writing nonfiction prose. Extensive practice in composition, revision, and editing. Reading in the literature of the essay from the Renaissance to the present, with an emphasis on modern writers. Classes alternate between discussion of published readings and workshops on student work. Individual conferences. Limited to 18.  
*Staff*

21W.740 Writing Autobiography and Biography  
Prereq: None  
U (Fall)  
3-0-9 HASS-A  
Writing an autobiography is a vehicle for improving one's style while studying the nuances of the language. Literary works are read with an emphasis on different forms of autobiography. Students examine various stages of life, significant transitions, personal struggles, and memories translated into narrative prose, and discuss: what it means for autobiographer and biographer to develop a personal voice; and the problems of reality and fiction in autobiography and biography.  
*K. Manning*

21W.741J Black Matters: Introduction to Black Studies  
(Same subject as 24.912J, 21A.125J, 21H.106J, 21L.008J, WGS.190J)  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Spring)  
3-0-9 HASS-A, HASS-H; CI-H  
See description under subject 24.912J.  
*Staff*

21W.742J Writing about Race  
(Same subject as WGS.231J)  
Prereq: None  
U (Spring)  
3-0-9 HASS-H; CI-H  
The issue of race and racial identity have preoccupied many writers throughout the history of the US. Students read Jessica Abel, Diana Abu-Jaber, Lynda Barry, Felicia Luna Lemus, James McBride, Sigrid Nunez, Ruth Ozeki, Danzy Senna, Gloria Anzaldua, 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. Manning*

21W.743 Voice and Meaning: Speaking to Readers through Memoir, Fact, and Fiction  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-0-9 HASS-E  
Studies the meaning of various texts (fiction, nonfiction, poetry) through the chosen voice. Readings include Ian Frazier’s “Hints From Heloise,” Robert Hayden’s “Middle Passage,” E.L. Doctorow’s “The Waterworks,” and Susan Mitchell’s “From The Journals Of The Frog Prince.” Examines how writers of various backgrounds and in a variety of forms use everything from rhythm, syntax and line-breaks to lexicon in order to create character, time, and place. Seeks to ultimately understand how form functions not just as ornamentation, but as meaning. Limited to 18.  
*Staff*

21W.745 Advanced Essay Workshop  
Prereq: Permission of instructor  
U (Spring)  
3-0-9 HASS-H; CI-H  
Can be repeated for credit  
For students with experience in writing essays and nonfiction prose. Focuses on negotiating and representing identities grounded in gender, race, class, nationality, and sexuality in prose that is expository, exploratory, investigative, persuasive, lyrical, or incantatory. Authors include James Baldwin, Minnie Bruce Pratt, Audre Lorde, Richard Rodriguez, Alice Walker, John Edgar Wideman, Diana Hume George, bell hooks, Margaret Atwood, Patricia J. Williams, and others. Designed to help students build upon their strengths as writers and to expand their repertoire of styles and approaches in essay writing. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Limited to 18.  
*Staff*

21W.747 Rhetoric  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-H; CI-H  
For students with a special interest in learning how to make forceful arguments in written form. Studies the forms and structures of argumentation, including organization of ideas, awareness of audience, methods of persuasion, evidence, factual vs. emotional argument, figures of speech, and historical forms and uses of arguments. Limited to 18 per section.  
*Fall: S. Strong, S. Lane  
Spring: E. Schiappa, S. Strong*

21W.754J Playwriting I  
(Same subject as 21M.604J)  
Prereq: None  
U (Fall)  
3-0-9 HASS-A  
See description under subject 21M.604J.  
*L. Harrington*

21W.755 Writing and Reading Short Stories  
Prereq: None  
U (Fall, Spring)  
3-0-9 HASS-A  
An introduction to writing fiction. Students write their own stories and study essays and short stories by contemporary authors from around the world. Discussion focuses on students’ writing and on assigned works in their historical and social contexts.  
*Fall: H. Lee, J. Diaz  
Spring: S. Lewitt*
21W.765 Writing and Reading Poems
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A
Examination of the formal structural and textual variety in poetry. Extensive practice in the making of poems and the analysis of both students' manuscripts and texts from 16th- to 20th-century literature. Attempts to make relevant the traditional elements of poetry and their contemporary alternatives. Weekly writing assignments, including some exercises in prosody.
Staff

21W.757 Fiction Workshop
Prereq: 21W.755
U (Fall, Spring)
3-0-9 HASS-A
Can be repeated for credit
Intermediate class for students with some experience in writing fiction. Students write short stories and complete other writing exercises. Readings include short story collections by contemporary writers such as Sandra Cisneros, Benjamin Percy, Leila Lalami, Laura Pritchett, Bret Anthony Johnston, and Edward P. Jones. Discussions focus on sources of story material, characterization, setting, architecture, point of view, narrative voice, and concrete detail.
S. Lewitt

21W.758 Genre Fiction Workshop
Prereq: A subject in writing short fiction or comparable writing experience
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-A
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 roundtable workshops. Limited to 15.
M. Liu

21W.759 Writing Science Fiction
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A
Students write and read science fiction and analyze and discuss stories written for the class. For the first eight weeks, readings in contemporary science fiction accompany lectures and formal writing assignments intended to illuminate various aspects of writing craft as well as the particular problems of writing science fiction. The rest of the term is given to roundtable workshops on students’ stories.
J. Haldeman

21W.760 Creative Writing and Visual Culture: Writing in the Museum
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Critically explores how and why objects are collected and consumed, drawing upon visual culture and museum and cultural studies. Students engage in forms of creative writing that imitate museums, enact curatorial gestures, and/or try to dismantle such structures. They also curate their own writing into a chapbook, blog, or other creative form. Readings cover a range of genres. Includes visits to actual and virtual galleries.
G. Henderson

21W.761 (un)Writing the Book
Prereq: None
U (Spring)
3-0-9 HASS-H
Explores the material and historical components of books, dissecting and regenerating individual and collective writings into new forms. Students engage in weekly creative experiments and other exercises, handle rare books on field trips to Special Collections, and edit collaborative chapbooks. Examines the history and mystery of the book, considering where this technology has come from and envisioning where it might go.
N. Montfort, G. Henderson

21W.762 Poetry Workshop
Prereq: None
U (Fall, Spring)
3-0-9 HASS-A
Can be repeated for credit
For students with some previous experience in poetry writing. Frequent assignments stress use of language, diction, word choice, line breaks, imagery, mood, and tone. Considers the functions of memory, imagination, dreams, poetic impulses. Throughout the term, students examine the work of published poets. Revision stressed.
Fall: E. Barrett
Spring: Staff

21W.769J Playwrights’ Workshop
(Standard subject as 21M.785J)
(Subject meets with 21M.789)
Prereq: 21M.604, 21W.754, or permission of instructor
U (Spring)
3-2-7 HASS-A
Can be repeated for credit
See description under subject 21M.785J.
A. Brody

21W.770 Advanced Fiction Workshop
Prereq: Permission of instructor
U (Fall, Spring)
3-0-9 HASS-A
Can be repeated for credit
For students with some experience in writing fiction. Write longer works of fiction and short stories which are related or interconnected. Read short story collections by individual writers, such as Sandra Cisneros, Raymond Carver, Edward P. Jones, and Tillie Olsen, and discuss them critically and analytically, with attention to the ways in which the writers' choices about component parts contribute to meaning. In-class exercises and weekly workshops of student work focus on sources of story material, characterization, structure, narrative voice, point of view and concrete detail. Concentration on revision.
H. Lee

21W.771 Advanced Poetry Workshop
Prereq: Prior manuscript submission required
U (Spring)
3-0-9 HASS-A
Can be repeated for credit
For students experienced in writing poems. Regular reading of published contemporary poets and weekly submission of manuscripts for class review and criticism. Students expected to do a substantial amount of rewriting and revision. Classwork supplemented with individual conferences.
E. Funkhouser
21W.773 Writing Longer Fiction
Prereq: A fiction workshop or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A

Designed for students who have some experience in writing fiction and want to try longer forms like the novella and novel. Students interested in writing a novel are expected to produce at least two chapters and an outline of the complete work. Readings include several novels from Fitzgerald to the present, and novellas from Gogol’s The Overcoat to current examples. Students discuss one another’s writing in a roundtable workshop, with a strong emphasis on revision.

J. Haldeman

SCIENCE WRITING

Introductory

See subjects 21W.031, 21W.034, and 21W.035.

Advanced

21W.729J Engineering Communication in Context (Same subject as ES.729J)
Prereq: None
U (Fall)
3-1-8 HASS-E; CI-H

See description under subject ES.729J.

D. Custer

21W.736 News Writing
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

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.737J Topics and Methods in 21st-Century Journalism
(Subject meets with CMS.850)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-E

See description under subject CMS.850.

S. Mnookin

21W.739J Darwin and Design
(Same subject as 21L.022J)
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H

See description under subject 21L.022J.

A. Kibel

21W.746 Humanistic Perspectives on Medicine: From Ancient Greece to Modern America
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H; CI-H

For students with experience in nonfiction prose and interest in the non-science side of medicine. Advanced study of the art of essay (form, style, techniques of persuasion) and practice of that form. Students required to write substantial essays and revise their work. Students read and discuss the writings of distinguished physicians from antiquity to the late 20th century. Limited to 18.

K. Manning

21W.749 Documentary Photography and Photojournalism: Still Images of a World in Motion
(Subject meets with CMS.935)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-A

Designed to increase students’ understanding of, appreciation for, and ability to do documentary photography and photojournalism. Each three-hour class is divided between a discussion of issues and readings, and a group critique of students’ projects. Students must have their own photographic equipment and be responsible for processing and printing: either by student or commercial lab. Students must show basic proficiency with their equipment. Readings include Susan Sontag, Robert Coles, Ken Light, Eugene Richards, and others. Previous photographic experience required. Limited to 15.

B. D. Colen

21W.775 Writing about Nature and Environmental Issues
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

Focuses on traditional nature writing and the environmentalist essay. Students keep a web log as a journal. Writings are drawn from the tradition of nature writing and from contemporary forms of the environmentalist essay. Authors include Henry Thoreau, Loren Eiseley, Annie Dillard, Chet Raymo, Sue Hubbel, Rachel Carson, Bill McKibben, and Terry Tempest Williams. Limited to 18.

Staff

21W.777 Science Writing in Contemporary Society
Prereq: None
U (Spring)
3-0-9 HASS-H

Drawing in part from their own interests and ideas, students write about science within various cultural contexts using an array of literary and reportorial tools. Studies the work of contemporary science writers, such as David Quammen and Atul Gawande, and examines the ways in which science and technology are treated in media and popular culture. Discussions focus on students’ writing and address topics such as false equivalency, covering controversy, and the attenuation of initial observations. Emphasizes long-form narratives; also looks at blogs, social media, and other modes of communication. Not a technical writing class.

S. Mnookin

21W.778 Science Journalism
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H

An introduction to print daily journalism and news writing, focusing on science news writing in general, and medical writing in particular. Emphasis is on writing clearly and accurately under deadline pressure. Class discussions involve the realities of modern journalism, how newsrooms function, and the science news coverage in daily publications. Discussions of, and practice in, interviewing and various modes of reporting. In class, students write numerous science news stories on deadline. There are additional longer writing assignments outside of class. Enrollment limited.

B. D. Colen
DIGITAL MEDIA

Introductory

See subject 21W.032.

Advanced

21W.750 Experimental Writing
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-A

Students use innovative compositional techniques, focusing on new writing methods rather than on traditional lyrical or narrative concerns. Writing experiments, conducted individually, collaboratively and during class meetings, culminate in chapbook-sized projects. Students read, listen to, and create different types of work, including sound poetry, cut-ups, constrained and Oulipian writing, uncreative writing, sticker literature, false translations, artists’ books, and digital projects.

N. Montfort

21W.751J Writing for Social Media
(Same subject as CMS.613J)
Prereq: None
U (Spring)
3-0-9 HASS-A

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, and develop their own social media practices. 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.

Staff

21W.752 Making Documentary: Audio, Video, and More
(Same subject as 21W.824)
Prereq: 21W.786, 21A.550, or permission of instructor
U (Spring)
3-6-3 HASS-A

Focuses on the technical demands of long-form storytelling in sound and picture. Students build practical writing and production skills through a series of assignments: still photo-text works, audio-only documentaries, short video projects (4-6 minutes), and a term-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.

Staff

21W.753J Phantasmal Media: Theory and Practice
(Same subject as CMS.314J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A

See description under subject CMS.314).

D. Harrell

21W.763J Transmedia Storytelling: Modern Science Fiction
(Same subject as CMS.309J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-2-7 HASS-A

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.

H. Hendershot

21W.764J The Word Made Digital
(Same subject as CMS.609J)
Prereq: None
U (Spring)
3-0-9 HASS-A

Video games, digital art and literature, online texts, and source code are analyzed in the contexts of history, culture, and computing platforms. Approaches from poetics and computer science are used to understand the non-narrative digital uses of text. Students undertake critical 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 Narrative
(Same subject as 21L.489J)
Prereq: None
U (Fall)
3-0-9 HASS-A

Provides a workshop environment for understanding interactive narrative (print and digital) through critical writing, narrative theory, and creative practice. Covers important multisequential books, hypertexts, and interactive fictions. Students write critically, and give presentations, about specific works; write a short multisequential fiction; and develop a digital narrative system, which involves significant writing and either programming or the structuring of text. Programming ability helpful.

N. Montfort

21W.767J Writing for Videogames
(Same subject as CMS.612J)
Prereq: None
U (Spring)
3-0-9 HASS-A

See description under subject CMS.612).

C. Fernandez Vara

21W.768J Games and Culture
(Same subject as CMS.616J, WGS.125J)
Prereq: None
U (Fall)
3-0-9 HASS-S

See description under subject CMS.616).
21W.786| The Social Documentary: Analysis and Production  
Prereq: None  
U (Spring)  
3-0-9 HASS-A
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.789 Communicating with Mobile Technology  
Prereq: 1.00, 6.005, or permission of instructor  
U (Spring)  
3-0-9 HASS-H; CI-H
Students work in small collaborative design teams to propose, build, and document a term-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. Limited to 18.
E. Barrett

21W.722 Digital Poetry  
Prereq: None  
U (Spring)  
3-0-9 HASS-A
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 handheld 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)  
Not offered regularly; consult department
3-0-9 HASS-H; 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; 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. Limited to 18.
E. Barrett

21W.788| South Asian America: Transnational Media, Culture, and History  
Prereq: None  
U (Spring)  
3-0-9 HASS-H
Examines the history of South Asian immigration, sojourning, and settlement from the 1880s to the present. Focuses on the US as one node in the global circulation, not only of people, but also 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, pamphlets, and 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.787 Film, Music, and Social Change: Intersections of Media and Society  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-0-9 HASS-H
Examines films from the 1950s onward that document music subcultures and moments of social upheaval. Combines screening films about free jazz, glam rock, punk, reggae, hip-hop, and other genres with an examination of critical/scholarly writings to illuminate the connections between film, popular music, and processes of social change. Students critique each film in terms of the social, political, and cultural world it documents, and the historical context and effects of the film’s reception. Students taking graduate version complete additional assignments. Limited to 18.
V. Bald

21W.790| Short Attention Span Documentary  
Prereq: None  
U (Spring)  
3-0-9 HASS-A
Focuses on the production of short (1- to 5-minute) digital video documentaries: a form of non-fiction filmmaking that has proliferated in recent years due to the ubiquity of palm-sized and mobile phone cameras and the rise of web-based platforms, such as YouTube. Students shoot, edit, workshop and revise a series of short videos meant to engage audiences in a topic, introduce them to new ideas, and/or persuade them. Screenings and discussions cover key principles of documentary film—narrative, style, pace, point of view, argument, character development—examining how they function and change in short format. Students taking graduate version complete additional assignments. Limited to 18.
V. Bald

21W.784J Becoming Digital: Writing about Media Change  
Prereq: None  
U (Fall)  
Not offered regularly; consult department
3-0-9 HASS-H; 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; 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. Limited to 18.
E. Barrett

21W.788| South Asian America: Transnational Media, Culture, and History  
Prereq: None  
U (Spring)  
3-0-9 HASS-H
Examines the history of South Asian immigration, sojourning, and settlement from the 1880s to the present. Focuses on the US as one node in the global circulation, not only of people, but also 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, pamphlets, and 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; CI-H
Students work in small collaborative design teams to propose, build, and document a term-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. Limited to 18.
E. Barrett

21W.790| Short Attention Span Documentary  
Prereq: None  
U (Spring)  
3-0-9 HASS-A
Focuses on the production of short (1- to 5-minute) digital video documentaries: a form of non-fiction filmmaking that has proliferated in recent years due to the ubiquity of palm-sized and mobile phone cameras and the rise of web-based platforms, such as YouTube. Students shoot, edit, workshop and revise a series of short videos meant to engage audiences in a topic, introduce them to new ideas, and/or persuade them. Screenings and discussions cover key principles of documentary film—narrative, style, pace, point of view, argument, character development—examining how they function and change in short format. Students taking graduate version complete additional assignments. Limited to 18.
V. Bald

21W.786| The Social Documentary: Analysis and Production  
Prereq: None  
U (Spring)  
3-0-9 HASS-A
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.789 Communicating with Mobile Technology  
Prereq: 1.00, 6.005, or permission of instructor  
U (Spring)  
3-0-9 HASS-H; CI-H
Students work in small collaborative design teams to propose, build, and document a term-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. Limited to 18.
E. Barrett

21W.790| Short Attention Span Documentary  
Prereq: None  
U (Spring)  
3-0-9 HASS-A
Focuses on the production of short (1- to 5-minute) digital video documentaries: a form of non-fiction filmmaking that has proliferated in recent years due to the ubiquity of palm-sized and mobile phone cameras and the rise of web-based platforms, such as YouTube. Students shoot, edit, workshop and revise a series of short videos meant to engage audiences in a topic, introduce them to new ideas, and/or persuade them. Screenings and discussions cover key principles of documentary film—narrative, style, pace, point of view, argument, character development—examining how they function and change in short format. Students taking graduate version complete additional assignments. Limited to 18.
V. Bald
21W.791J Network Cultures
(Same subject as CMS.614J)
(Subject meets with CMS.867)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
See description under subject CMS.614J.
T. L. Taylor

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.
J. Paradis

21W.800J Business Writing for Supply Chain Management (New)
(Same subject as ESD.259J)
Prereq: None
G (Fall)
1-0-2
See description under subject ESD.259J.
L. Myka, B. Arntzen

21W.THT Writing and Humanistic Studies
Pre-Thesis Tutorial
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Definition of and early stage work on a thesis project leading to 21W.THT. Taken during the first term of a student’s two-term commitment to the thesis project. Student works closely with an individual faculty tutor. Required of all students pursuing a full major in Course 21W. Joint majors register for 21.THT.
Staff

21W.THT Writing and Humanistic Studies Thesis
Prereq: 21W.THT
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.THT.
Staff

21W.UR Research in Writing and Humanistic Studies
Prereq: 21W.799
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.
J. Paradis

21W.794 Graduate Technical Writing Workshop
Prereq: None
G (IAP)
2-0-1
Designed to improve the student’s ability to communicate technical information. Covers the basics of working with sources, including summarizing and paraphrasing, synthesizing source materials, citing, quoting, and avoiding plagiarism. Also covers how to write an abstract and a literature review. Limited to graduate engineering students based on results of the Graduate Writing Exam. Permission of instructor
Staff

21W.790J Writing: Science, Technology, and Society
(Same subject as STS.477J)
Prereq: 21H.991
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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

21W.823 Lab Experience for Science Writers
Prereq: 21W.825
G (Fall, IAP, Spring)
0-2-1 H-LEVEL Grad Credit
During the fall or IAP, students conduct 20 hours of observation in a lab of their choosing that is outside their previous scientific experience. Participation in the work of the lab encouraged. In the spring, students make an in-class presentation and submit a written report of publication quality. Preference to students in the Graduate Program in Science Writing.
T. Levenson, M. Bartusiak

21W.824 Making Documentary: Audio, Video, and More
(Same subject as 21W.752)
Prereq: 21W.786, 21A.550, or permission of instructor
G (Spring)
3-6-3
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 term-long, team-produced video science documentary (12-15 minutes). Readings, screenings and written work hone students’ analytical capacity. Students taking the graduate version complete additional assignments. Students from the Graduate Program in Science Writing center their work on topics in science, technology, engineering, and/or medicine.
T. Levenson

21W.825 Advanced Science Writing Seminar I
Prereq: Permission of instructor
G (Fall)
6-0-18 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.

M. Bartusiak

21W.826 Advanced Science Writing Seminar II
Prereq: 21W.825 or 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.890 Short Attention Span Documentary
(Subject meets with 21W.790J, CMS.335J)
Prereq: None
G (Spring)
3-0-9

Focuses on the production of short (1- to 5-minute) digital video documentaries: a form of non-fiction filmmaking that has proliferated in recent years due to the ubiquity of palm-sized and mobile phone cameras and the rise of web-based platforms, such as YouTube. Students shoot, edit, workshop and revise a series of short videos meant to engage audiences in a topic, introduce them to new ideas, and/or persuade them. Screenings and discussions cover key principles of documentary film—narrative, style, pace, point of view, argument, character development—examining how they function and change in short format. Students taking graduate version complete additional assignments. Limited to 16.

V. Bald

21W.892 Science Writing Internship
Prereq: Permission of instructor
G (Spring)
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

### 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>[all but two subjects can be from 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>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

**Units**

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

#### Option 1: Creative Writing (fiction, nonfiction, poetry)

**Required Subjects**

- 21W.ThT: Writing and Humanistic Studies Pre-Thesis Tutorial, 6
- 21W.ThU: Writing and Humanistic Studies Thesis, 12, CI-M; 21W.ThT

**Restricted Electives**

- Six subjects centered on creative writing, of which one is normally introductory; three subjects in literature, one of which may be in CMS.

#### Option 2: Science Writing

**Required Subjects**

- 21W.777: Science Writing in Contemporary Society, 12, HASS-H, CI-M
- 21W.778: Science Journalism, 12, HASS-A, CI-H
- 21W.792: Science Writing Internship, 12, HASS-A
- 21W.ThT: Writing and Humanistic Studies Pre-Thesis Tutorial, 6
- 21W.ThU: Writing and Humanistic Studies Thesis, 12, CI-M; 21W.ThT

**Restricted Electives**

- Four subjects in writing, of which one is normally introductory; three are writing subjects approved for this major, and one is in digital media (48 units).

#### Option 3: Digital Media

**Required Subjects**

- 21W.764J: The Word Made Digital, 12, HASS-A
- 21W.765J: Interactive and Non-Linear Narrative: Theory and Practice, 12, HASS-A
- 21W.785: Communicating with Web-Based Media, 12, HASS-A, CI-H
- 21W.ThT: Writing and Humanistic Studies Pre-Thesis Tutorial, 6
- 21W.ThU: Writing and Humanistic Studies Thesis, 12, CI-M; 21W.ThT

**Restricted Electives**

- Three subjects in writing, which may be in digital media, creative writing, or science writing, and three related subjects from another department.

### Departmental Program Units That Also Satisfy the GIRs

(63–72)

### Unrestricted Electives

<table>
<thead>
<tr>
<th>Option</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>114–132</td>
</tr>
<tr>
<td>Option 2</td>
<td>129–138</td>
</tr>
<tr>
<td>Option 3</td>
<td>114–123</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

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.
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Prerequisites</th>
<th>Credits</th>
<th>Schedule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.00</td>
<td>Introduction to Modeling and Simulation</td>
<td>None</td>
<td>U (Spring)</td>
<td>2-0-4</td>
<td>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.</td>
</tr>
<tr>
<td>22.01</td>
<td>Introduction to Nuclear Engineering and Ionizing Radiation</td>
<td>None</td>
<td>U (Fall)</td>
<td>5-0-7</td>
<td>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.</td>
</tr>
<tr>
<td>22.011</td>
<td>Seminar in Nuclear Science and Engineering</td>
<td>None</td>
<td>U (Fall)</td>
<td>2-0-4</td>
<td>Surveys 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.</td>
</tr>
<tr>
<td>22.012</td>
<td>Seminar in Fusion and Plasma Physics</td>
<td>None</td>
<td>U (Spring)</td>
<td>2-0-1</td>
<td>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.</td>
</tr>
<tr>
<td>22.013</td>
<td>Applications of Radiation Science and Technology in Biomedical Research</td>
<td>None</td>
<td>U (Fall)</td>
<td>2-0-4</td>
<td>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.</td>
</tr>
<tr>
<td>22.02</td>
<td>Introduction to Applied Nuclear Physics</td>
<td>Physics II (GIR), Calculus II (GIR); 8.03 or permission of instructor</td>
<td>U (Spring)</td>
<td>5-0-7</td>
<td>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.</td>
</tr>
<tr>
<td>22.03</td>
<td>Nuclear Systems Design Project</td>
<td>None</td>
<td>U (Fall)</td>
<td>3-0-9</td>
<td>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.</td>
</tr>
<tr>
<td>22.04</td>
<td>Social Problems of Nuclear Energy</td>
<td>None</td>
<td>U (Fall)</td>
<td>3-0-9</td>
<td>(Same subject as STS.084J)</td>
</tr>
</tbody>
</table>

* M. Buehler, M. Demkowicz
* D. Whyte
* M. S. Kazimi
* A. White
* B. Rosen
* M. Short
* P. Cappellaro
* R. S. Kemp
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.

K. Smith

22.05d] Materials Performance in Extreme Environments
(Same subject as 3.154d)
Prereq: 3.032, 3.044
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-2-7
See description under subject 3.154d.

R. Ballinger

22.055 Radiation Biophysics
(Same subject as 22.55j, HST.560j)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9
Provides a background in sources of radiation with an emphasis on terrestrial and space environments and on industrial production. Discusses experimental approaches to evaluating biological effects resulting from irradiation regimes differing in radiation type, dose and dose-rate. Effects at the molecular, cellular, organism, and population level are examined. Literature is reviewed identifying gaps in our understanding of the health effects of radiation, and responses of regulatory bodies to these gaps is discussed. Students taking graduate version complete additional assignments.

Staff

22.06 Engineering of Nuclear Systems
Prereq: 2.005
U (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.

M. S. Kazimi, K. Shirvan

22.070 Materials for Nuclear Applications
Prereq: Permission of instructor
U (Spring)
3-0-9
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. Preference to juniors and seniors.

B. Yildiz

22.071) Electronics, Signals, and Measurement
(Same subject as 6.071j)
Prereq: 18.03
U (Spring)
3-3-6
See description under subject 6.071j.

A. White

22.081j Introduction to Sustainable Energy
(Same subject as 2.650j, 10.291j)
Prereq: Permission of instructor
U (Fall)
3-0-9
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
Prereq: 22.02
U (Fall)
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

22.099–22.094 Special Subject in Nuclear Science and Engineering
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Seminar or lecture on a topic in nuclear science and engineering that is not covered in the regular curriculum.

D. Whyte

22.EPE UPOP Engineering Practice Experience
Engineering School-Wide Elective Subject
(Offered 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)
0-0-1 [P/D/F]
See description under subject 2.EPE.

Staff

22.EPW UPOP Engineering Practice Workshop
Engineering School-Wide Elective Subject
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (Fall, IAP)
1-0-0 [P/D/F]
See description under subject 2.EPW.

Staff
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.
D. Whyte

22.TH 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.UR Undergraduate Research Opportunities Program
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
The Undergraduate Research Opportunities Program is an excellent way for undergraduate students to become familiar with the department of Nuclear Science and Engineering. Student research as a UROP project has been conducted in areas of fission reactor studies, utilization of fusion devices, applied radiation physics research, and biomedical applications. Projects include the study of engineering aspects for fusion and fission energy sources, and utilization of radiations.
M. Short

22.107 Computational Science and Engineering
Prereq: 18.085, 22.00, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Develops practical scientific computing skills with applications in radiation physics, reactor engineering and design, nuclear materials, fusion, etc. Topics include compiling/profiling/time and memory complexities/debugging, solvers of ordinary differential equations and partial differential equations, error versus stability, and pre-and post-processing. Includes a survey of visualization and parallel computing and case studies in quantum mechanics, neutron diffusion and transport, simple CFD, and radiation cascade simulations. Assignments require programming in one or several languages of choice; some MATLAB-free assignments also required.
B. Yildiz

22.11 Applied Nuclear Physics
Prereq: 22.02 or permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Introduction to nuclear structure, reactions, and radioactivity. Review of quantization, the wave function, angular momentum and tunneling. Simplified application to qualitative understanding of nuclear structure. Stable and unstable isotopes, radioactive decay, decay products and chains. Nuclear reactions, cross-sections, and fundamental forces, and the resulting phenomena.
J. Li

22.12 Radiation Interactions, Control, and Measurement
Prereq: 8.02 or permission of instructor
G (Fall; second half of term)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
D. Whyte

22.13 Nuclear Energy Systems
Prereq: 22.01, 2.005, or permission of instructor
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Introduction to generation of energy from nuclear reactions. Characteristics of nuclear energy. Fission cross-sections, criticality, and reaction control. Basic considerations of fission reactor engineering, thermal hydraulics, and safety. Nuclear fuel and waste characteristics. Fusion reactions and the character and conditions of energy generation. Plasma physics and approaches to achieving terrestrial thermonuclear fusion energy.
M. Short

22.14 Materials in Nuclear Engineering
Prereq: Chemistry (GIR) or permission of instructor
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Introduces the fundamental phenomena of materials science with special attention to radiation and harsh environments. Materials lattices and defects and the consequent understanding of strength of materials, fatigue, cracking, and corrosion. Coulomb collisions of charged particles; their effects on structured materials; damage and defect production, knock-ons, transmutation, cascades and swelling. Materials in fission and fusion applications: cladding, waste, plasma-facing components, blankets.
M. Short

22.15 Essential Numerical Methods
Prereq: 12.010 or permission of instructor
G (Fall; first half of term)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Introduces computational methods for solving physical problems in nuclear applications. Ordinary and partial differential equations for particle orbit, and fluid, field, and particle conservation problems; their representation and solution by finite difference numerical approximations. Iterative matrix inversion methods. Stability, convergence, accuracy and statistics. Particle representations of Boltzmann’s equation and methods of solution such as Monte-Carlo and particle-in-cell techniques.
I. Hutchinson

22.16 Nuclear Technology and Society
Prereq: 22.01 or permission of instructor
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Can be repeated for credit
Introduces the societal context and challenges for nuclear technology. Major themes include economics and valuation of nuclear power, interactions with government and regulatory frameworks; safety, quantification of radiation hazards, and public attitudes to risk. Covers policies and methods for limiting nuclear-weapons proliferation, including nuclear detection, materials security and fuel-cycle policy.
R. S. Kemp
Nuclear Reactor Physics

22.211 Nuclear Reactor Physics I
Prereq: 22.05
G (Spring)
3-0-9 H-LEVEL Grad Credit

Provides an overview of reactor physics methods for core design and analysis. Topics include nuclear data, neutron slowing down, homogeneous and heterogeneous resonance absorption, calculation of neutron spectra, determination of group constants, nodal diffusion methods, Monte Carlo simulations of reactor core reload design methods.
B. Forget

22.212 Nuclear Reactor Analysis II
Prereq: 22.211
G (Fall)
3-2-7 H-LEVEL Grad Credit

Addresses advanced topics in nuclear reactor physics with an additional focus towards computational methods and algorithms for neutron transport. Covers current methods employed in lattice physics calculations, such as resonance models, critical spectrum adjustments, advanced homogenization techniques, fine mesh transport theory models, and depletion solvers. Also presents deterministic transport approximation techniques, such as the method of characteristics, discrete ordinates methods, and response matrix methods.
B. Forget

22.213 Nuclear Reactor Physics III (New)
Prereq: 22.211
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

Covers numerous high-level topics in nuclear reactor analysis methods and builds on the student's background in reactor physics to develop a deep understanding of concepts needed for time-dependent nuclear reactor core physics, including coupled non-linear feedback effects. Introduces numerical algorithms needed to solve read-world time-dependent reactor physics problems in both diffusion and transport. Additional topics include iterative numerical solution methods (e.g., CG, GMRES, JFNK, MG), nonlinear accelerator methods, and numerous modern time-integration techniques.
K. Smith, B. Forget

22.251 Systems Analysis of the Nuclear Fuel Cycle
Prereq: 22.05
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.
K. Smith

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.
J. Buongiorno

22.313J Thermal Hydraulics in Power Technology
(Subject meets with 22.033)
Prereq: 2.006, 10.302, 22.312, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-2-7 H-LEVEL Grad Credit

E. Baglioetto

22.314J Structural Mechanics in Nuclear Power Technology
(Same subject as 1.56J, 2.084J)
Prereq: 2.001 or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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

22.315 Applied Computational Fluid Dynamics and Heat Transfer
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

Focuses on the application of computational fluid dynamics to the analysis of power generation and propulsion systems, and on industrial and chemical processes in general. Discusses simulation methods for single and multiphase applications and their advantages and limitations in industrial situations. Students practice breaking down an industrial problem into its modeling challenges, designing and implementing a plan to optimize and validate the modeling approach, performing the analysis, and quantifying the uncertainty margin.
E. Baglioetto

22.33 Nuclear Engineering Design
Prereq: 22.312
G (Fall)
3-0-9 H-LEVEL Grad Credit

Group design project involving integration of nuclear physics, particle transport, control, heat transfer, safety, instrumentation, materials, environmental impact, and economic optimization. Provides opportunity to synthesize knowledge acquired in nuclear and non-nuclear subjects and apply this knowledge to practical problems of current interest in nuclear applications design. Past projects have included using a fusion reactor for transmutation of nuclear waste, design and implementation of an experiment to predict and measure pebble flow in a pebble bed reactor, and development of a mission plan for a manned Mars mission including the conceptual design of a nuclear powered space propulsion system and power plant for the Mars surface.
Students taking graduate version complete additional assignments.

M. Short

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


M. W. Golay

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 regulatory processes 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.

E. Baglietto

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

22.55J Radiation Biophysics
(Same subject as HST.560J)
Subject meets with 22.055
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

P. Cappellaro

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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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

22.56LJ Magnetic Resonance Analytic, Biochemical, and Imaging Techniques
(Same subject as HST.584J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-12 H-LEVEL Grad Credit

See description under subject HST.584J.

L. Wald, K. Setsompop

22.562 Spatial Aspects of Nuclear Magnetic Resonance Spectroscopy
Prereq: 18.03, 8.05
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 diffusive 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


A. White
22.614J 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 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.
Staff

22.617 Plasma Turbulence and Transport
Prereq: 22.616 or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
Introduces plasma turbulence and turbulent transport, with a focus on fusion plasmas. Covers theory of mechanisms for turbulence in confined plasmas, fluid and kinetic equations, and linear and nonlinear gyrokinetic equations; transport due to stochastic magnetic fields, magnetohydrodynamic (MHD) turbulence, and drift wave turbulence; and suppression of turbulence, structure formation, intermittency, and stability thresholds. Emphasis on comparing experiment and theory. Discusses experimental techniques, simulations of plasma turbulence, and predictive turbulence-transport models.
Staff

22.62 Fusion Energy
Prereq: 22.611
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 2014–2015: G (Spring)
Acad Year 2015–2016: 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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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.
I. Hutchinson

22.71J Modern Physical Metallurgy
(Same subject as 3.40J)
Prereq: 3.022, 3.032
3-0-9 H-LEVEL Grad Credit
See description under subject 3.40J.
J. Li

22.72J Corrosion: The Environmental Degradation of Materials
(Same subject as 3.54J)
Prereq: 3.012
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 3.54J.
R. G. Ballinger

22.74 Radiation Damage and Effects in Nuclear Materials (New)
Prereq: 22.14, 3.21, or permission of instructors
G (Fall)
3-0-9 H-LEVEL Grad Credit
Studies the origins and effects of radiation damage in structural materials for nuclear applications. Radiation damage topics include formation of point defects, defect diffusion, defect reaction kinetics and accumulation, and differences in defect microstructures due to the type of radiation (ion, proton, neutron). Radiation effects topics include detrimental changes to mechanical properties, phase stability, corrosion properties, and differences in fission and fusion systems. Term project required.
M. Short, B. Yildiz

22.76 Nuclear Chemical Engineering
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-1-8 H-LEVEL Grad Credit
Staff
22.78 Principles of Nuclear Chemical Engineering and Waste Management
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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

22.814 Nuclear Non-Proliferation
Prereq: None
G (Spring)
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.
R. C. Lanza

22.90 Nuclear Science and Engineering Laboratory
(Subject meets with 22.09)
Prereq: 22.101
G (Fall)
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

22.912J 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 start-up. Lectures and demonstrations with use of the MIT Research Reactor. Open to undergraduates with permission of instructor.
J. Bernard

22.93 Teaching Experience in Nuclear Science and Engineering
Prereq: Permission of department
G (Fall, Spring, Summer)
Units arranged H-LEVEL Grad 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 availability of suitable teaching 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

22.5902–22.5905 Special Subject in Nuclear Science and Engineering
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 nuclear science and engineering that is not covered in the regular curriculum. 22.5905 is graded P/D/F.
M. S. Kazimi
Bachelor of Science in Nuclear Science and Engineering/Course 22

General Institute Requirements (GiRs)

<table>
<thead>
<tr>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [can be satisfied by 22.04j in the Departmental Program]</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 8.03; 18.03 or 18.034; 22.01; 22.02; and 22.071j, in the Departmental Program]</td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 22.09 in the Departmental Program]</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)

Basic Requirements

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>84</td>
</tr>
</tbody>
</table>

2.005 Thermal-Fluids Engineering I, 12, REST; Physics II (GIR), Calculus II (GIR), 18.03
6.0001 Introduction to Computational Thinking and Data Science, 6; 6.0001* 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 18.034 Differential Equations, 12, REST; Calculus II (GIR)
18.06 Linear Algebra, 12, REST; Calculus II (GIR)
22.01 Introduction to Nuclear Engineering and Ionizing Radiation, 12, REST
22.071j Electronics, Signals, and Measurement, 12, REST; 18.03

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:

22.04j Social Problems of Nuclear Energy, 12; HASS-S, CI-M
22.055 Radiation Biophysics, 12; permission of instructor
22.06 Engineering of Nuclear Systems, 12; 2.005
22.070 Materials for Nuclear Applications, 12; permission of instructor

Required Undergraduate Nuclear Science and Engineering Thesis

12

22.0ThT Undergraduate Thesis Tutorial (minimum of 3 units); 22.09
22.0ThU Undergraduate Thesis (minimum of 9 units), CI-M; 22.0ThT

Department Program Units That Also Satisfy the GIRs

(48)

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 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.

(1) The combination of 6.0001 and 6.0002 counts as a REST subject.

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.
24.00 Problems of Philosophy  
Prereq: None  
U (Fall)  
3-0-9 HASS-H; CI-H  

Introduction to the problems of philosophy— in particular, to problems in ethics, metaphysics, theory of knowledge, and philosophy of logic, language, and science. A systematic rather than historical approach. Readings from classical and contemporary sources, but emphasis is on examination and evaluation of proposed solutions to the problems.  
C. Hare

24.01 Classics of Western Philosophy  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Spring)  
3-0-9 HASS-H; CI-H  

Introduction to Western philosophical tradition through the study of selected major thinkers such as Plato, Aristotle, Lucretius, Descartes, Hobbes, Leibniz, Locke, Berkeley, Hume, Kant, Nietzsche and Marx. Emphasis on changes of intellectual outlook over time, and the complex interplay of scientific, religious and political concerns that influence the development of philosophical ideas.  
Staff

24.02 Moral Problems and the Good Life  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Spring)  
3-0-9 HASS-H; CI-H  

Introduction to important philosophical debates about moral issues and what constitutes a good life: What is right, what is wrong, and why? How important are personal happiness, longevity, and success if one is to live a good life? When is it good for you to get what you want? To what extent are we morally obliged to respect the rights and needs of others? What do we owe the poor, the discriminated, our loved ones, animals and fetuses?  
Staff

24.03 Good Food: The Ethics and Politics of Food  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-0-9 HASS-H; CI-H  

Explores the values (aesthetic, moral, cultural, religious, prudential, political) expressed in the choices of food people eat. Analyzes the decisions individuals make about what to eat, how society should manage food production and consumption collectively, and how reflection on food choices might help resolve conflicts between different values.  
S. Haslanger

24.04j Justice  
(Same subject as 17.01j)  
Prereq: None  
U (Fall)  
3-0-9 HASS-H; 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.  
K. Gallagher

24.06j Bioethics  
(Same subject as STS.006j)  
Prereq: None  
U (Spring)  
3-0-9 HASS-H; CI-H  

Considers ethical questions that have arisen from the growth of biomedical research and the health-care industry since World War II. Should doctors be allowed to help patients end their lives? If so, when and how? Should embryos be cloned for research and/or reproduction? Should parents be given control over the genetic makeup 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.  
N. Schüll, V. Urbanek

24.08j Philosophical Issues in Brain Science  
(Same subject as 9.48j)  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-0-9 HASS-H; CI-H  

An introduction to some central philosophical questions about the mind, specifically those intimately connected with contemporary psychology and neuroscience. Discussions focus on arguments over innate concepts; 'mental images' as pictures in the head; whether color is in the mind or in the world; and whether there can be a science of consciousness. Explains the relevant parts of psychology and neuroscience as the subject proceeds.  
A. Byrne

24.09 Minds and Machines  
Prereq: None  
U (Fall)  
3-0-9 HASS-H; CI-H  

Introduction to philosophy of mind. Can computers think? Is the mind an immaterial thing? Alternatively, is the mind the brain? How can creatures like ourselves think thoughts that are about things? Can I know whether your experiences are the same as mine when we both look at raspberries, fire trucks, and stoplights? Can consciousness be given a scientific explanation?  
A. Byrne

24.111 Philosophy of Quantum Mechanics  
Prereq: None  
U (Spring)  
3-0-9 HASS-H  

Quantum mechanics is said to describe a world in which physical objects often lack "definite" properties, indeterminism creeps in at the point of "observation," ordinary logic does not apply, and distant events are perfectly yet inexplicably correlated. Examination of these and other issues central to the philosophical foundations of quantum mechanics, with special attention to the measurement problem, no-hidden-variables proofs, and Bell’s Inequalities. Rigorous approach to the subject matter nevertheless neither presupposes nor requires the development of detailed technical knowledge of the quantum theory.  
B. Skow
24.112 Space, Time, and Relativity
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

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 relationship between matter and energy in relativity, and the possibility of time travel. Previous exposure to special relativity will be helpful but is not required.
B. Skow

24.114J A Philosophical History of Energy
(Same subject as 10.04J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H; CI-H

See description under subject 10.04J.
B. L. Trout, A. Schulman

24.115 Philosophy and Time (New)
Prereq: None
U (Fall)
3-0-9 HASS-H

Considers a wide range of philosophical questions about time through the lenses of metaphysics, philosophy of mind, and theory of value. Topics include the question of time’s existence, how our minds represent events in time, and whether it is rational to be ‘biased toward the future.’
B. Skow

24.118 Paradox and Infinity
Prereq: None
U (Fall)
3-0-9 HASS-H

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 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

An examination of philosophical theories of action and motivation in the light of empirical findings from social psychology, sociology and neuroscience. Topics include belief, desire, and moral motivation; sympathy and empathy; intentions and other committing states; strength of will and weakness of will; free will; addiction and compulsion; guilt, shame and regret; evil; self-knowledge and self-deception; virtues and character traits.
D. Smithies

24.201 Topics in the History of Philosophy
Prereq: One philosophy subject or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

Can be repeated for credit with permission of the instructor and advisor

Close examination of a text, an author, or a theme in the history of philosophy.

Staff

24.202 Decision, Games, and Rational Choice
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Foundations and philosophical applications of Bayesian decision theory, game theory and theory of collective choice. Why should degrees of belief be probabilities? Is it always rational to maximize expected utility? If so, why and what is its utility? What is a solution to a game? What does a game-theoretic solution concept such as Nash equilibrium say about how rational players will, or should, act in a game? How are the values and the actions of groups, institutions and societies related to the values and actions of the individuals that constitute them?
J. Khoo

24.211 Theory of Knowledge
Prereq: One philosophy subject
U (Spring)
3-0-9 HASS-H

Study of problems concerning our concept of knowledge, our knowledge of the past, our knowledge of the thoughts and feelings of ourselves and others, and our knowledge of the existence and properties of physical objects in our immediate environment.
R. White

24.215 Topics in the Philosophy of Science
Prereq: One philosophy subject
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Can be repeated for credit

Close examination of a small number of issues central to recent philosophy of science, such as the demarcation problem, causal relations, laws of nature, underdetermination of theory by data, paradoxes of confirmation, scientific realism, the role of mathematics in science, elimination of bias, and the objectivity of scientific discourse.
B. Skow

24.216 Metaphysics
Prereq: One philosophy subject
U (Spring)
3-0-9 HASS-H

Study of basic metaphysical issues concerning existence, the mind-body problem, personal identity, and causation plus its implications for freedom. Classical as well as contemporary readings. Provides practice in written and oral communication.
J. Khoo

24.217 Basic Ethics
Prereq: One philosophy subject
U (Fall)
3-0-9 HASS-H

Systematic study of central theories in ethics, including egoism, act and rule utilitarianism, intuitionism, emotivism, rights theories, and contractualism. Discussion and readings also focus on problems associated with moral conflicts, justice, the relationship between rightness and goodness, objective vs. subjective moral judgments, moral truth, and relativism.
K. Setiya

24.222 Ethics
Prereq: One philosophy subject
U (Fall)
3-0-9 HASS-H

Systematic study of central theories in ethics, including egoism, act and rule utilitarianism, intuitionism, emotivism, rights theories, and contractualism. Discussion and readings also focus on problems associated with moral conflicts, justice, the relationship between rightness and goodness, objective vs. subjective moral judgments, moral truth, and relativism.
K. Setiya

24.223J Philosophy of Law
(Same subject as 17.021J)
Prereq: One Philosophy subject or permission of instructor
U (Spring)
3-0-9 HASS-H

Examines fundamental issues in philosophy of law, such as the nature and limits of law and a legal system, and the relation of law to morality, with particular emphasis on the philosophical issues and problems associated with privacy, liberty, justice, punishment, and responsibility. Historical and contemporary readings, including
court cases. Instruction and practice in oral and written communication provided.

V. Urbanek

24.236 Topics in Social Theory and Practice (New)
(Subject meets with 24.636)
Prereq: One philosophy subject or permission of instructor
U (Fall)
3-0-9 HASS-H
An in-depth consideration of a topic in social theory with reflection on its implications for social change. Examples of topics include race and racism; punishment and prison reform; global justice and human rights; gender and global care chains; environmentalism and industrial agriculture; bioethics, disability, and human enhancement; capitalism and commodification; and sexuality and the family. Readings draw from both social science and philosophy with special attention to the normative literature relevant to the issue. Students taking graduate version complete additional assignments.
S. Haslanger

24.237J Feminist Thought
(Same subject as 17.007J, WGS.301J)
(Subject meets with 17.006)
Prereq: None
U (Fall)
3-0-9 HASS-H
See description under subject WGS.301J.
S. Haslanger

24.241 Logic I
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Introduction to the aims and techniques of formal logic. The logic of truth functions and quantifiers. The concepts of validity and truth and their relation to formal deduction. Applications of logic and the place of logic in philosophy.
V. McGee

24.242 Logic II
Prereq: 24.241 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
The central results of modern logic: the completeness of predicate logic, recursive functions, the incompleteness of arithmetic, the unprovability of consistency, the indefinability of truth, Skolem-Löwenheim theorems, and nonstandard models.
V. McGee

24.243 Classical Set Theory
Prereq: 24.241 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
Introduction to the basic concepts and results of standard, i.e., Zermelo-Fraenkel, set theory, the axioms of ZF, ordinal and cardinal arithmetic, the structure of the set-theoretic universe, the axiom of choice, the (generalized) continuum hypothesis, inaccessibles, and beyond.
V. McGee

24.244 Modal Logic
Prereq: 24.241
U (Spring)
3-0-9 HASS-H
Sentential and quantified modal logic, with emphasis on the model theory (“possible worlds semantics”). Soundness, completeness, and characterization results for alternative systems. Tense and dynamic logics, epistemic logics, and as well as logics of necessity and possibility. Applications in philosophy, theoretical computer science, and linguistics.
S. Yablo

24.245 Theory of Models
Prereq: 24.241 or permission of instructor
U (Fall)
3-0-9 HASS-H
Studies fundamental results in the model theory of the first-order predicate calculus. Includes completeness, compactness, Löwenheim-Skolem, omitting types, ultraproducts, and categoricity in a cardinal, starting with Tarski’s definition of logical consequence, in terms of truth in a model.
V. McGee

24.251 Introduction to Philosophy of Language
Prereq: One philosophy subject
U (Spring)
3-0-9 HASS-H
Examines views on the nature of meaning, reference, and truth, and their bearing on the use of language in communication. No knowledge of logic or linguistics presupposed. Instruction and practice in oral and written communication provided.
J. Khoo

24.253 Philosophy of Mathematics
Prereq: One philosophy subject or permission of instructor
U (Spring)
3-0-9 HASS-H
Philosophical issues about or related to mathematics, including the existence and nature of basic mathematical objects such as numbers and sets, how we can come to have knowledge of such objects, the status of mathematical truth, the relation of mathematics to logic, and whether classical logic can be called into question.
V. McGee

24.260 Topics in Philosophy
Prereq: Two subjects in philosophy
U (Fall)
3-0-9 HASS-H
Close examination of a single book, or group of related essays, with major significance in recent philosophy. Subject matter varies from year to year. Intended primarily for majors and minors in philosophy. Opportunities are provided for oral presentation. Students will be required to revise at least one paper in response to instructor’s comments.
C. Hare

24.280 Foundations of Probability
Prereq: One philosophy subject or one subject on probability
U (Fall)
3-0-9 HASS-H
Topics include probability puzzles, common fallacies in probabilistic reasoning, defenses and criticisms of Kolmogorov’s axiomatization, interpretations of probability (including the frequency, logical, propensity, and various subjectivist interpretations), the relation of objective chance to rational subjective credence, conditional probability, rules for updating probability, and proposals for supplementing the probability calculus with further principles.
R. White

24.292 Independent Study: Philosophy
Prereq: Any two subjects in philosophy
U (Fall)
Units arranged
Open to qualified students who wish to pursue special studies or projects. Students electing this subject must consult the undergraduate officer.
Staff
24.293 Independent Study: Philosophy
Prereq: Any two subjects in philosophy
U (Spring)
Units arranged
Open to qualified students who wish to pursue special studies or projects. Students electing this subject must consult the undergraduate officer.
Staff

24.500 Special Subject: Philosophy
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, Spring)
3-0-9
Can be repeated for credit
24.520 Special Subject: Philosophy
Prereq: One philosophy subject or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.
Staff

Undergraduate Seminars

24.190J Doing Right
(Same subject as 21L.301J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
2-0-4 [P/D/F]
See description under subject 21L.301J.
R. Perry

24.191 Being, Thinking, Doing (or Not): Ethics in Your Life
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

Graduate Subjects

24.400 Proseminar in Philosophy I
Prereq: Permission of instructor
G (Fall)
6-0-18 H-LEVEL Grad Credit
Advanced study of the basic problems of philosophy. Intended for first-year graduate students in philosophy.
J. Spencer, S. Yablo

24.401 Proseminar in Philosophy II
Prereq: Permission of instructor
G (Spring)
6-0-18 H-LEVEL Grad Credit
Advanced study of the basic problems of philosophy. Intended for first-year graduate students in philosophy.
S. Haslanger, A. Rayo

24.410 Topics in the History of Philosophy
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be taken repeatedly for credit with permission of instructor and advisor.

Selected topics in the history of philosophy. Content varies from year to year. Topics may include the traditional arguments for the existence of God, religious experience, the problem of evil, survival after death, God and ethics.
A. Byrne

24.500 Problems in Metaphysics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be taken repeatedly for credit with permission of instructor and advisor
Systematic examination of selected problems in metaphysics. Content varies from year to year.
R. Stalnaker

24.502 Topics in Metaphysics and Ethics
Prereq: Permission of instructor
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Can be taken repeatedly 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.
Fall: J. Khoo, J. Spencer
Spring: K. Setiya

24.503 Topics in Philosophy of Religion
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

24.601 Topics in Moral Philosophy
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit only with permission of instructor and advisor
Systematic examination of selected problems in moral philosophy. Content varies from year to year.
C. Hare, R. White
4.611 Political Philosophy
(Same subject as 17.000)
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
See description under subject 17.000).
L. Stanczyk

24.636 Topics in Social Theory and Practice
(New)
(Subject meets with 24.236)
Prereq: None
G (Fall)
3-0-9
An in-depth consideration of a topic in social theory with reflection on its implications for social change. Examples of topics include race and racism; punishment and prison reform; global justice and human rights; gender and global care chains; environmentalism and industrial agriculture; bioethics, disability, and human enhancement; capitalism and commodification; and sexuality and the family. Readings draw from both social science and philosophy with special attention to the normative literature relevant to the issue. Students taking graduate version complete additional assignments.
S. Haslanger

24.711 Topics in Philosophical Logic
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be taken repeatedly for credit with permission of instructor and advisor
Problems of ontology, epistemology, and philosophy of language that bear directly on questions provided by basic examination of language. Assumes no prior training in linguistics. Topics vary from year to year. Content varies from year to year.
V. McGee

24.729 Topics in Philosophy of Language
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
Can be taken repeatedly for credit with permission of instructor
Major issues in the philosophy of language. Topics change each year.
J. Khoo

24.805 Topics in Theory of Knowledge
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be taken repeatedly 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be taken repeatedly 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
Units arranged 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.
B. Skow

24.892 Independent Study: Philosophy
Prereq: Permission of advisor
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 2014–2015: Not offered
Acad Year 2015–2016: 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

24.900 Introduction to Linguistics
Prereq: None
U (Fall, Spring)
4-0-8 HASS-S; 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: A. Albright
Spring: S. Iatridou

LINGUISTICS AND PHILOSOPHY
24.901 Language and Its Structure I: Phonology
(Subject meets with 24.931)
Prereq: 24.900
U (Fall)
3-0-9 HASS-S
Introduction to fundamental concepts in phonological theory and their relation to issues in philosophy and cognitive psychology. Articulatory and acoustic phonetics, distinctive features and the structure of feature systems, underlying representations and underspecification, phonological rules and derivations, syllable structure, accentual systems, and the morphology-phonology interface. Examples and exercises from a variety of languages.
M. DeGraff

24.902 Language and Its Structure II: Syntax
(Subject meets with 24.932)
Prereq: 24.900
U (Fall)
3-0-9 HASS-S
Introduction to fundamental concepts in syntactic theory and its relation to issues in philosophy and cognitive psychology. Examples and exercises from a variety of languages.
M. DeGraff

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
R. Schwarzschild

24.904 Language Acquisition
Prereq: 24.900 or permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-S
Covers the major results in the study of first-language acquisition concentrating on the development of linguistic structure, including morphology, syntax, and semantics. Universal aspects of development are discussed, as well as a variety of cross-linguistic phenomena.

24.905J Laboratory in Psycholinguistics
(Same subject as 9.59j)
Prereq: 9.00 or 24.900
U (Spring)
3-3-6 Institute LAB
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; 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 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
Can be repeated for credit
In-depth study of an advanced topic in phonetics, phonology, morphology, syntax or semantics, with a focus on the interfaces among these grammar components. Provides practice in written and oral communication.
A. Albright

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 phonology and syntax, work in groups on specific aspects of the language’s structure, and assemble reports to create a partial grammar of the language. Provides instruction and practice in written and oral communication. Enrollment limited.
A. Albright

24.910 Advanced Topics in Linguistic Analysis
Prereq: 24.901, 24.902, 24.903; or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
Can be repeated for credit

24.912J Black Matters: Introduction to Black Studies
(Same subject as 21A.125j, 21H.106j, 21L.008j, 21W.741j, WGS.190j)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-A, HASS-H; CI-H
Interdisciplinary survey of people of African descent that draws on the overlapping approaches of history, literature, anthropology, legal studies, media studies, performance, linguistics, and creative writing. Connects the experiences of African-Americans and of other American minorities, focusing on social, political, and cultural histories, and on linguistic patterns. Includes lectures, discussions, workshops, and required field trips that involve minimal cost to students.
Staff
24.913| Language and Technology
(Same subject as 21A.503J, STS.070J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
See description under subject 21A.503J.
G. Jones

24.914 Language Variation and Change
Prereq: 24.900
U (Spring)
3-0-9 HASS-S
Explores how linguistic systems vary across time and space. Uses case studies in particular languages to examine how language transmission and social factors shape the grammatical systems of individual speakers, and how grammar constrains variation and change. Students work in groups to analyze corpus or survey data. Provides instruction and practice in written and oral communication.
E. Flemming

24.915 Linguistic Phonetics
(Subject meets with 24.963)
Prereq: 24.900
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
The study of speech sounds: how we produce and perceive them and their acoustic properties. The influence of the production and perception systems on phonological patterns and sound change. Acoustic analysis and experimental techniques. Students taking the graduate version complete different assignments.
E. Flemming

24.918 Workshop in Linguistic Research
Prereq: 24.901, 24.902, 24.903; or permission of instructor
U (Spring)
3-0-9 HASS-S
Students pursue individual research projects in linguistic analysis under the guidance of an advisor. Class meets weekly for presentation of student research and to critically discuss background reading. Focuses on developing skills in linguistic argumentation and presentation of findings. Provides practice in written and oral communication. Includes a 20-page final paper that each student presents to the class.
S. Flynn

24.919 Independent Study: Linguistics
Prereq: None
U (Fall, Spring, Summer)
Units arranged
Can be repeated for credit
Open to qualified students who wish to pursue special studies or projects.
Consult Department Headquarters

24.921 Independent Study: Linguistics
Prereq: Permission of advisor
G (Fall, Spring, Summer)
Units arranged
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

24.922 Independent Study: Linguistics
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 linguistics who wish to pursue special studies or projects.
Consult Department Headquarters

24.924 Independent Study: Linguistics
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 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 instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Meets with 24.902, but assignments differ. See description under 24.902.
M. DeGraff

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.
R. Schwarzschild

24.942 Topics in the Grammar of a Less Familiar Language
Prereq: 24.951
G (Spring)
3-0-9 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

24.943 Syntax of a Language (Family)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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.
Staff

 Graduate Subjects

See description under subject 24.900.

24.950 Special Subject: Linguistics
Prereq: 24.900 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

24.959 Special Subject: Linguistics
Prereq: 24.900 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, Spring)
3-0-9
Can be repeated for credit
Graduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Staff

24.970 Special Subject: Lingustics
Prereq: 24.900 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, Spring)
3-0-9
Can be repeated for credit
Graduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Staff

24.980 Special Subject: Linguistics
Prereq: 24.900 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall, Spring)
3-0-9
Can be repeated for credit
Graduate subject that covers topics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.
Staff

24.999 Independent Study: Linguistics
Prereq: Permission of advisor
1-0-0
Can be repeated for credit
Open to qualified students who wish to pursue special studies or projects.
Consult Department Headquarters

24.S90 Special Subject: Linguistics
Prereq: None
G (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.
Staff
24.946 Linguistic Theory and Japanese Language
(Subject meets with 21F.514)
Prereq: Permission of instructor
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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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
G (Spring)
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

24.949 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, M. Hackl

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

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.
D. Pesetsky

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.
D. Fox, I. Heim

24.955 More Advanced Syntax
Prereq: 24.951, 24.952
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.
D. Fox, 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.
D. Pesetsky

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 problemsolving, 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
The study of speech sounds: how we produce and perceive them and their acoustic properties. The influence of the production and perception systems on phonological patterns and sound change. Acoustic analysis and experimental techniques. Students taking the graduate version complete different assignments.
E. Flemming
24.964 Topics in Phonology  
Prereq: 24.961  
G (Fall)  
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  
G (Spring)  
3-0-9 H-LEVEL Grad Credit  
A. Albright, D. Pesetsky

24.966 Laboratory on the Physiology, Acoustics, and Perception of Speech  
(Same subject as 6.542J, HST.712J)  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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

24.968 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, S. S. Ghosh, 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, R. Schwarzschild

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.  
K. von Fintel

24.979 Topics in Semantics  
Prereq: Permission of instructor  
G (Fall, Spring)  
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.  
Fall: D. Fox, R. Schwarzschild  
Spring: K. von Fintel, I. Heim, S. Iatridou

24.981 Topics in Computational Phonology  
Prereq: 24.961 or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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  
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: D. Pesetsky, D. Steriade  
Spring: 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.  
Staff

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.S94 Special Seminar: Linguistics  
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

24.997 Topics in 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.  
Staff

24.998 Topics 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.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

24.594 Special Seminar: Linguistics  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall; partial term)  
3-0-3 H-LEVEL Grad Credit  
Can be repeated for credit  
Half-term subject that covers topics in linguistics not offered in the regular curriculum. Consult department to learn of offerings for a particular term.  
Staff
Bachelor of Science in Philosophy/Course 24-1

General Institute Requirements (GiRs) | Subjects
--- | ---
Humanities, Arts, and Social Sciences Requirement [all but two subjects can be from the Departmental Program] | 6
Restricted Electives in Science and Technology (REST) Requirement | 8
Laboratory Requirement | 2
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
One CI-H philosophy subject(1)
24.01 Classics of Western Philosophy, 12, HASS-H, CI-H
24.02 Topics in the History of Philosophy, 12, HASS-H, CI-M

One Knowledge and Reality subject:
24.08 Philosophical Issues in Brain Science, 12, HASS-HT, CI-H
24.09 Minds and Machines, 12, HASS-H, CI-H
24.111 Philosophy of Quantum Mechanics, 12, HASS-H
24.112 Space, Time, and Relativity, 12, HASS-H
24.114 A Philosophical History of Energy, 12, HASS-H, CI-H
24.155 Philosophy and Time, 12, HASS-H
24.211 Theory of Knowledge, 12, HASS-H
24.215 Topics in the Philosophy of Science, 12, HASS-H
24.221 Metaphysics, 12, HASS-H, CI-M
24.251 Introduction to Philosophy of Language, 12, HASS-H, CI-M
24.253 Philosophy of Mathematics, 12, HASS-H
24.284 Foundations of Probability, 12, HASS-H

One Value subject:
24.02 Moral Problems and the Good Life, 12, HASS-H, CI-H
24.04 Justice, 12, HASS-H, CI-H
24.06 Feminist Thought, 12, HASS-H, CI-H
24.120 Moral Psychology, 12, HASS-H, CI-M
24.222 Decisions, Games and Rational Choice, 12, HASS-H
24.231 Ethics, 12, HASS-H, CI-M
24.233 Philosophy of Law, 12, HASS-H, CI-M
24.237 Feminist Thought, 12, HASS-H, CI-M

One Logic subject:
24.118 Paradox and Infinity, 12, HASS-H
24.241 Logic I, 12, HASS-H
24.242 Logic II, 12, HASS-H
24.243 Classical Set Theory, 12, HASS-H
24.244 Modal Logic, 12, HASS-H
24.245 Theory of Models, 12, HASS-H

and
24.260 Topics in Philosophy, 12, HASS-H, CI-M

---

24.595 Special Seminar: Linguistics
Prereq: Permission of instructor
G (Fall)
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. R. Berwick, N. Chomsky

24.596 Special Seminar: Linguistics
Prereq: Permission of instructor
G (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. R. Berwick, M. DeGraff
**Restricted Electives**  
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 or 24.251.

**Departmental Program Units That Also Satisfy the GIRs**  
(72)

**Unrestricted Electives**  
120–135

**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.*

1. 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.
2. May not also satisfy the departmental distribution requirement in philosophy.
3. Students may select a logic subject from another department (e.g., Mathematics) with the approval of their major 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.
# Bachelor of Science in Linguistics and Philosophy/Course 24-2

## General Institute Requirements (GIRs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [all but two subjects can be from the Departmental Program]</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement [can be satisfied by 24.905 in the Departmental Program]</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
<td></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

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

### Required Subjects

**Linguistics Track**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.900 Introduction to Linguistics, 12, HASS-S1, CI-H</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

Students choose either a linguistics or philosophy track.

### Linguistics Track

- 24.901 Language and Its Structure I: Phonology, 12, HASS-S*
- 24.902 Language and Its Structure II: Syntax, 12, HASS-S, CI-M*
- 24.903 Language and Its Structure III: Semantics and Pragmatics, 12, HASS-S *
- 24.918 Workshop in Linguistic Research, 12, HASS-S, CI-M*

**One of the following three Linguistic Analysis subjects:**

- 24.909 Field Methods in Linguistics, 12, LAB, CI-M*
- 24.910 Advanced Topics in Linguistic Analysis, 12, HASS-S, CI-M*
- 24.914 Language Variation and Change, 12, HASS-S, CI-M*

**One of the following three Philosophy subjects:**

- 24.09 Minds and Machines, 12, HASS-H, CI-H
- 24.241 Logic I, 12, HASS-H
- 24.251 Introduction to Philosophy of Language, 12, HASS-H, CI-M*

**One of the following five Experimental Results subjects:**

- 24.904 Language Acquisition, 12, HASS-S*
- 24.905J Laboratory in Psycholinguistics, 12, LAB*
- 24.906J The Linguistic Study of Bilingualism, 12, HASS-S, CI-H*
- 24.907J Abnormal Language, 12*, HASS-S
- 24.915 Linguistic Phonetics, 12, HASS-S*

**Philosophy Track**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.08J Philosophical Issues in Brain Science, 12, HASS-H, CI-H</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>24.201 Topics in the History of Philosophy, 12, HASS-H, CI-M*</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>24.204 Logic I, 12, HASS-H</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.251 Introduction to the Philosophy of Language, 12, HASS-H, CI-M*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.260 Topics in Philosophy, 12, HASS-H, CI-M*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td><strong>One of the following two subjects:</strong></td>
<td><strong>24</strong></td>
<td><strong>12</strong></td>
</tr>
<tr>
<td>24.09 Minds and Machines, 12, HASS-H, CI-H</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td><strong>One of the following Knowledge and Reality subjects:</strong></td>
<td><strong>24</strong></td>
<td><strong>12</strong></td>
</tr>
<tr>
<td>24.111 Philosophy of Quantum Mechanics, 12, HASS-H</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.112 Space, Time, and Relativity, 12, HASS-H</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.114J A Philosophical History of Energy, 12, HASS-H</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.118 Theory of Knowledge, 12, HASS-H*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.119 Topics in the Philosophy of Science, 12, HASS-H*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.221 Metaphysics, 12, HASS-H*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.253 Philosophy of Mathematics, 12, HASS-H*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.280 Foundations of Probability, 12, HASS-H*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td><strong>One of the following three subjects:</strong></td>
<td><strong>24</strong></td>
<td><strong>12</strong></td>
</tr>
<tr>
<td>24.904 Language Acquisition, 12, HASS-S*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>24.905J Laboratory in Psycholinguistics, 12, LAB*</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Category</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Restricted Electives</td>
<td>27</td>
<td>36</td>
</tr>
<tr>
<td>部稀选修科</td>
<td></td>
<td></td>
</tr>
<tr>
<td>可以从语言学、哲学或相关领域选择三个完整的课程。</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Departmental Program Units That Also Satisfy the GIRs</td>
<td>(84)</td>
<td></td>
</tr>
<tr>
<td>Unrestricted Electives</td>
<td>132–141</td>
<td></td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>180</td>
<td></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.

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).
CC CONCOURSE PROGRAM

CONCOURSE SCIENCE SUBJECTS

Chemistry

CC.5111 Principles of Chemical Science
Prereq: None
U (Fall)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.111, 5.112, ES.3091, ES.5111, ES.5112
Equivalent to 5.111; see 5.111 for description.
Limited to students in Concourse.
E. Taylor

Mathematics

CC.181A Calculus
Prereq: Knowledge of differentiation and
elementary integration; Coreq: CC.A10 or CC.010
U (Fall)
5-0-7 CALC I
Credit cannot also be received for 18.01, 18.01A, ES.181A
Equivalent to 18.01A; see 18.01A for description. Limited to students in Concourse.
R. Winters

CC.182A Calculus
Prereq: Calculus I (GIR); Coreq: CC.A10, CC.010, or CC.011
U (Fall)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.022, 18.023, 18.024, 18.02A, CC.182A, ES.1802, ES.182A
Equivalent to 18.02; see 18.02 for description. Limited to students in Concourse.
R. Winters

CC.1802 Calculus
Prereq: Calculus I (GIR); Coreq: CC.A10, CC.010, or CC.011
U (Fall)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.022, 18.023, 18.02A, CC.182A, ES.1802, ES.182A
Equivalent to 18.02; see 18.02 for description. Limited to students in Concourse.
R. Winters

CC.1803 Differential Equations
Prereq: None. Coreq: Calculus II (GIR); CC.A10, CC.010 or CC.011
U (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.
R. Winters

Physics

CC.801 Physics I
(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.
S. Rayyan

CC.8012 Physics I
(Subject meets with CC.801)
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.801, ES.801, ES.8012
Equivalent to 8.012; see 8.012 for description. Limited to students in Concourse.
S. Rayyan

CC.802 Physics II
Prereq: Physics I (GIR), Calculus I (GIR); Coreq; CC.A10, CC.010, or CC.011
U (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. Rayyan

CONCOURSE HASS SUBJECTS

CC.110 Becoming Human: Ancient Perspectives on the Best Life
Prereq: None. Coreq; CC.A10 or CC.010
U (Fall)
3-0-9 HASS-H; CI-H
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. Rabieh

CC.111 Modern Conceptions of Freedom
Prereq: None. Coreq; CC.011
U (Spring)
3-0-9 HASS-H; CI-H
Students read early modern political theorists, and trace the growth of the value of freedom. Examines the modern definition of freedom, and the obligations that people accept in honoring it. Also investigates how these obligations are captured in the principles of our political association. Studies how the centrality of freedom plays out in the political thought of such authors as Hobbes, Locke, Rousseau, Burke and Montesquieu. Students also debate which notions of freedom inspire and sustain the American experiment by carefully reading the documents and arguments of the founding of the United States.
Limited to students in Concourse.
L. Rabieh, L. Perlman
CC.112 Philosophy of Love  
Prereq: None  
U (Spring)  
3-0-9 HASS-H  
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.  
L. Perlman, L. Rabieh

CC.113 Ancient Greek Philosophy and Mathematics  
Prereq: None. Coreq: CC.A10 or CC.010  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: U (Fall)  
3-0-9 HASS-H; CI-H  
Explores the relationship between ancient Greek philosophy and mathematics. Investigates how ideas of definition, reason, argument and proof, rationality/irrationality, number, quality and quantity, truth, and even the idea of an idea were shaped by the interplay of philosophic and mathematical inquiry. Examines how discovery of the incommensurability of magnitudes challenged the Greek presumption that the cosmos is fully understandable. Explores the influence of mathematics on ancient Greek ethical theories. Authors: Euclid, Plato, Aristotle, Nicomachus, Theon of Smyrna, Bacon, Descartes, Dedekind, and Newton. Limited to students in Concourse.  
L. Perlman

CC.116 How to Rule the World: The Promises and Pitfalls of Politics, War, and Empire  
Prereq: None  
U (Spring)  
4-0-8 HASS-H; CI-H  
Explores the ambitions and constraints of political rule in order to understand how transformational leaders have (or should have) managed both in the service of good government. Employs normative and empirical methods to assess effective leadership, with particular attention to trade-offs between justice and security and to competing notions of justice itself. Includes case studies and various foundational texts that address the theme of great political leadership. Drawing on the texts, students discern different criteria for good rule and assess both the adequacy of those criteria and whether case studies support them. Preference to Concourse students.  
L. Rabieh

CONCOURSE SEMINARS

CC.010 Seminar I  
(Subject meets with CC.A10)  
Prereq: Permission of instructor  
U (Fall)  
2-0-4 [P/D/F]  
Can be repeated for credit  
The key academic integration in which philosophic, 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  
Prereq: Permission of instructor  
U (Spring)  
2-0-4 [P/D/F]  
Can be repeated for credit  
The key academic integration in which philosophic, 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  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged  
Can be repeated for credit  
Tutoring, leadership of study and review groups, seminars and recitations in the Concourse Program, under the supervision of senior Concourse staff. Limited to students in Concourse.  
Staff

CC.210 Independent Study  
Prereq: Permission of instructor  
U (Fall, IAP, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit  
Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and a final report. Limited to students in Concourse.  
Staff

CC.011 Special Subject: Concourse  
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

CONCOURSE SPECIAL SUBJECTS

CC.UR Undergraduate Research  
Prereq: Permission of instructor  
U (Fall, Spring)  
Units arranged [P/D/F]  
Can be repeated for credit  
For students wishing to pursue undergraduate research opportunities in Concourse. Limited to students in Concourse.  
Staff
COURSE CMS COMPARATIVE MEDIA STUDIES

UNDERGRADUATE SUBJECTS

CMS.100 Introduction to Media Studies
Prereq: None
U (Fall, Spring)
3-3-6 HASS-H; CI-H
Offers an overview of the social, cultural, political, and economic impact of mediated communication on modern culture. Combines critical discussions with experiments working with different media. Media covered include radio, television, film, the printed word, and digital technologies. Topics include the nature and function of media, core media institutions, and media in transition. Enrollment limited.

Fall: 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
Introduction to the interdisciplinary study of videogames as texts through an examination of their cultural, educational, and social functions in contemporary settings. Students play and analyze videogames while reading current research and theory from a variety of sources in the sciences, social sciences, humanities, and industry. Assignments focus on game analysis in the context of the theories discussed in class. Includes regular reading, writing, and presentation exercises. No prior programming experience required. Students taking graduate version complete additional assignments. Limited to 20.

M. Jakobsson

CMS.301 Introduction to Game Design Methods
Prereq: None
U (Spring)
5-0-7 HASS-A
Provides an introduction to the process of designing games and playful experiences. Familiarizes students with concepts, methods, techniques and tools used in the design of a wide variety of games. Focuses on aspects of the process such as rapid prototyping, play testing, and design iteration using a player-centered approach. Students work in project groups where they engage with a series of confined exercises, practice communicating design ideas, and discuss their own and others work in a constructive manner. No prior programming experience required. Limited to 15.

T. L. Taylor

CMS.308 The Visual Story: Graphic Novel, Type to Tablet
(Subject meets with CMS.808)
Prereq: None
U (Spring)
3-0-9 HASS-E
Focuses on the interactions between graphic stories and media technologies from the rotary press of the late 19th century to contemporary touch screens, exploring the changing relations among narrative expression, reader experience and media form. Working with examples from Pulitzer’s Yellow Kid and McKay’s Little Nemo, through the classic comics (from DC superheroes to EC horror) and graphic novels, to interactive and non-linear texts (Cognitos Operation Ajax), examines such elements as graphic design, interface, and form as well as the circulation and economies of these various media-based texts. Students taking graduate version complete additional assignments.

J. Paradis, W. Uricchio

CMS.309J Transmedia Storytelling: Modern Science Fiction
(Subject same as 21W.763)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A
See description under subject 21W.763).

H. Hendershot

CMS.311J Media in Weimar and Nazi Germany
(Subject same as 21F.055J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-2-8 HASS-H; CI-H
See description under subject 21F.055J.

W. Uricchio

CMS.312 Topics in National and Post-National Cinema
(Subject meets with CMS.812)
Prereq: CMS.100 or permission of instructor
U (Spring)
3-0-9 HASS-H
Studies contemporary films emerging from nations such as South Korea, Iran, and Denmark. Explores the importance of cultural settings, the nature of local funding schemes and production practices, and deeper stylistic continuities with the past. Focuses on one nation’s productions (including émigré filmmakers), considering their history, innovations, and meanings in a world in which the idea of nation is increasingly challenged by such factors as immigration, labor outsourcing, and multiculturalism. Examines film’s relationship with other media forms, such as television and social media. Students taking graduate version complete additional assignments.

H. J. Chung

CMS.313 Silent Film
(Subject meets with CMS.813)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Examines how the key elements of today’s films—composition, continuity editing, lighting, narrative structure—were originally created. Studies the history of cinema, from its origins in the late 19th century to the transition to sound in the late 1920s and early 1930s. Students view a range of films (both mainstream and experimental) from all over the world, with a particular focus on US productions. Emphasis on how color, sound, and other developments paved the way for today’s technological innovations. Students taking graduate version complete additional assignments.

H. Hendershot
CMS.314| Phantasmal Media: Theory and Practice
(Same subject as 21W.753J)
(Subject meets with CMS.814)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A
Engages students in theory and practice of using computational techniques for developing expressive digital media works. Surveys approaches to understanding human imaginative processes, such as constructing concepts, metaphors, and narratives, and applies them to producing and understanding socially, culturally, and critically meaningful works in digital media. Readings engage a variety of theoretical perspectives from cognitive linguistics, literary and cultural theory, semiotics, digital media arts, and computer science. Students produce interactive narratives, games, and related forms of software art. Some programming and/or interactive web scripting experience (e.g., Flash, Javascript) is desirable. Students taking the graduate version complete a project requiring more in-depth theoretical engagement.
V. Bald

CMS.333J| Production of Educational Videos: Skills for Communicating Academic and Professional Content
(Same subject as ES.333J)
Prereq: None
U (Spring)
3-1-8 HASS-E; CI-H
See description under subject ES.333J.
D. Custer

CMS.334J| South Asian America: Transnational Media, Culture, and History
(Same subject as 21W.788J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
See description under subject 21W.788J.
V. Bald

CMS.335J| Short Attention Span Documentary
(Same subject as 21W.790J)
(Subject meets with 21W.890)
Prereq: None
U (Spring)
3-0-9 HASS-A
See description under subject 21W.790J.
V. Bald

CMS.336| The Social Documentary: Analysis and Production
(Same subject as 21W.786J)
(Subject meets with CMS.836)
Prereq: None
U (Spring)
3-0-9 HASS-A
See description under subject 21W.786J.
V. Bald

CMS.338| Innovation in Documentary: Technologies and Techniques
(Subject meets with CMS.838)
Prereq: CMS.100 or permission of instructor
U (Spring)
3-0-9 HASS-A
Discusses emerging technologies and techniques available to media-makers (e.g., location-based technologies, transmedia storytelling, crowdsourcing, and interactivity) and their implications on the film and television documentary. Studies the development of these tools and considers the many new directions in which they may take the genre. Includes screenings, meetings with documentary makers, and an experimental component in which students can explore new approaches to documentary production. Students taking graduate version complete additional assignments.
W. Uricchio

CMS.350| Topics and Methods in 21st-Century Journalism
(Same subject as 21W.737J)
(Subject meets with CMS.850)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-E
Gives a broad understanding of what it means to produce journalism today. Evaluates the limitations and strengths of specific types of media, ranging from New York Times stories to Twitter feeds. Provides students with tools to effectively communicate their own work and research to non-specialist audiences. Students submit assignments via an online portal, which mimics the style and substance of an online news source. Students taking graduate version complete additional assignments. Limited to 18.
S. Mnookin

CMS.356| Advertising and Media: Comparative Perspectives (New)
(Same subject as 21F.036J)
(Subject meets with 21F.190, CMS.888)
Prereq: None
U (Spring)
3-0-9 HASS-H
See description under subject 21F.036J.
J. Wang

CMS.360| Introduction to Civic Media
(Subject meets with CMS.860)
Prereq: None
U (Spring)
3-0-9 HASS-H
Examines civic media in comparative, transnational and historical perspectives. Introduces various theoretical tools, research approaches, and project design methods. Students engage with multimedia texts on concepts such as citizen journalism, transmedia activism, media justice, and civic, public, radical, and tactical media. Case studies explore civic media across platforms (print, radio, broadcast, internet), contexts (from local to global, present-day to historical), and use (dialogic, contentious, hacktivist). As a final project, students develop a case study or project proposal. Students taking the graduate version complete additional assignments. Limited to 20.
S. Costanza-Chock

CMS.361| Networked Social Movements: Media and Mobilization
(Subject meets with CMS.861)
Prereq: None
U (Spring)
3-0-9 HASS-S
Provides an overview of social movement studies as a body of theoretical and empirical work, with an emphasis on understanding the relationship between social movements and the media. Explores multiple methods of social movement investigation, including textual and media analysis, surveys, interviews, focus groups, participant observation, and co-research. Covers recent innovations in social movement theory, as well as new data sources and tools for research and analysis. Includes short papers, a literature review, and a final research project. Students taking graduate version complete additional assignments. Limited to 16.
S. Costanza-Chock
CMS.362 Civic Media Collaborative Design Studio
(Subject meets with CMS.862)
Prereq: One subject in CMS or MAS
U (Spring)
3-0-9 HASS-S
Can be repeated for credit

Project-based studio focusing on collaborative design of civic media provides a service-learning opportunity for students interested in working with community organizations. Multidisciplinary teams create civic media projects based on real-world community needs. Covers co-design methods and best practices to include the user community in iterative stages of project ideation, design, implementation, testing, and evaluation. Students taking graduate version complete additional assignments. Limited to 16.
S. Costanza-Chock

CMS.363 Civic Media, Past and Future
(Subject meets with CMS.873)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-E

Explores the history and futures of civic media and the corresponding vision of citizenship that civic media facilitates. Topics include orality and literacy during the rise of democratic governance in ancient Greece, the affordances and limitations of new civic media in the 19th and 20th centuries, the role of education in promoting civic media use, the “Gutenberg parenthesis,” and the emergence of secondary orality in the digital age. Uses historical case studies to illustrate the political and economic effects of new civic media; to enhance theoretical and practical understanding of communication, technology, and political action; and to imagine future models to maximize the opportunities and efficacy of civic media. Students taking graduate version complete additional assignments.
E. Schiappa

CMS.376 History of Media and Technology
(Subject meets with CMS.876)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

Surveys the interrelated histories of communications media and technological development, from the emergence of 19th-century forms of mass print media and telegraphy, to sound capture and image-based forms (e.g., film, radio, and television), to the shift from analog to digital cultures. Examines how new forms of communication exert social, political, and cultural influences in the global context. Explores how technological innovation and accelerating media affect social values and behaviors in the popular and global adoption of a media device. Includes two papers and a research project on aspects of media history. Students taking graduate version complete additional assignments. Enrollment limited.
J. Scheib

CMS.400 Media Systems and Texts
Prereq: One subject in Comparative Media Studies or permission of instructor
U (Fall)
3-3-6 HASS-H

Explores theoretical, historical and critical approaches to the comparative study of media. Examines media from three perspectives: the historical evolution of particular media forms (media in transition); the migration of particular narratives across different media forms (transmedia texts); and the ways in which media texts and systems cross cultural and national boundaries (global crossings). Instruction and practice in written and oral communication provided.
J. Picker

CMS.403J Media and Methods: Performing
(Same subject as 21M.703J)
Prereq: CMS.100, 21L.011, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-3-6 HASS-H

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
U (Spring)
3-3-6 HASS-H

Explores the process of making and sharing visual artifacts using a trans-cultural, trans-historical, constructionist approach. Explores the relationship between perceived reality and the narrative imagination, how an author’s choice of medium and method constrains the work, how desire is integrated into the structure of a work, and how the cultural-economic opportunity for exhibition/distribution affects the realization of a work. Instruction and practice in written and oral communication provided. Limited to 20.
D. F. Harrell

CMS.407 Media and Methods: Sound
Prereq: None
U (Spring)
3-0-9 HASS-H

Credit cannot also be received for 21A.505, STS.065

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

See description under subject 11.127J.
E. Klopfinger
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.605 Media Internship (New)
Prereq: None
U (Fall, Spring)
Units arranged
Can be repeated for credit
Part-time internships arranged in Boston and the wider Northeast for students wishing to develop professional experience in a media production organization or industry. Students work with a CMS faculty advisor to produce a white paper on a research topic of interest based on their intern experience. Students planning to take this subject must contact the instructor before the end of the preceding term.
Staff

CMS.606 Media Internship (New)
Prereq: None
G (Fall, Spring)
Units arranged
Can be repeated for credit
Part-time internships arranged in Boston and the wider Northeast for students wishing to develop professional experience in a media production organization or industry. Students work with a CMS/W faculty advisor to produce a white paper on a research topic of interest based on their intern experience. Students planning to take this subject must contact the instructor before the end of the preceding term.
Staff

CMS.607 From Gamer to Player: Theory and Practice of Player Research
(Subject meets with CMS.843)
Prereq: CMS.300, CMS.608, or permission of instructor
U (Spring)
3-0-9 HASS-S
Focuses on the theories and methods of researching digital game players. Draws on approaches from humanities, social science, and mass communication fields to inform and inspire student research. Examines the strengths, weaknesses, and appropriate use of different data collection methods. Emphasizes familiarity with research philosophy, rules and regulations for working with human subjects. Analyzes current research on digital games and their players to inform understanding of research in practice. Students theorize and develop a player-focused study, collect data, and produce a research paper analyzing their data over the course of the term. Students taking the graduate version complete additional assignments. Limited to 20.
T. Harper

CMS.608 Game Design
(Subject meets with CMS.864)
Prereq: One subject in Comparative Media Studies or permission of instructor
U (Spring)
3-3-6 HASS-A
Practical instruction in the design and analysis of non-digital games. Provides students the texts, tools, references, and historical context to analyze and compare game designs across a variety of genres. In teams, students design, develop, and thoroughly test their original games to better understand the interaction and evolution of game rules. Covers various genres and types of games, including sports, game shows, games of chance, card games, schoolyard games, board games, and role-playing games. Students taking the graduate version complete additional assignments. Limited to 20.
P. Tan

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
See description under subject 21W.764J.
N. Montfort

CMS.610 Media Industries and Systems: The Art, Science and Business of Games
(Subject meets with CMS.922)
Prereq: Two CMS subjects or permission of instructor
U (Spring)
3-0-9 HASS-S
Examines the interplay of art, science, law, and commerce in the production, marketing, distribution, and consumption of historic and contemporary videogames. Students create prototypes and develop marketing programs to illustrate the challenges of producing videogames in a professional context. Combines perspectives on media industries and systems with an examination of the creative process, development, and trends that shape content. Includes discussions with industry leaders in various areas. Students taking graduate version complete additional assignments.
C. Weaver

CMS.611J Creating Video Games
(Same subject as 6.073J)
Prereq: CMS.608 or 6.01
U (Fall)
3-3-6 HASS-A
Introduces students to the complexities of working in small, multidisciplinary teams to develop video games. Covers creative design and production methods, stressing design iteration and regular testing across all aspects of game development (design, visual arts, music, fiction, and programming). Assumes a familiarity with current video games, and the ability to discuss games critically. Previous experience in audio design, visual arts, or project management recommended. Limited to 24.
P. Tan, S. Verrilli, 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
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)
Prereq: None
U (Spring)
3-0-9 HASS-A
See description under subject 21W.751J.
Staff
CMS.614J Network Cultures
(Same subject as 21W.791J)
(Subject meets with CMS.867)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
Focuses on the social and cultural aspects of networked life through internet-related technologies (including computers, mobile devices, entertainment technologies, and emerging media forms). Theories and readings focus on the cultural, social, economic, and political aspects of internet use and design. Topics include online communication and communities, social media, gender and race in network spaces, activism and hacking, networked publics, remix culture and intellectual property. Students taking the graduate version complete additional readings and assignments.
T. L. Taylor

CMS.615 Games for Social Change
(Subject meets with CMS.815)
Prereq: None
U (Fall)
3-0-9 HASS-H
Examines how various movements have tried over time to create games that enable players to enact social change. Students collaborate in teams to design and prototype games for social change and civic engagement. In a workshop setting, teams develop games and showcase them at an end-of-term open house. Features guest speakers from academia and industry as well as the nonprofit sector and the gaming community. Readings explore principals of game design and the social history of games. Students taking graduate version complete additional assignments.
S. Osterweil

CMS.616J Games and Culture
(Same subject as 21W.768J, WGS.125J)
(Subject meets with CMS.868)
Prereq: None
U (Fall)
3-0-9 HASS-S
Examines the social, cultural, economic, and political aspects of digital games. Topics include the culture of gameplay, gaming styles, communities, spectatorship and performance, gender and race within digital gaming, and the politics and economics of production processes, including co-creation and intellectual property. Students taking graduate version complete additional readings and assignments.
T. L. Taylor

CMS.617 Advanced Game Studio
Prereq: CMS.608 or CMS.611
U (Spring)
3-3-6 HASS-A
Students join the class in pre-formed teams, which work under the supervision of experienced mentors to complete a term-long game creation project. Covers management best practices for software engineering teams; creative expression as a collaborative project; developing and evaluating prototypes for potential viability, and translating them into a final polished product; planning and running qualitative testing of design elements; and targeting and selecting an appropriate audience for testing. Includes regular reviews and critiques to discuss progress, design, and work plan. Culminates with public presentation of games. Limited to 15.
P. Tan, S. Verrilli, T. L. Taylor

CMS.618J Gender and Media Studies (New)
(Same subject as WGS.111J)
Prereq: None
U (Fall)
3-0-9 HASS-H
See description under subject WGS.111J.
K. Surkan

CMS.621 Fans and Fan Cultures
(Subject meets with CMS.821)
Prereq: None
U (Spring)
3-0-9 HASS-H
Examines media audiences—specifically, fans—and the subcultures that evolve around them. Examines the different historical, contemporary and transnational understandings of fans. Explores products of fan culture, i.e., clubs, fiction, “vids,” activism, etc. Readings place these products within the context of various disciplines. Students consider the concept of the “aca-fan” and reflect on their own “fannish” practices. Requires several short papers. Students taking graduate version complete additional assignments. Limited to 20.
Staff

CMS.627 Imagination, Computation, and Expression Studio
(Subject meets with CMS.827)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A
Can be repeated for credit
D. F. Harrell

CMS.628 Advanced Identity Representation
(Subject meets with CMS.828)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A
Can be repeated for credit
Can be repeated for credit
D. F. Harrell
CMS.631 Systems Visualization
(Subject meets with CMS.831)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-A
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.

J. Paradis, K. Fendt

CMS.633 Digital Humanities: Topics, Techniques, and Technologies
(Subject meets with CMS.833)
Prereq: None
U (Spring)
3-0-9 HASS-H
Examines theory and practice of using computational methods in the emerging field of digital humanities. Develops an understanding of key digital humanities concepts such as data representation, digital archives, information visualization, and user interaction through the study of contemporary research in conjunction with working on real-world projects for scholarly, educational, and public needs. Students create prototypes, write design papers, and conduct user studies. Some programming and design experience is helpful but not required. Students taking graduate version complete additional assignments.

J. Paradis, K. Fendt

CMS.634 Designing Interactions: Media and Mobile Technologies
(Subject meets with 4.569J, CMS.834J)
Prereq: None
U (Fall)
3-3-6 HASS-E
Can be repeated for credit with permission of instructor
Explores the future of mobile interactions and pervasive computing, taking into consideration design, technological, social and business aspects. Discusses theoretical works on human-computer interaction, mobile media and interaction design, and covers research and design methods. Students work in multidisciplinary teams and participate in user-centric design projects aimed to study, imagine and prototype concepts illustrating the future of mobile applications and ubiquitous computing. Students taking graduate version complete additional assignments. Limited to 12.

F. Casalegno, T. Nagakura

CMS.701 Current Debates in Media
(Subject meets with CMS.901)
Prereq: CMS.100
U (Spring)
3-0-9 HASS-H
Addresses important, current debates in media with in-depth discussion of popular perceptions and policy implications. Students use multiple perspectives to analyze texts emanating from these debates, and present their findings through discussions and reports. Explores emerging topics (e.g., piracy and IP regimes, net neutrality, media effects, social media and social change, and changing literacies) across media forms and from various historical, transcultural, and methodological perspectives. Examines the framing of these issues, their ethical and policy implications, and strategies for repositioning the debate. Students taking graduate version complete additional assignments.

CMS.60 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Seminor or lecture on a topic that is not covered in the regular curriculum.

M. Montpetit

CMS.61 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
U (Fall)
Units arranged
Can be repeated for credit
Seminar or lecture on a topic that is not covered in the regular curriculum.

J. Diaz

CMS.62 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.

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.

CMS.TTH 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.

Seminor or lecture on a topic that is not covered in the regular curriculum.

M. Montpetit
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.

E. Brinkema

CMS.801 Media in Transition
Prereq: Permission of instructor
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.808 The Visual Story: Graphic Novel, Type to Tablet
(Subject meets with CMS.308)
Prereq: None
G (Spring)
3-0-9

Focuses on the interactions between graphic stories and media technologies from the rotary press of the late 19th century to contemporary touch screens, exploring the changing relations among narrative expression, reader experience and media form. Working with examples from Pulitzers Yellow Kid and McKays Little Nemo, through the classic comics (from DC superheroes to EC horror) and graphic novels to interactive and non-linear texts (Cognitos Operation Ajax), the course examines such elements as graphic design, interface and form as well as the circulation and economies of these various media-based texts.

J. Paradis, W. Uricchio

CMS.809 Transmedia Storytelling: Modern Science Fiction
(Subject meets with 21W.763J, CMS.309)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-2-7

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.

H. Hendershot

CMS.812 Topics in National and Post-National Cinema
(Subject meets with CMS.312)
Prereq: CMS.100 or permission of instructor
G (Spring)
3-0-9

Studies contemporary films emerging from nations such as South Korea, Iran, and Denmark. Explores the importance of cultural settings, the nature of local funding schemes and production practices, and deeper stylistic continuities with the past. Focuses on one nation’s productions (including émigré filmmakers), considering their history, innovations, and meanings in a world in which the idea of nation is increasingly challenged by such factors as immigration, labor outsourcing, and multiculturalism. Examines film’s relationship with other media forms, such as television and social media. Students taking graduate version complete additional assignments.

H. J. Chung

CMS.813 Silent Film
(Subject meets with CMS.313)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-3-6

Examines how the key elements of today’s films—composition, continuity editing, lighting, narrative structure—were originally created. Studies the history of cinema, from its origins in the late 19th century to the transition to sound in the late 1920s and early 1930s. Students view a range of films (both mainstream and experimental) from all over the world, with a particular focus on US productions. Emphasis on how color, sound, and other developments paved the way for today’s technological innovations. Students taking graduate version complete additional assignments.

H. Hendershot
CMS.814 Phantasmal Media: Theory and Practice
(Subject meets with 21W.753, CMS.314J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
Engages students in theory and practice of using computational techniques for developing expressive digital media works. Surveys approaches to understanding human imaginative processes, such as constructing concepts, metaphors, and narratives, and applies them to producing and understanding socially, culturally, and critically meaningful works in digital media. Readings engage a variety of theoretical perspectives from cognitive linguistics, literary and cultural theory, semiotics, digital media arts, and computer science. Students produce interactive narratives, games, and related forms of software art. Some programming and/or interactive web scripting experience (e.g., Flash, Javascript) is desirable. Students taking the graduate version complete a project requiring more in-depth theoretical engagement.
D. F. Harrell

CMS.815 Games for Social Change
(Subject meets with CMS.615)
Prereq: None
G (Fall)
3-0-9
Students will collaborate in teams to design and prototype games for social change and civic engagement. Run as a workshop in which student teams develop their games and showcase them at a semester-end open house. Features guest speakers from academia and industry as well as the non-profit sector and the gaming community. Readings will explore principals of game design, or social science research methods. Can be repeated for credit with permission of instructor.
Graduate students taking graduate version complete additional assignments. Limited to 20.
Staff

CMS.827 Imagination, Computation, and Expression Studio
(Subject meets with CMS.627)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
Can be repeated for credit with permission of instructor
Aims to help students invent and analyze new forms of computer-based art, gaming, social media, interactive narrative, and related technologies. Students participate in a range of new and ongoing projects that are designed to hone skills in research, development, design, and evaluation. Topics vary from year to year; examples include cognitive science and artificial intelligence-based approaches to the arts; social aspects of game design; computing for social empowerment; and game character, avatar, and online profile design. Students taking graduate version complete additional assignments.
D. F. Harrell

CMS.828 Advanced Identity Representation
(Subject meets with CMS.628)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
Can be repeated for credit
Studies and develops computational identity systems for games, social media, virtual worlds, and computer-based artwork. An interdisciplinary set of readings (cognitive science, computer science, art, and sociology) looks at both the underlying technology and the social/cultural aspects of identity. Includes topics such as developing improved characters, avatars, agents, social networking profiles, and online accounts. Students taking graduate version complete additional assignments.
D. F. Harrell

CMS.830 Studies in Film
(Subject meets with 21L.706)
Prereq: Permission of instructor
G (Fall, Spring)
3-3-6
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: P. Donaldson
Spring: E. Brinkema

CMS.831 Systems Visualization
(Subject meets with CMS.631)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
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.
Staff

CMS.833 Digital Humanities: Topics, Techniques, and Technologies
(Subject meets with CMS.633)
Prereq: None
G (Spring)
3-0-9
Examines theory and practice of using computational methods in the emerging field of digital humanities. Develops an understanding of key digital humanities concepts such as data representation, digital archives, information visualization, and user interaction through the study of contemporary research in conjunction with working on real-world projects for scholarly, educational, and public needs. Students create
prototypes, write design papers, and conduct user studies. Some programming and design experience is helpful but not required. Students taking graduate version complete additional assignments.

J. Paradis, K. Fendt

CMS.834 Designing Interactions: Media and Mobile Technologies
(Same subject as 4.569j)
(Subject meets with CMS.634)
Prereq: None
G (Fall)
3-0-9
Can be repeated for credit with permission of instructor

Explores the future of mobile interactions and pervasive computing, taking into consideration design, technological, social and business aspects. Discusses theoretical works on human-computer interaction, mobile media and interaction design, and covers research and design methods. Students work in multidisciplinary teams and participate in user-centric design projects aimed to study, imagine and prototype concepts illustrating the future of mobile applications and ubiquitous computing. Students taking graduate version complete additional assignments. Limited to 12.

F. Casalegno, T. Nagakura

CMS.836 The Social Documentary: Analysis and Production
(Subject meets with 21W.786, CMS.336j)
Prereq: None
G (Spring)
3-0-9

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.837 Film, Music, and Social Change: Intersections of Media and Society
(Subject meets with 21W.787)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.838 Innovation in Documentary: Technologies and Techniques
(Subject meets with CMS.338)
Prereq: CMS.100 or permission of instructor
G (Spring)
3-0-9

Discusses emerging technologies and techniques available to media-makers (e.g., location-based technologies, transmedia storytelling, crowdsourcing, and interactivity) and their implications on the film and television documentary. Studies the development of these tools and considers the many new directions in which they may take the genre. Includes screenings, meetings with documentary makers, and an experimental component in which students can explore new approaches to documentary production. Students taking graduate version complete additional assignments.

W. Uricchio

CMS.840 Literature and Film
(Subject meets with 21L.435)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9
Can be repeated for credit

Investigates relationships between the two media, including film adaptations as well as works linked by genre, topic, and style. Explores how artworks challenge and cross cultural, political, and aesthetic boundaries. Students taking graduate version complete additional assignments.

E. Brinkema

CMS.841 Introduction to Videogame Theory
(Subject meets with CMS.300)
Prereq: None
G (Fall, Spring)
3-3-6

Introduction to the interdisciplinary study of videogames as texts through an examination of their cultural, educational, and social functions in contemporary settings. Students play and analyze videogames while reading current research and theory from a variety of sources in the sciences, social sciences, humanities, and industry. Assignments focus on game analysis in the context of the theories discussed in class. Includes regular reading, writing, and presentation exercises. No prior programming experience required. Students taking graduate version complete additional assignments. Limited to 20.

M. Jakobsson

CMS.843 From Gamer to Player: Theory and Practice of Player Research
(Subject meets with CMS.607)
Prereq: CMS.300, CMS.608, or permission of instructor
G (Spring)
3-0-9

Focuses on the theories and methods of researching digital game players. Draws on approaches from humanities, social science, and mass communication fields to inform and inspire student research. Examines the strengths, weaknesses, and appropriate use of different data collection methods. Emphasizes familiarity with research philosophy, rules and regulations for working with human subjects. Analyzes current research on digital games and their players to inform understanding of research in practice. Students theorize and develop a player-focused study, collect data, and produce a research paper analyzing their data over the course of the term. Students taking the graduate version complete additional assignments. Limited to 20.

T. Harper

CMS.845 Interactive Narrative
(Subject meets with 21L.489j, 21W.765j)
Prereq: Permission of instructor
G (Fall)
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
CMS.864 Game Design
(Subject meets with CMS.608)
Prereq: One subject in Comparative Media Studies or permission of instructor
G (Spring)
3-3-6
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.866 Writing for Videogames
(Subject meets with 21W.767, CMS.612J)
Prereq: None
G (Spring)
3-0-9
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.867 Network Cultures
(Subject meets with 21W.791, CMS.614J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
Focuses on the social and cultural aspects of networked life through internet-related technologies (including computers, mobile devices, entertainment technologies, and emerging media forms). Theories and readings focus on the cultural, social, economic, and political aspects of internet use and design. Topics include online communication and communities, social media, gender and race in network spaces, activism and hacking, networked publics, remix culture and intellectual property. Students taking the

CMS.860 Introduction to Civic Media
(Subject meets with CMS.360)
Prereq: None
G (Spring)
3-0-9
Examines civic media in comparative, transnational and historical perspective. Introduces various theoretical tools, research approaches, and project design methods. Students engage with multimedia texts on concepts such as citizen journalism, transmedia activism, media justice, and civic, public, radical, and tactical media. Case studies explore civic media across platforms (print, radio, broadcast, internet), contexts (from local to global, present-day to historical), and use (dialogic, contentious, hacktivist). As a final project, students develop a case study or project proposal. Students taking the graduate version complete additional assignments. Limited to 20.
S. Costanza-Chock

CMS.861 Networked Social Movements: Media and Mobilization
(Subject meets with CMS.361)
Prereq: None
G (Spring)
3-0-9
Provides an overview of social movement studies as a body of theoretical and empirical work, with an emphasis on understanding the relationship between social movements and the media. Explores multiple methods of social movement investigation, including textual and media analysis, surveys, interviews, focus groups, participant observation, and co-research. Covers recent innovations in social movement theory, as well as new data sources and tools for research and analysis. Includes short papers, a literature review, and a final research project. Students taking graduate version complete additional assignments. Limited to 16.
S. Costanza-Chock

CMS.850 Topics and Methods in 21st Century Journalism
(Subject meets with 21W.737, CMS.350J)
Prereq: None
G (Fall, Spring)
3-0-9
Gives a broad understanding of what it means to produce journalism today. Evaluates the limitations and strengths of specific types of media, ranging from New York Times stories to Twitter feeds. Provides students with tools to effectively communicate their own work and research to non-specialist audiences. Students submit assignments via an online portal, which mimics the style and substance of an online news source. Students taking graduate version complete additional assignments. Limited to 18.
S. Mnookin

CMS.866 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.862 Civic Media Collaborative Design Studio
(Subject meets with CMS.362)
Prereq: One subject in CMS or MAS
G (Spring)
3-0-9 H-LEVEL Grad Credit
Can be repeated for credit
Project-based studio focusing on collaborative design of civic media provides a service-learning opportunity for students interested in working with community organizations. Multidisciplinary teams create civic media projects based on real-world community needs. Covers co-design methods and best practices to include the user community in iterative stages of project ideation, design, implementation, testing, and evaluation. Students taking graduate version complete additional assignments. Limited to 16.
S. Costanza-Chock

CMS.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 11.252J.
E. Klopfer

CMS.864 Game Design
(Subject meets with CMS.608)
Prereq: One subject in Comparative Media Studies or permission of instructor
G (Spring)
3-3-6
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.866 Writing for Videogames
(Subject meets with 21W.767, CMS.612J)
Prereq: None
G (Spring)
3-0-9
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.867 Network Cultures
(Subject meets with 21W.791, CMS.614J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
Focuses on the social and cultural aspects of networked life through internet-related technologies (including computers, mobile devices, entertainment technologies, and emerging media forms). Theories and readings focus on the cultural, social, economic, and political aspects of internet use and design. Topics include online communication and communities, social media, gender and race in network spaces, activism and hacking, networked publics, remix culture and intellectual property. Students taking the
graduate version complete additional readings and assignments.
T. L. Taylor

CMS.868 Games and Culture
(Subject meets with 21W.768J, CMS.616J, WGS.125J)
Prereq: None
G (Fall)
3-0-9
Examines the social, cultural, economic, and political aspects of digital games. Topics include the culture of gameplay, gaming styles, communities, spectatorship and performance, gender and race within digital gaming, and the politics and economics of production processes, including co-creation and intellectual property. Students taking graduate version complete additional readings and assignments.
T. L. Taylor

CMS.871 Media in Cultural Context
(Subject meets with 21L.715)
Prereq: Permission of instructor
G (Fall)
3-0-9
Can be repeated for credit
Seminar uses case studies to examine specific media or media configurations and the larger social, cultural, economic, political, or technological contexts within which they operate. Organized around recurring themes in media history, as well as specific genres, movements, media, or historical moments. Previously taught topics include Gendered Genres: Horror and Maternal Melodramas; Comics, Cartoons, and Graphic Storytelling; and Exploring Children’s Culture. Students taking graduate version complete additional assignments. Approved for credit in Women’s and Gender Studies when content meets the requirements for subjects in that program. Limited to 12.
M. Marks

CMS.873 Civic Media, Past and Future
(Subject meets with CMS.363)
Prereq: None
G (Fall)
Not offered regularly; consult department
3-0-9
Explores the history and futures of civic media and the corresponding vision of citizenship that civic media facilitates. Topics include orality and literacy during the rise of democratic governance in ancient Greece, the affordances and limitations of new civic media in the 19th and 20th centuries, the role of education in promoting civic media use, the “Gutenberg parenthesis,” and the emergence of secondary orality in the digital age. Uses historical case studies to illustrate the political and economic effects of new civic media; to enhance theoretical and practical understanding of communication, technology, and political action; and to imagine future models to maximize the opportunities and efficacy of civic media. Students taking graduate version complete additional assignments.
E. Schiappa

CMS.874J Visualizing Japan in the Modern World (New)
(Same subject as 21F.027J)
(Subject meets with 21F.590)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H; CI-H
See description under subject 21F.027J.
S. Miyagawa

CMS.876 History of Media and Technology
(Subject meets with CMS.376)
Prereq: None
G (Spring)
3-0-9
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.
M. Szablewicz

CMS.880 From Print to Digital: Technologies of the Word, 1450–Present
(Subject meets with 21H.343)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. Students taking graduate version complete additional assignments.
D. Thorburn

CMS.888 Advertising and Media: Comparative Perspectives
(Subject meets with 21F.036J, 21F.190, CMS.356J)
Prereq: Permission of instructor
G (Spring)
3-0-9
Meets with 21F.036 but assignments differ. See description under subject 21F.036.
J. Wang

CMS.901 Current Debates in Media
(Subject meets with CMS.701)
Prereq: None
G (Spring)
3-0-9
Addresses important, current debates in media with in-depth discussion of popular perceptions and policy implications. Students use multiple perspectives to analyze texts emanating from these debates, and present their findings through discussions and reports. Explores emerging topics (e.g., piracy and IP regimes, net neutrality, media effects, social media and social change, and changing literacies) across media forms and from various historical, transcultural, and methodological perspectives. Examines the framing of these issues, their ethical and policy implications, and strategies for repositioning the debate. Students taking graduate version complete additional assignments.

CMS.915 Understanding Television
(Subject meets with 21L.432)
Prereq: Permission of instructor
G (Spring)
3-0-9
Can be repeated for credit
A cultural approach to television’s evolution as a technology and system of representation. Considers television as a system of storytelling and mythmaking, and as a cultural practice studied from anthropological, literary, and cinematic perspectives. Focuses on prime-time commercial broadcasting, the medium’s technological and economic history, and theoretical perspectives. Considerable television viewing and readings in media theory and cultural interpretation are required. Previously taught topics include American Television: A Cultural History. Students taking graduate version complete additional assignments.
D. Thorburn
COMPARATIVE MEDIA STUDIES

CMS.920 Popular Culture and Narrative
(Subject meets with 21L.430)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9
Can be repeated for credit with permission of instructor
Examines relationships between popular culture and art, focusing on problems of evaluation and audience, and the uses of different media within a broader social context. Typically treats a range of narrative and dramatic works as well as films. Previously taught topics include Elements of Style; Gender, Sexuality and Popular Narrative. Students taking graduate version complete additional assignments. Approved for credit in Women's and Gender Studies when content meets the requirements for subjects in that program.
K. Delaney

CMS.922 Media Industries and Systems: The Art, Science and Business of Games
(Subject meets with CMS.610)
Prereq: Permission of instructor
G (Spring)
3-0-9
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.925 Film Music
(Subject meets with 21M.284)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. Subsidiary topics include new trends in contemporary film-scoring, pop scores, the impact of electronics, and specialized genres (e.g., animation). Students taking the graduate version complete different assignments. Some background in the study of film and/or music is expected.
M. Marks

CMS.935 Documentary Photography and Photojournalism: Still Images of a World in Motion
(Subject meets with 21W.749)
Prereq: Permission of instructor
G (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.
J. Paradis

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, mediarmakers, policymakers, and industry leaders on cutting edge issues in media. Registered CMS graduate students only.
Staff

CMS.992 Portfolio in Comparative Media
Prereq: CMS.950 or Permission of Instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Students work individually with an advisor to produce a portfolio project which combines technical skills and a substantial intellectual component.
J. Diaz

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
Can be repeated for credit
Opportunity for individual research in comparative media studies. Registration subject to prior arrangement for subject matter and supervision by a faculty member.
Staff

CMS.995 Independent Study
Prereq: Permission of instructor
G (Fall, IAP, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for independent study. Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

CMS.S96 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
G (Fall, IAP)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for independent study. Seminar or lecture on a topic that is not covered in the regular curriculum.
Staff

CMS.S97 Special Subject: Comparative Media Studies
Prereq: Permission of instructor
G (Fall)
Units arranged
Can be repeated for credit
Opportunity for independent study. Seminar or lecture on a topic that is not covered in the regular curriculum.
J. Diaz
# Bachelor of Science in Comparative Media Studies/Course CMS

## General Institute Requirements (GiRs)

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement [all but two subjects can be from 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

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<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>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
</tr>
</tbody>
</table>

**Tier I**

- **21L.011** The Film Experience, 12, HASS, CI-H
- **CMS.100** Introduction to Media Studies, 12, HASS-H, CI-H

**Tier II (Mid-tier)**

- Choose one of the following:
  - **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; **21L.011**, **CMS.100**, or permission of instructor
  - **CMS.405** Media and Methods: Seeing and Expression, 12, HASS-H, CI-M; **21L.011** or **CMS.100**
  - **CMS.407** Media and Methods: Sound, 12, HASS-H, CI-M

**Tier III (Capstone)**

- Choose one of the following:
  - **21L.706** Studies in Film, 12, HASS-H, CI-M; **21L.011** and one subject in CMS or Literature; or permission of instructor
  - **CMS.701** Current Debates in Media, 12, HASS-H, CI-M; **CMS.100**

### 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.

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>152</td>
</tr>
</tbody>
</table>

## Departmental Program Units That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(72)</td>
</tr>
</tbody>
</table>

## Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60–108</td>
</tr>
</tbody>
</table>

## Total Units Beyond the GIRs Required for SB Degree

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
</tr>
</tbody>
</table>

No subject can be counted both as part of the 27-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).
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 a PhD thesis; to be arranged by the student and the MIT faculty advisor.

Information: Faculty Advisor
The Edgerton Center specializes in experiential learning and offers many interactive subjects in electronics, high-speed photography, and video production. The center is also the home of D-Lab classes (see EC.700–EC.799).

**SEMINARS**

**EC.050 Recreate Experiments from History: Inform the Future from the Past**  
(Subject meets with EC.090)  
Prereq: None  
U (Fall, IAP, Spring)  
1-3-2 [P/D/F]

Provides perspective for thinking about the future through the study of historical physical science and historically significant experiments. Designed to build awareness of the unexpected through both observation of the sky and lab activities that focus on light, electricity, and motion. Labs are complemented by museum and site visits; readings include accounts by Galileo, Archimedes, and other historical observers. Individual and team assignments provide opportunities to develop skills in observation, exploration, and evaluation. Students must keep an observing notebook and write a reflective paper; students taking the graduate version complete additional assignments.  
J. Bales, E. Cavicchi

**EC.074 The Start-up Experience at MIT**  
Prereq: None  
U (Fall)  
2-0-4 [P/D/F]

Explores some of the critical actions in starting up a technology-based business, including concept generation, searching prior art and patents, protecting intellectual property, founders agreements, forming and building teams, and work-life balance. Students review case studies and complete exercises that develop practicable knowledge in these areas. Each student keeps an “idea log book,” which includes critical assessments of each case study, to be presented at the end of the term. First in a two-part series (seminars do not have to be taken sequentially; see EC.075 in spring term). Preference to undergraduates; open to graduate students with permission of advisor.  
J. Hadzima

**EC.075 Starting Up New Technology-Based Business Enterprises at MIT**  
Prereq: None  
U (Spring)  
2-0-4 [P/D/F]

Seminar participants define and study the development stages of new enterprises at MIT, from the exciting moment a new idea for a tech product or service is realized, through to selling, customer support, and the next new idea. Follows the history of successful MIT spin-off companies with attention to the people (and their ideas) behind the start-up. Students attend MIT technology and science start-up case presentations given by individuals and teams working from zero-stage, and by partners in going concerns of historical relevance to the Institute and the economy. Second in a two-part series (seminars do not have to be taken sequentially; see EC.074 in fall term).  
J. G. Hadzima

**EC.090 Recreate Experiments from History: Inform the Future from the Past**  
(Subject meets with EC.050)  
Prereq: None  
G (Fall, IAP, Spring)  
1-3-2

Provides perspective for thinking about the future through the study of historical physical science and historically significant experiments. Designed to build awareness of the unexpected through both observation of the sky and lab activities that focus on light, electricity, and motion. Labs are complemented by museum and site visits; readings include accounts by Galileo, Archimedes, and other historical observers. Individual and team assignments provide opportunities to develop skills in observation, exploration, and evaluation. Students must keep an observing notebook and write a reflective paper; students taking the graduate version complete additional assignments.  
J. Bales, E. Cavicchi

**ELECTRONICS AND PROGRAMMING**

**EC.100 Electronics Fabrication and Design I**  
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. Limited to 10.  
A. Caloggero

**EC.101 Electronics Fabrication and Design II**  
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. Limited to 10.  
A. Caloggero

**EC.110J Introduction to Digital Electronics**  
(Same subject as 6.072J)  
Prereq: None  
U (Fall, IAP, 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.  
J. Bales
**MEDIA AND PRODUCTION**

**EC.120j** Electronics Project Laboratory (Same subject as 6.070j)
Prereq: None
U (Fall, Spring)
2-2-2
See description under subject 6.070j.
J. Boles

**EC.130j** Introduction to Microcontrollers
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

**IMAGING AND VISUALIZATION**

**EC.210** Visualization for Mathematics, Science, and Technology Education
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 (Subject meets with EC.A305)
Prereq: None
U (Fall)
2-0-4 [P/D/F]
Credit cannot also be received for EC.310

Students use both film and digital photography to develop a creative imaging project of their own choice. Develops skills in the use of image editing software to enhance, select, and combine images that the student has taken. Uses the darkroom to develop film for scanning and for chemical enlargement. Discusses topics such as the camera, composition, lighting, modes and formats, image compression, and halftone and dye sublimation printing. Students are expected to produce a duplicate set of black and white and/or color prints, along with a writeup and digital copy as the project output.
T. Mislick

**EC.310** Creative Imaging
Prereq: None
U (Spring)
2-1-6 HASS-E
Credit cannot also be received for EC.305, EC.A305

Focuses on film and digital photography. Develops skill in the use of chemical darkrooms, scanners, digital printers and cameras to create striking still images capable of evoking strong emotional and intellectual responses from a viewer. Emphasizes the interplay between classical chemical and digital techniques and how they can be used to control the use of lighting, color, depth, and composition in an image. Students present their intermediate assignments to the class for critical discussion; at the end of the term, they submit a substantive project presenting their own creative images for critique and evaluation.
T. Mislick, J. K. Vandiver

**ENGINEERING AND DESIGN**

**EC.430** Advanced Toy Product Design
Prereq: 2.00B or permission of instructor
U (Fall, Spring)
Not offered regularly; consult department
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 opportunities in creative product design and community service. Students further develop ideas for new toys that serve clients in the community, and work independently with local sponsors and with experienced mentors on a themed toy design 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
Prereq: None
U (Fall)
Not offered regularly; consult department
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 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.700** D-Lab: Field Study
Prereq: One D-Lab subject, permission of instructor
U (IAP)
Units arranged
Can be repeated for credit

Provides the opportunity to gain direct fieldwork experience in a global context. Subject spans three-four weeks in which students continue work from a prior D-Lab subject. Students work directly with international community partners to find solutions to real world problems, focusing on one or more issues in education, design, or public service. Group presentations and written reflection required.
A. B. Smith
EC.701J D-Lab: Development
(Subject meets with 11.025J)
Prereq: None
U (Fall)
3-2-7 HASS-S

Issues in international development, appropriate technology and project implementation addressed through lectures, case studies, guest speakers and laboratory exercises. Students form project teams to partner with community organizations in developing countries, and formulate plans for an optional IAP site visit. (Previous field sites include Ghana, Brazil, Honduras and India.) Recitation sections focus on specific project implementation, and include cultural, social, political, environmental and economic overviews of the target countries as well as an introduction to the local languages. Enrollment limited by lottery; must attend first class session.
A. B. Smith, B. Sanyal

EC.702J Cross-Cultural Investigations:
Technology and Development
(Same subject as 21A.801J, STS.071J)
(Subject meets with EC.792J, 21A.839J, STS.481J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S

See description under subject 21A.801J.
C. Walley

EC.710 D-Lab: Health Technologies for the Developing World
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 challenges observed in the field. Travel to Nicaragua during spring break includes additional fee; consult 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
(Subject meets with EC.791)
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, robust, low-cost systems for generating electrical power. Includes projects such as micro-hydro, solar, or wind turbine generators along with theoretical analysis, design, prototype construction, evaluation and implementation. Students will have the opportunity for an optional spring break site visit to identify and implement projects. Students taking graduate version complete additional assignments. Enrollment limited by lottery; must attend first class session.
Staff

EC.712 D-Lab: Information and Communication Technologies for Development (ICT)
(Subject meets with EC.782)
Prereq: None
U (Fall)
2-2-8

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. The first half of term presents an introduction to communication hardware, including antenna design, RFID, Bluetooth, Wi-Fi, and low-power sensors. Second half covers development of mobile phone applications and server communications, as well as system architecture for data collection and mapping. Students work in multidisciplinary teams, collaborating with local community partners. Culminates in a final project to be deployed in the field. Students taking graduate version complete additional assignment related to the term project.
R. Fletcher, A. Smith

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

See description under subject 4.411J.
L. K. Norford

EC.714 D-Lab: Biodiversity
Prereq: None
U (Spring)
2-2-5

Multidisciplinary exploration of the dynamic nexus between global biodiversity and human well-being. Includes guest lectures and experiential activities and projects. Covers topics such as reforestation, nutrient cycles, poaching, complexity, climate change, fair trade, ecotourism, and governance. Provides opportunities to develop and practice skills in cross-cultural engagement, negotiation, ecological measurement, permaculture, and sustainable technology design. Students collaborate remotely with community partners on projects in which they identify community concerns and design potential solutions. Opportunities for summer travel to partner communities. Enrollment limited by lottery; must attend first class session.
A. B. Smith, J. Huang, A. Phillips, E. Reynolds

EC.715 D-Lab: Disseminating Water/ Environment, Sanitation, and Hygiene Innovations for the Common Good
(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.716 D-Lab: Waste
(Subject meets with EC.786)
Prereq: None
U (Fall)
3-2-4
Provides a multidisciplinary approach to managing waste in low- and middle-income countries with strategies that diminish greenhouse gas emissions and provide enterprise opportunities for marginalized populations. Studies waste management strategies in cities in Africa, India, and Latin America; examines case studies of collection, recycling, and waste-to-energy businesses developed in low-income settings; and researches public policy that supports sustainable, integrated, solid waste management systems. Student teams develop waste management strategies that culminate in a two-week IAP trip to Nicaragua where students will work with a local NGO and the municipality to assist in the implementation of waste management initiatives. Includes guest speakers and field trips. Students taking graduate version complete additional assignments.
A. B. Smith

EC.717 D-Lab: Education
Prereq: None
U (Spring)
4-0-8
Explores education in the international development context and how modern best practices can be applied to overcome challenges, such as limited resources, language barriers, large class sizes, and entrenched pedagogy. Through an overview of core teaching skills emphasizing experiential and project-based learning, provides the necessary background to nurture creativity in youth and develop interactive lessons around science, technology, engineering, and math. Students draft and deliver lessons, receive feedback from peers and mentors, and then practice teaching in local Boston-area schools. Opportunity to teach abroad over summer. Limited to 20.
A. B. Smith

EC.720 D-Lab: Design
(5ame subject as 2.722)
Prereq: 2.670 or permission of 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.

EC.721 Wheelchair Design in Developing Countries
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
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
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.729 D-Lab: Design for Scale
Prereq: EC.720 or permission of instructor
U (Fall)
3-2-7
Focuses on product development of technologies for people in less industrialized markets. Students work in interdisciplinary teams to develop previously established prototypes or technologies towards manufacturing-ready product designs. Topics are presented within the context of the developing world and include technology feasibility and scalability assessment; value chain analysis; product specification; design for affordability, manufacturability, usability, and desirability; and product testing and manufacturing at various scales. Lessons are experiential and case study-based; taught by instructors with field experience and by industry experts from product development consulting firms and the consumer electronics industry.
E. Reynolds

EC.731J Development Ventures
(Same subject as 15.375J, MAS.665J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject MAS.665J.
A. Pentland, J. Bonsen

EC.733 J D-Lab: Supply Chains
(Same subject as 15.772J)
Prereq: None
U (Fall)
2-2-5
See description under subject 15.772J.
S. C. Graves
EC.743 An Introduction to Green Woodworking
Prereq: None
U (Spring)
1-3-2 [P/D/F]

Students with little or no previous woodworking experience design and build a post and rung stool. Starting with a green (not dried) oak log and using only hand tools, students learn material properties and tool capabilities in the historical context of a 17th-century New England woodworker. Provides the experience of creating a functional stool from basic raw materials as well as insight on life and work in 17th-century New England.
K. Stone

EC.781J D-Lab: Development
(Same subject as 11.472J)
(Subject meets with 11.025J, EC.701J)
Prereq: None
G (Fall)
3-2-7

Issues in international development, appropriate technology and project implementation address 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.782 D-Lab: Information and Communication Technologies for Development (ICT)
(Subject meets with EC.712)
Prereq: None
G (Fall)
2-2-8

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. The first half of term presents an introduction to communication hardware, including antenna design, RFID, Bluetooth, Wi-Fi, and low-power sensors. Second half covers development of mobile phone applications and server communications, as well as system architecture for data collection and mapping. Students work in multidisciplinary teams, collaborating with local community partners. Culminates in a final project to be deployed in the field. Students taking graduate version complete additional assignment related to the term project.
R. Fletcher, A. Smith

EC.786 D-Lab: Waste
(Subject meets with EC.716)
Prereq: None
G (Fall)
3-2-4

Provides a multidisciplinary approach to managing waste in low- and middle-income countries with strategies that diminish greenhouse gas emissions and provide enterprise opportunities for marginalized populations. Studies waste management strategies in cities in Africa, India, and Latin America; examines case studies of collection, recycling, and waste-to-energy businesses developed in low-income settings; and researches public policy that supports sustainable, integrated, solid waste management systems. Student teams develop waste management strategies that culminate in a two-week IAP trip to Nicaragua where students will work with a local NGO and the municipality to assist in the implementation of waste management initiatives. Includes guest speakers and field trips. Students taking graduate version complete additional assignments.
E. McDonald

EC.791 D-Lab: Energy
(Subject meets with EC.711)
Prereq: None
G (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, robust, low-cost systems for generating electrical power. Includes projects such as micro-hydro, solar, or wind turbine generators along with theoretical analysis, design, prototype construction, evaluation and implementation. Students will have the opportunity for an optional spring break site visit to Identify and implement projects. Students taking graduate version complete additional assignments. Enrollment limited by lottery; must attend first class session.

EC.792J Cross-Cultural Investigations: Technology and Development
(Subject meets with EC.702J, 21A.801J, STS.071J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9

See description under subject 21A.839J.
C. Wolley

TEACHING, UROP, INDEPENDENT STUDY

EC.900 Independent Study
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and final report.
Staff

EC.910 Edgerton Center Undergraduate Teaching
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
An opportunity for undergraduates to participate in teaching and tutoring Center subjects and seminars. Students develop one-on-one teaching skills under the supervision of an Edgerton Center instructor.
J. K. Vandiver

EC.980 Edgerton Center Independent Study—Graduate
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged Can be repeated for credit
Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and final report.
J. K. Vandiver
EC.990 Edgerton Center Graduate Teaching
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
An opportunity for graduate students to participate in teaching and tutoring Edgerton Center subjects and seminars. Permission of Edgerton Center staff required.
Staff

EC.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
EC.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Undergraduate research opportunities in the Edgerton Center.
J. K. Vandiver

SPECIAL SUBJECTS

EC.S00–EC.S05 Special Subject at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit
EC.S06–EC.S10 Special Subject at the Edgerton Center
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
EC.S11 Special Subject at the Edgerton Center
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 term, covering a different topic each time. Students can take one or all of the seminars.
J. K. Vandiver
ESG SCIENCE SUBJECTS

Biology

ES.7012 Introductory Biology
Prereq: None
U (Fall)
5-0-7 BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.014, 7.015, 7.016, ES.7013
Equivalent to 7.012; see 7.012 for description. Instruction provided through small, interactive classes. Limited to students in ESG.

ES.5112 Principles of Chemical Science
Prereq: None
U (Spring)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.111, 5.112, CC.5111, ES.3091, ES.5112
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.5111 Principles of Chemical Science
Prereq: None
U (Spring)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.111, 5.112, CC.5111, ES.3091, ES.5112
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.7013 Introductory Biology
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
5-0-7 BIOLOGY
Credit cannot also be received for 7.012, 7.013, 7.014, 7.015, 7.016, ES.7012
Equivalent to 7.013; see 7.012 for description. Instruction provided through small, interactive classes. Limited to students in ESG.
P. Christie

Chemistry

ES.3091 Introduction to Solid-State Chemistry
(Subject meets with 3.091)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
5-0-7 CHEMISTRY
Credit cannot also be received for 5.111, 5.112, CC.5111, ES.5111, ES.5112
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.5112 Principles of Chemical Science
Prereq: None
U (Fall)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.111, 5.112, CC.5111, ES.3091, ES.5111
Equivalent to 5.112; see 5.112 for description. Instruction provided through small, interactive classes taught by ESG staff. Limited to students in ESG.
P. Christie

ES.5111 Principles of Chemical Science
Prereq: None
U (Spring)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.111, 5.112, CC.5111, ES.3091, ES.5112
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

Mathematics

ES.1801 Calculus
Prereq: None
U (Fall)
5-0-7 CALC I
Credit cannot also be received for 18.01, 18.01A, CC.181A, ES.181A
Equivalent to 18.01; see 18.01 for description. Instruction provided through small, interactive classes. Limited to students in ESG.
G. Stoy

ES.1802 Calculus
Prereq: Calculus I (GIR)
U (Fall, Spring)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.02A, CC.182A
Equivalent to 18.02A; see 18.02A for description. Instruction provided through small, interactive classes. Limited to students in ESG.
G. Stoy

ES.1803 Differential Equations
Prereq: None. Coreq: Calculus II (GIR)
U (Fall, Spring)
5-0-7 REST
Credit cannot also be received for 18.03, 18.03A, 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

ES.181A Calculus
Prereq: Knowledge of differentiation and elementary integration
U (Fall)
5-0-7 CALC I
Credit cannot also be received for 18.01, 18.01A, CC.181A
Equivalent to 18.01A; see 18.01A for description. Instruction provided through small, interactive classes. Limited to students in ESG.
J. Orloff

ES.182A Calculus
Prereq: Calculus I (GIR)
U (Fall, IAP)
5-0-7 CALC II
Credit cannot also be received for 18.02, 18.02A, CC.182A
Equivalent to 18.02A; see 18.02A for description. Instruction provided through small, interactive classes. Limited to students in ESG.
J. Orloff

Physics

ES.801 Physics I
Prereq: None
U (Fall)
5-0-7 PHYSICS I
Credit cannot also be received for 8.01, 8.01A, 8.01B, 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
EXPERIMENTAL STUDY GROUP

ES.8012 Physics I
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.801
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

ES.802 Physics II
Prereq: Physics I (GIR), Calculus I (GIR)
U (Spring)
5-0-7 PHYSICS II
Credit cannot also be received for 8.02, 8.021, 8.022, CC.802, ES.8022
Equivalent to 8.02; see 8.02 for description. Instruction done through small, interactive classes. Limited to students in ESG. A. Barrantes

ES.8022 Physics II
Prereq: Physics I (GIR); Coreq: Calculus II (GIR)
U (Fall, Spring)
5-0-7 PHYSICS II
Credit cannot also be received for 8.02, 8.021, 8.022, CC.802, ES.802
Equivalent to 8.02; see 8.02 for description. Students complete individual and group projects; content for the last week of the term is decided by students. Limited to students in ESG. P. Rebusco

ESG WRITING PROGRAM

ES.333J Production of Educational Videos: Skills for Communicating Academic and Professional Content
(Same subject as CMS.333J)
Prereq: None
U (Spring)
3-1-8 HASS-E; CI-H
Develops communication and media skills through the production of educational videos. Students conceive, plan, script, shoot and edit video content to teach elements of MIT’s curriculum. Each student creates a series of short videos that concisely explains and contextualizes specific problems of importance to disciplines at MIT, especially physics, math, chemistry, biology, or the humanities. The resulting videos present these problems through compelling use of illustrations, demonstrations, animations, and commentary, all from the student's perspective. Empowers students specifically to communicate their MIT expertise to communities of learners and generally to reach broad audiences with quality, accessible online content. Preference to students in ESG. D. Custer, G. Ramsay

ES.729 Engineering Communication in Context
(ES.033)
(Same subject as 21W.729J)
Prereq: None
U (Fall)
3-1-8 HASS-E; CI-H
Introduces writing, graphics, meetings, reading, oral presentation, collaboration, and design as tools for product development. Students work in teams to conceive, design, prototype, and evaluate energy-related mechanical engineering products. Instruction focuses on communication tasks that are integral to the design process, including design notebooks, email, informal and formal presentations, meeting etiquette, literature searches, white papers, proposals, and reports. Other assignments address the cultural situation of engineers and engineering in the world at large. Limited to 18; preference to ESG students. D. Custer

ESG SEMINARS

ES.010 Chemistry of Sports: Understanding How Exercise Affects Your Body
Prereq: None
U (Spring)
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 training for and completion of triathlon competition. Students may earn up to 2 PE points during the term by attending supervised triathlon training workouts. Preference to students in ESG. P. Christie, S. Lyons

ES.011 Kitchen Chemistry
Prereq: None
U (Spring)
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 TEACHING AND RESEARCH

ES.200 ESG Undergraduate Teaching
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
An opportunity to assist in the teaching of subjects in ESG in biology, chemistry, humanities and social sciences, mathematics, and physics. Student instructors may be involved in grading, running problem solving sessions, or teaching classes depending on experience and interest. Qualified students may also develop and teach undergraduate seminars under the supervision of an appropriate faculty or staff member. Student instructors meet weekly with staff to discuss their teaching and cover a variety of topics related to effective teaching techniques. Limited to students in ESG. P. Christie, G. Ramsay, G. Stoy

ES.210 ESG Independent Study
Prereq: Permission of instructor
U (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity for independent study under regular supervision by a staff member. Projects require prior approval, as well as a written proposal and a final report. Limited to students in ESG. L. Royden

ES.UR Undergraduate Research in ESG
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For students wishing to pursue undergraduate research opportunities in the Experimental Study Group. Limited to students in ESG. L. Royden

ESG SPECIAL SUBJECTS

ES.510 Special Seminar in Science
Prereq: None
U (Fall)
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Topic for Fall 2014: Drugs and the Brain. Preference to students in ESG. Z. Fallows
ES.S11 Special Seminar in Science
Prereq: None
U (Fall)
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Topic for Fall 2014: There is more to physics than Newton. Preference to students in ESG.
A. Barrantes

ES.S20 Special Seminar in Mathematics
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

ES.S21 Special Seminar in Mathematics
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Preference to students in ESG.

ES.S30 Special Seminar in Engineering and Computer Science
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

ES.S31 Special Seminar in Engineering and Computer Science
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Preference to students in ESG.

ES.S40 Special Seminar in the Humanities
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Preference to students in ESG.

ES.S41 Special Seminar in the Humanities
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Preference to students in ESG.

ES.S50 Special Seminar in the Arts
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

ES.S51 Special Seminar in the Arts
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Preference to students in ESG.

ES.S60 Special Seminar in Social Science
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Preference to students in ESG.

ES.S61 Special Seminar in Social Science
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Preference to students in ESG.

ES.S70 Special Seminar in Interdisciplinary Studies
Prereq: None
U (Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit

ES.S71 Special Seminar in Interdisciplinary Studies
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged [P/D/F]
Can be repeated for credit with permission of instructor
Covers topics not included in the permanent curriculum. May not be used for GIR credit. Preference to students in ESG.

Staff
UNDERGRADUATE

**ESD.01| Transportation Systems Modeling**  
(Same subject as 1.041)  
Prereq: 1.00 or 1.000; 1.010  
U (Spring)  
3-1-8  
See description under subject 1.041].  
C. Osorio

**ESD.03| System Safety**  
(Same subject as 16.63)  
Prereq: None  
U (Spring)  
3-0-9 REST  
Introduces the concepts of system safety and how to analyze and design safer systems. Topics include the causes of accidents in general, and recent major accidents in particular; hazard analysis, safety-driven design techniques; design of human-automation interaction; integrating safety into the system engineering process; and managing and operating safety-critical systems.  
N. Leveson

**ESD.035| Engineering Design and Rapid Prototyping**  
(Same subject as 16.810)  
Prereq: 16.01, 16.02 or 2.001, 2.002 or permission of instructor  
U (IAP)  
2-4-0  
See description under subject 16.810].  
O. de Weck

**ESD.046| Global Environmental Science and Negotiations**  
(Same subject as 12.346)  
Subject meets with 12.846J, ESD.110J  
Prereq: Permission of instructor  
U (Fall)  
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. Students taking graduate version complete additional assignments.  
N. Selin

**ESD.05| Engineering Leadership Lab**  
(Subject meets with ESD.050)  
Prereq: None. Coreq: ESD.054 or permission of instructor  
U (Fall, Spring)  
0-2-1  
Can be repeated for credit  
Exposes students to engineering frameworks, models, and cases in an interactive, experience-based environment, and hones leadership skills. Students participate in guided reflection on successes and discover opportunities for improvement in a controlled setting. Activities include design-implement activities, role-playing, simulations, case study analysis, and performance assessment by and of other students. Content throughout the term is frequently student-driven. First-year GEL Program students register for ESD.05. Second-year GEL Program students register for ESD.050. Preference to first-year students in the Bernard M. Gordon-MIT Engineering Leadership Program.  
L. McGonagle, J. Magarian

**ESD.052| Project Engineering**  
Prereq: ESD.05 or permission of instructor  
U (Spring)  
3-2-1  
Credit cannot also be received for 1.401, ESD.018  
Students attend a four day off-site workshop during IAP where an introduction to basic principles, methods, and tools for project management in a realistic context are covered. Over remainder of term, progresses to an introduction to project management, with emphasis on finance, evaluation, and organization. In teams, students create a plan for a project of their choice; past projects include Debris Removal in Haiti and Food Preparation Robot for Restaurants. Develops skills applicable to the management of complex development projects. Topics include cost-benefit analysis, resource and cost estimation, and project control and delivery. Case studies highlight projects in both hardware/construction and software. Preference to students in the Bernard M. Gordon-MIT Engineering Leadership Program.  
O. de Weck

**ESD.051| Engineering Innovation and Design**  
(Subject meets as 2.723J, 6.902J)  
Prereq: None  
U (Fall, Spring)  
4-0-5  
Project-based seminar in innovative design thinking develops students’ ability to conceive, implement, and evaluate successful projects in any engineering discipline. Lectures focus on the iterative design process and techniques to enhance creative analysis. Students use this process to design and implement robust voice recognition applications using a simple web-based system. They also give presentations and receive feedback to sharpen their communication skills for high emotional and intellectual impact. Guest lectures illustrate multidisciplinary approaches to design thinking. Limited to 60.  
B. Kotelly

**ESD.050| Engineering Leadership Lab**  
Subject meets with ESD.050  
U (Fall, Spring)  
0-2-1  
Can be repeated for credit  
Exposes students to engineering frameworks, models, and cases in an interactive, experience-based environment, and hones leadership skills. Students participate in guided reflection on successes and discover opportunities for improvement in a controlled setting. Activities include design-implement activities, role-playing, simulations, case study analysis, and performance assessment by and of other students. Content throughout the term is frequently student-driven. First-year GEL Program students register for ESD.05. Second-year GEL Program students register for ESD.050. Preference to first-year students in the Bernard M. Gordon-MIT Engineering Leadership Program.  
L. McGonagle, J. Magarian

**ESD.051J| Engineering Innovation and Design**  
Prereq: ESD.05 or permission of instructor  
U (Fall, Spring)  
4-0-5  
Project-based seminar in innovative design thinking develops students’ ability to conceive, implement, and evaluate successful projects in any engineering discipline. Lectures focus on the iterative design process and techniques to enhance creative analysis. Students use this process to design and implement robust voice recognition applications using a simple web-based system. They also give presentations and receive feedback to sharpen their communication skills for high emotional and intellectual impact. Guest lectures illustrate multidisciplinary approaches to design thinking. Limited to 60.  
B. Kotelly

**ESD.052| Project Engineering**  
Prereq: ESD.05 or permission of instructor  
U (Spring)  
3-2-1  
Credit cannot also be received for 1.401, ESD.018  
Students attend a four day off-site workshop during IAP where an introduction to basic principles, methods, and tools for project management in a realistic context are covered. Over remainder of term, progresses to an introduction to project management, with emphasis on finance, evaluation, and organization. In teams, students create a plan for a project of their choice; past projects include Debris Removal in Haiti and Food Preparation Robot for Restaurants. Develops skills applicable to the management of complex development projects. Topics include cost-benefit analysis, resource and cost estimation, and project control and delivery. Case studies highlight projects in both hardware/construction and software. Preference to students in the Bernard M. Gordon-MIT Engineering Leadership Program.  
O. de Weck
ESD.054 Engineering Leadership
Prereq: None. Coreq: ESD.05 or permission of instructor
U (Fall, Spring)
1-0-2
Can be repeated for credit once with permission of instructor

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 Four 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 and team projects that change from term to term. Preference to first-year students in the Gordon Engineering Leadership Program.

J. Schindall, L. McGonagle, R. Schuhmann

ESD.07J Statistical Thinking and Data Analysis
(Same subject as 15.075J)
Prereq: 6.041
U (Fall)
4-0-8
See description under subject 15.075J.

C. Rudin

ESD.08J Science, Technology, and Public Policy
(Same subject as 17.309J, STS.082J)
(Same subject as 17.309J, ESD.103J, STS.482J)
Prereq: None
U (Fall)
4-0-8 HASS-S; CI-H
See description under subject 17.309J.

K. Oye

ESD.10J Science, Technology, and Public Policy
(Same subject as 17.310J)
(Subject meets with 17.309J, ESD.082J, STS.082J)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit

See description under subject 17.310J.

K. Oye

ESD.110J Global Environmental Science and Negotiations
(Same subject as 12.846J)
(Subject meets with 12.346J, ESD.046J)
Prereq: None
G (Fall)
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. Students taking graduate version complete additional assignments.

N. Selin

ESD.120J Sustainability Science and Engineering
(Same subject as 12.845J)
Prereq: None. Coreq: ESD.83 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.124 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.125 Mapping and Evaluating New Energy Technologies
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Project-based seminar covers recent developments in energy conversion and storage technologies. Merits of alternative technologies are debated based on their environmental performance and cost, and their potential improvement and scalability. Project teams develop quantitative models and interactive visualization tools to inform the future development of these technologies. Models may probe how the impact of a technology depends on assumptions about future advancements in materials or device design. Other projects may develop models for rational design choices (the selection of a particular material or processing technique) based on economic and environmental performance and physical constraints.

J. Trancik

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; permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-6

See description under subject 15.023J.

R. G. Prinn
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.
Staff

ESD.132 Law, Technology, and Public Policy
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 climate change; genetic engineering; telecommunications; industrial automation; the effect of health, safety, and environmental regulation on technological innovation; the impacts of intellectual property law on innovation and equity; pharmaceuticals; nanotechnology; cost/benefit analysis as a decision tool; public participation in governmental decisions affecting science and technology; corporate influence on technology; and law and economics as competing paradigms to encourage sustainability. Permission of instructor required for freshmen and sophomores.
N. Ashford, C. Caldart

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. Ashford, 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: 1.811 or permission of instructor
G (Spring)
Not offered regularly; consult department
3-0-9 H-LEVEL Grad Credit
See description under subject 1.812J.
N. Ashford, 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)
Not offered regularly; consult department
3-0-6 H-LEVEL Grad Credit
See description under subject 10.805J.
N. A. Ashford, C. C. Caldart

ESD.137J Technology, Globalization, and Sustainable Development
(Same subject as 1.813J, 11.466J, 15.657J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Investigates sustainable development, taking a broad view to include not only a healthy economic base, but also a sound environment, stable employment, adequate purchasing power, distributional equity, national self-reliance, and maintenance of cultural integrity. Explores national, multinational, and international political and legal mechanisms to further sustainable development through transformation of the industrial state. Addresses the importance of technological innovation and the financial crisis of 2008.
N. Ashford

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

ESD.162J Engineering, Economics and Regulation of the Electric Power Sector
(Same subject as 6.695S, 15.032J)
Prereq: Permission of instructor
G (Spring)
3-2-7 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. Topics include electricity markets, incentive regulation of network issues, retail competition, tariff design, distributed generation, rural electrification, multinational electricity markets, environmental impacts, future of utilities and strategic sustainability issues under both traditional and competitive regulatory frameworks. Background in policy, microeconomics, or engineering required.
I. Perez-Arriaga, C. Knittel

ESD.163J Managing Nuclear Technology
(Same subject as 22.812J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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.191J Urban and Regional Economics
(Same subject as 1.283J, 11.410J, 14.573J)
(Subject meets with 14.51)
Prereq: 14.04, 14.32
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 14.573J.
Consult W. Wheaton
ESD.192J Analyzing and Accounting for Regional Economic Change
(Same subject as 1.284J, 11.481J)
Prereq: 14.03, 14.04
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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, C. Osorio

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.
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 2014–2015: Not offered
Acad Year 2015–2016: 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.222J Transportation Policy, the Environment, and Livable Communities
(Same subject as 1.253J, 11.543J)
Prereq: 11.543J
G (Fall)
See description under subject 1.253J.
J. Coughlin

ESD.224J Planning and Design of Airport Systems
(Same subject as 1.231J, 16.781J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.
Staff

ESD.226J Public Transportation Systems
(Same subject as 1.253J, 11.543J)
Prereq: 1.201 or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 1.258J.
Staff

ESD.250 Analytical Methods for Supply Chain Management
Prereq: None
G (Fall; partial term)
3-0-3
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 students in the SCM program.
B. Arntzen, J. Goentzel, C. Caplice, E. Blanco

ESD.251 Supply Chain Finance
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 corporate finance. Emphasizes how the supply chain creates value for both the shareholders of the company and for the stakeholders affected by the company’s operations. Sessions combine lectures and data-rich cases from the manufacturer, distributor, and retailer perspective. Topics include accounting fundamentals, financial analysis, activity-based costing, working capital management, cash flow projections, capital budgeting, and sustainability.
J. Goentzel, J. Rice

ESD.259J Business Writing for Supply Chain Management (New)
(Same subject as 21W.800J)
Prereq: None
G (Fall)
1-0-2
Focuses on analyzing and tailoring content for specific audiences, developing argumentation and persuasion skills, and writing clear, concise and well-structured documents (business letters, memos, executive summaries, and briefings). Covers business writing techniques and strategies through lectures and exercises, individual writing assignments, and peer reviewed workshops. In preparation for the master's thesis requirement, students create problem statements, as well as research, write and revise a literature review. Restricted to students in the SCM program.
L. Myka, B. Arntzen
ESD.260J Logistics Systems  
(Same subject as 1.260J, 15.770J)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
Provides an introduction to supply chain management from both analytical and practical perspectives. Taking a unified approach, students develop a framework for making intelligent decisions within the supply chain. Covers key logistics functions, such as demand planning, procurement, inventory theory and control, transportation planning and execution, reverse logistics, and flexible contracting. Explores concepts such as postponement, portfolio management, and dual sourcing. Emphasizes skills necessary to recognize and manage risk, analyze various tradeoffs, and model logistics systems.  
Y. Sheffi, 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)  
2-0-6 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.260 or permission of instructor  
G (IAP)  
2-0-7  
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.  
B. Arntzen, C. Caplice

ESD.263 Thesis Writing for Supply Chain Management  
Prereq: None  
G (Spring)  
2-0-1 [P/D/F]  
Instruction provided on writing a thesis, including technical writing and presentation skills.

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.  
Staff

ESD.265J Global Supply Chain Management  
(Same subject as 1.265J, 2.965J, 15.765J)  
Prereq: 1.260, 1.261, 15.761, 15.778, or permission of instructor  
G (Spring)  
2-0-4 H-LEVEL Grad Credit  
See description under subject 2.965J.  
B. Arntzen

ESD.266 Freight Transportation  
Prereq: ESD.260  
G (Spring; second half of term)  
2-0-4 H-LEVEL Grad Credit  
Provides an in-depth introduction to the fundamental concepts and techniques related to the design, procurement, and management of freight transportation. Examines freight transportation as a bridging function for a firm, considering the physical flow of raw materials and finished goods as well as connections to suppliers and customers. Also covers how freight transportation insulates a firm’s core operations from external disruptions and variability of supply and demand.  
C. Caplice, Y. Sheffi

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

ESD.268J Manufacturing System and Supply Chain Design  
(Same subject as 1.274J, 15.763J)  
Prereq: 1.260, 15.761, or 15.778  
G (Spring)  
2-0-4 H-LEVEL Grad Credit  
See description under subject 15.763J.  
S. C. Graves, D. Simchi-Levi

ESD.269 Supply Chain Risk Management  
Prereq: None  
G (Spring)  
3-0-9  
Ways to develop effective and innovative strategies for risk mitigation are introduced. Also covered are identifying methods for the enterprise to respond to disruptions that may effect its business eco-system and the larger economy. Teaches ways to apply the SCRM framework in industrial practice.  
Y. Sheffi, J. Rice

ESD.270 Studies in Transportation  
Prereq: Permission of instructor  
G (Fall, Spring, Summer)  
Units arranged [P/D/F]  
Can be repeated for credit  
Individual advanced study of a topic in transportation systems, selected with the approval of the instructor.  
Consult B. Arntzen

ESD.271 Research Seminar in Transportation  
Prereq: Permission of instructor  
G (Fall, IAP, 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.  
Consult B. Arntzen

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

ESD.278J Managing Sustainable Businesses for People and Profits  
(Same subject as 11.383J, 15.662J)  
Prereq: None  
G (Spring)  
3-6-3  
See description under subject 15.662J.  
T. Kochan
ESD.283 Humanitarian Logistics  
(Subject meets with ESD.284)  
Prereq: None  
G (Spring)  
2-0-4  
Explores how logistics management principles apply in dynamic, resource-constrained contexts, ranging from humanitarian crisis response to international development. Class sessions combine interactive presentations, practical exercises, case discussions, and guest speakers from humanitarian organizations. Provides an introduction to supply chain concepts and the humanitarian context to accommodate students from various backgrounds.

J. Goentzel

ESD.284 Humanitarian Logistics Project  
(Subject meets with ESD.283)  
Prereq: None  
G (Spring)  
2-0-7  
Explores how logistics management principles apply in dynamic, resource-constrained contexts, ranging from humanitarian crisis response to international development. Class sessions combine interactive presentations, practical exercises, case discussions, and guest speakers from humanitarian organizations. Provides an introduction to supply chain concepts and the humanitarian context to accommodate students from various backgrounds. Team projects utilize data and information from the UN, NGOs, government agencies, and the private sector.

J. Goentzel

ESD.30J Engineering Apollo: The Moon Project as a Complex System  
(Subject same as 16.895J, STS.471J)  
Prereq: Permission of instructor  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
4-0-8 H-LEVEL Grad Credit  
See description under subject STS.471J.

D. Mindell

ESD.301 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.31 SDM Leadership: The Missing Link  
Prereq: ESD.34, 15.905/15.965, participation in SDM IAP session, as well as SDM Spring and Summer business trips  
G (Fall; partial term)  
3-0-3  
Hands-on experience blends theory and practice. Curriculum is integrated into the first year of the SDM program. Students reflect on prior leadership experiences and then apply concepts presented during seminars to further develop their leadership capabilities.

J. Williams, A. Sanchez

ESD.32J Product Design and Development  
(Subject same as 2.739J, 15.783J)  
Prereq: 2.009, 15.761, 15.778, 15.810, or permission of instructor  
G (Spring)  
3-3-6 H-LEVEL Grad Credit  
Credit cannot also be received for 15.735, ESD.40  
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.341J Architecting and Engineering Software Systems  
(Subject same 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.

R. de Neufville

ESD.344 Real Options for Product and Systems Design  
(Subject same as 16.886J)  
Prereq: Permission of instructor  
G (Fall)  
3-2-7 H-LEVEL Grad Credit  
See description under subject 16.886J.

R. J. Hansman

ESD.351J Air Transportation Systems Architecting  
(Subject same as 16.89J)  
Prereq: 16.851, 16.892, or permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
4-2-6 H-LEVEL Grad Credit  
See description under subject 16.89J.

J. A. Hoffman

ESD.355J Concepts in the Engineering of Software  
(Subject same as 16.355J)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit  
See description under subject 16.355J.

N. G. Leveson
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.

D. Nightingale, D. Rhodes

Principles and practices used in systems architecting are presented, adapted and extended to design a future architecture for an enterprise undergoing change. Uses case-based exercises and examples. Team projects investigate a real-world enterprise from multiple perspectives and apply architecting and design techniques. Topics include theories, frameworks, and methods for generating and evaluating alternative architectures, selecting a preferred future state architecture, and developing implementation strategies.

D. Nightingale, D. Rhodes

Focuses on the practical means for integrating leadership and systems and engineering approaches to solve real-world problems. In addition to classroom learning and exercises, students work one day a week with the top management of a high-tech business on a relevant systems and management challenge. The host company sets the project focus. Project teams of four to six students help to solve a problem that is of concern to the host company. Limited to SDM fellows.

M. Davies

ESD.40 Product-System Design
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
Credit cannot also be received for 2.739, 15.735, 15.783, ESD.32

Modern tools and methods for product design and development. Teams conceive, design, and prototype a physical product. Cases and exercises reinforce key ideas. Topics include product planning, identifying customer needs, concept generation/selection, project architecture, industrial design, concept design, and design-for-manufacturing. Preference to SDM students.

M. Yang, P. Hale

ESD.411 Foundations of System Design and Management (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit

Presents the foundations of systems architecture, systems engineering and project management in an integrated format, through a synchronized combination of in-class discussion, industrial guest speakers, team projects, and individual assignments. Topics include stakeholder analysis, project planning and monitoring, requirements definition, concept generation and selection, complexity management, system integration, verification and validation, cost modeling, systems safety, organizational design and effective teamwork, risk management, and leadership styles. Restricted to students in the SDM program.

O. de Weck

ESD.50J Software and Computation for Simulation
(Same subject as 1.124J, 2.091J)
Prereq: 1.00 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.56J Digital Evolution: Managing Web 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.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.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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 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.515J)
Prereq: 16.400, 16.06, 16.060, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-1-8 H-LEVEL Grad Credit
See description under subject 16.423J.
D. J. Newman

ESD.69J Seminar on Health Care Systems Innovation
(Same subject as HST.926J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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. Moses, J. Coughlin

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
See description under subject 15.136J.
T. J. Allen, C. L. Cooney, S. N. Finkelstein, A. J. Sinskey, G. K. Raju

ESD.70J Engineering Economy Module
(Same subject as 1.145J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 decision 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, ESD.71J)
Prereq: 1.145 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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
(Offered under: 1.146, 16.861J, ESD.71J)
Prereq: 1.145 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 analysis; 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.
R. de Neufville, M. Webster

ESD.712 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. Geltner, R. de Neufville

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, R. E. 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. E. Welsch

ESD.755J Predictive Data Analytics and Statistical 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
(See description under subject 16.470J)
Prereq: 6.041, 16.09, or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.470J.
L. A. Stirling

ESD.762 Systems Optimization
Prereq: 1.145 or permission of instructor
G (Spring; first half of term)
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.
Staff

ESD.763 Operations and Supply Chain Management
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Summer; partial term)
3-0-3 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. Preference to SDM students.
Staff

ESD.771J Multidisciplinary System Design Optimization
(See description under subject 16.888J)
Prereq: 18.085 or permission of instructor
G (Spring)
3-1-8 H-LEVEL Grad Credit
O. de Weck, K. E. Willcox

ESD.773J Human Factors Engineering
(See description under subject 16.453J)
Prereq: meets with 16.400
Acad Year 2014–2015: G (Fall)
1-1-8 H-LEVEL Grad Credit
See description under subject 16.453J.
L. A. Stirling

ESD.774J Human Supervisory Control of Automated Systems
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
2-3-0 H-LEVEL Grad Credit
See description under subject 16.422J.
J. A. Shah

ESD.775J Human-Computer Interface Design Colloquium
(See description under subject 16.422J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
2-0-2 H-LEVEL Grad Credit
See description under subject 16.475J.
Staff

ESD.776J Human Computer Interface Design
Prereq: 15.081 or permission of instructor
G (Fall; partial term)
2-0-1 H-LEVEL Grad Credit
See description under subject 16.422J.
O. de Weck, K. E. Willcox

ESD.780 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.
J. Clark

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, and to take advantage of leadership opportunities. An initial Outward Bound experience builds trust, teamwork and communications. Readings and assignments emphasize the characteristics of desired leadership skills. Global leaders participate in the Leadership Lunch series to share their experiences and recommendations. Discussions explore leadership development. Culminates in a personal leadership plan. Restricted to entering students in the Technology and Policy program or instructor permission.
F. Field

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. Hole

ESD.803 Supply Chain Leadership Workshop
Prereq: None
G (Fall; partial term)
2-0-1 [P/D/F]
Designed to enhance your ability to manage and lead in challenging times through a series of self assessment instruments, case studies, and workshops. The objectives are to increase awareness of your strengths and weaknesses as a leader, provide a battery of instruments and surveys to help one understand the way one operates in an organizational setting, and offer strategies and tips on how to leverage one’s strengths and work on areas in need of development. Restricted to students in the SCM program.
Information: B. Arntzen

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: 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. Focuses on analysis of scholarship on key concepts such as complexity, uncertainty, fragility, and robustness, as well as a critical look at the historical roots of the field and related areas such as systems engineering, systems dynamics, agent modeling, and systems simulations. Contextual applications range from aerospace to technology implementation to regulatory systems to large-scale systems change. Special attention to the interdependence of social and technical dimensions of engineering systems. Restricted to students enrolled in ESD doctoral program.
C. Magee, J. Sussman

ESD.86j) Models, Data and Inference for Socio-Technical Systems
(Same subject as 15.078j)
Prereq: ESD.83, 6.041, or permission of instructor
G (Spring)
3-0-9

Use data and systems knowledge to build models of complex socio-technical systems for improved system design and decision-making. Enhance model-building skills, including: review and extension of functions of random variables, Poisson processes, and Markov processes. Move from applied probability to statistics via Chi-squared t and f tests, derived as functions of random variables. Review classical statistics, hypothesis tests, regression, correlation and causation, simple data mining techniques, and Bayesian vs. classical statistics. Class project.
R. Larson, R. Welsch

ESD.863j) System Safety Concepts
(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.864J) Modeling and Assessment for Policy
(Same subject as 12.844J)
Prereq: ESD.10 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit
Explores how scientific information and quantitative models can be used to inform policy decision-making. Develops an understanding of quantitative modeling techniques and their role in the policy process through case studies and interactive activities. Addresses issues such as analysis of scientific assessment processes, uses of integrated assessment models, public perception of quantitative information, methods for dealing with uncertainties, and design choices in building policy-relevant models. Examples focus on models and information used in Earth system governance.
Staff

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

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.
Information: R. Larson

ESD.911–ESD.913 Independent Study in Engineering Systems
Prereq: Permission of instructor
G (Fall, IAP, Spring)
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.
Information: R. Larson

ESD.921 Teaching in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring)
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: R. Larson

ESD.921 Teaching in Engineering Systems Division
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Opportunity for study of 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.
Information: R. Larson

ESD.910–ESD.922 Special Graduate Subject in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
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.
Information: R. Larson
ESD.S30–ESD.S31 Special Graduate Studies in Engineering Systems Division
Prereq: None
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity for individual or group 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.
Information: R. Larson

ESD.S40–ESD.S43 Special Graduate Studies in Engineering Systems Division
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged H-LEVEL Grad Credit
Can be repeated for credit
Opportunity for individual or group 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.
Information: R. Larson

ESD.S50, ESD.S51 Special Graduate Studies in Engineering Systems Division
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 individual or 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: R. Larson

ESD.THG ESD 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 with a member of the ESD faculty. A minimum of 24 thesis units are required for the SM degree.
Information: R. Larson

ESD.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Undergraduate research opportunities in Engineering Systems.
Information: R. Larson
Enrollment restricted to graduate students.

Organ system research. Only HST students may register under HST.010, graded P/D/F. Lab fee.

Lecturers focus on current problems in genes responsible for normal and abnormal stress both normal and abnormal functions of the body and present evolving knowledge of the body and respond to stress and fracture, calcium and phosphate homeostasis and regulations by parathyroid hormone and vitamin D, and the pathogenesis of metabolic bone diseases and disease of connective tissue, joints, and muscles, with consideration of possible mechanisms and underlying metabolic derangements. Only HST students may register under HST.020, graded P/D/F. Enrollment limited; restricted to medical and graduate students.

M. Bouxsein, M. Seton

HST.034, graded P/D/F. Credit cannot also be received for HST.030, HST.035

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.

R. Drapkin

HST.035 Principles and Practice of Human Pathology
(Subject meets with HST.034)
Prereq: 7.05; or permission of instructor
G (Spring)
4-2-10 H-LEVEL Grad Credit

Credit cannot also be received for HST.030, HST.031

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 prosections provide a thorough exploration of the gross structure and function of the human body. Fundamental principles of bioengineering are employed to promote analytical approaches to understanding the body’s design. The embryology of major organ systems is presented, together with certain references to phylogenetic development, as a basis for comprehending anatomical complexity. Correlation clinics stress both normal and abnormal functions of the body and present evolving knowledge of genes responsible for normal and abnormal anatomy. Lecturers focus on current problems in organ system research. Only HST students may register under HST.010, graded P/D/F. Lab fee. Enrollment restricted to graduate students.

L. Gehrke

HST.011 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 biophysics of bone and response to stress and fracture, calcium and phosphate homeostasis and regulation by parathyroid hormone and vitamin D, and the pathogenesis of metabolic bone diseases and disease of connective tissue, joints, and muscles, with consideration of possible mechanisms and underlying metabolic derangements. Only HST students may register under HST.020, graded P/D/F. Enrollment limited; restricted to medical and graduate students.

M. Bouxsein, 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)
4-3-8 H-LEVEL Grad Credit

Credit cannot also be received for HST.034, HST.035

Introduction to the functional structure of normal cells and tissues, pathologic principles of cellular adaptation and injury, inflammation, circulatory disorders, immunologic injury, infection, genetic disorders, and neoplasia in humans. Lectures, conferences emphasizing clinical correlations and contemporary experimental biology. Laboratories with examination of microscopic and gross specimens, and autopsies provide a thorough exploration of the gross structure and function of the human body. Fundamental principles of bioengineering are employed to promote analytical approaches to understanding the body’s design. The embryology of major organ systems is presented, together with certain references to phylogenetic development, as a basis for comprehending anatomical complexity. Correlation clinics stress both normal and abnormal functions of the body and present evolving knowledge of genes responsible for normal and abnormal anatomy. Lecturers focus on current problems in organ system research. Only HST students may register under HST.010, graded P/D/F. Lab fee. Enrollment restricted to graduate students.

R. Mitchell, R. Padera

HST.035 Principles and Practice of Human Pathology
(Subject meets with HST.034)
Prereq: 7.05; or permission of instructor
G (Spring)
4-2-10 H-LEVEL Grad Credit

R. Drapkin

HST.041 Mechanisms of Microbial Pathogenesis
(Subject meets with HST.040)
Prereq: Biology (GIR), 7.05, permission of instructor
G (Fall)
3-3-6 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, D. Breault

HST.071 Human Reproductive Biology
(Subject meets with HST.070)
Prereq: 7.05, permission of instructor
G (Fall; first half of term)
4-0-2 H-LEVEL Grad Credit

Lectures and clinical case discussions designed to provide the student with a clear understanding of the physiology, endocrinology, and pathology of human reproduction. Emphasis is on the role of technology in reproductive science. Suggestions for future research contributions in the field are probed. Students become involved in the wider aspects of reproduction, such as prenatal diagnosis, in vitro fertilization, abortion, menopause, contraception and ethics relative to reproductive science. Only HST students may register under HST.070, graded P/D/F.

A. Koniaris, J. Yeh

HST.081 Hematology
(Subject meets with HST.080)
Prereq: 7.05, permission of instructor
G (Spring; second half of term)
3-6-3 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.

H. F. Bunn, N. Berliner

HST.091 Cardiovascular Pathophysiology
(Subject meets with HST.090)
Prereq: HST.030 or HST.031; permission of instructor
G (Spring)
4-3-8 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.

E. Edelman

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 pathological mechanisms. Use of medical ventilators is discussed in lecture and in laboratory experiences. For MD candidates and other students with background in science. Only HST students may register under HST.100, graded P/D/F. Enrollment limited.

J. Drazen, S. Loring

HST.111 Renal Pathophysiology
(Subject meets with HST.110)
Prereq: 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, A. Lam

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)
3-1-2 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.

A. Rutherford, S. Flier

HST.131 Neuroscience
(Subject meets with HST.130)
Prereq: Permission of instructor
G (Fall)
6-3-6 H-LEVEL Grad Credit

Comprehensive study of neuroscience where students explore the brain on levels ranging from molecules and cells through neural systems, perception, memory, and behavior. Includes some aspects of clinical neuroscience, within neuropharmacology, pathophysiology, and neurology. Lectures supplemented by conferences and labs. Labs review neuroanatomy at the gross and microscopic levels. Only HST students may register under HST.130, graded P/D/F. Limited to 50.

J. Assad, M. Frosch

HST.141 Molecular Medicine (New)
Prereq: 7.05
G (Fall)
2-0-4

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. Students 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; partial term)
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. Students must register for both Fall and IAP sections. 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)
6-0-6 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

HST.161 Molecular Biology and Genetics in Modern Medicine
Prereq: 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.
K. Musunuru

HST.176 Cellular and Molecular Immunology
(Subject meets with HST.175)
Prereq: 7.05
G (Fall)
5-0-7 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.

S. Pillai, B. Cherayil

HST.182 Introduction to Biostatistics and Epidemiology
(Subject meets with HST.181)
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.182, graded P/D/F. Enrollment limited; restricted to medical and graduate students.

R. Betensky, M. Hernandez

HST.147 Human Biochemistry and Metabolic Diseases
(Subject meets with HST.146)
Prereq: Permission of instructor
G (Fall, IAP; partial term)
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. Students must register for both Fall and IAP sections. 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)
6-0-6 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

HST.161 Molecular Biology and Genetics in Modern Medicine
Prereq: 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.
K. Musunuru

HST.176 Cellular and Molecular Immunology
(Subject meets with HST.175)
Prereq: 7.05
G (Fall)
5-0-7 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.

S. Pillai, B. Cherayil

HST.182 Introduction to Biostatistics and Epidemiology
(Subject meets with HST.181)
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.182, graded P/D/F. Enrollment limited; restricted to medical and graduate students.

R. Betensky, M. Hernandez

HST.192 Medical Decision Analysis and Probabilistic Medical Inference
Prereq: Permission of instructor; HST.191 recommended
G (IAP)
2-0-2 P/D/F

Teaches the essentials of quantitative diagnostic reasoning and medical decision analysis. Guides participants through the process of choosing an appropriate contemporary medical problem in which risk-benefit tradeoffs play a prominent role, conducting a decision analysis, and ultimately publishing the results in a medical journal. Topics include decision trees, influence diagrams, Markov decision models and Monte Carlo simulation, methods for quantifying patient values, Bayesian inference, decision thresholds, and the cognitive science of medical decision making. Limited to 8; preference to HST students

M. B. Westover, M. Bianchi, S. Cash

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. S. Pillai, R. L. Maas, S. P. Balk, M. L. Bulyk, A. Rosenzweig
HST.200 Introduction to Clinical Medicine
Prereq: Permission of instructor
G (Spring)
0-19-12 [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 are exposed to clinical problems in medicine, surgery, and pediatrics in groups of two or three students under one faculty member. Findings are 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 (Summer)
0-20-0 [P/D/F] H-LEVEL Grad Credit

Develop skills in patient interviewing and physical examination; become proficient at organizing and communicating clinical information in both written and oral forms; begin integrating history, physical, and laboratory data with pathophysiological 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, 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.

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.

HST Faculty

HST.211 Biomedical Inventions: Clinical Introduction
Prereq: Permission of instructor
G (IAP)
3-0-3 H-LEVEL Grad Credit

Provides students with an understanding of modern biomedicine. Explores the clinical areas where medical practice and biomedical enterprise intersect. Hear and interact with academic physicians engaged in care and treatment of patients, in the wards, ICUs, ORs and outpatient areas, and develop the knowledge base needed to obtain elective clinical experiences. Learn to interact with patients and clinicians. Focus is on the various needs of medical specialties, both device, IT and Pharma to better treat common medical diseases.

W. Zapol, R. Anderson

HST.212 Biomedical Inventions: Clinical Experience and Selected Success Analysis
Prereq: HST.211
G (Spring)
3-0-3 H-LEVEL Grad Credit

Provides students with a survey of key biomedical research needs by lecture-discussions and facilitating interaction with academic-clinicians and scientists active in medical care/research. Both drug and technology development in the various medical and surgical specialties are examined. Students develop the knowledge base needed to obtain elective clinical experiences. Unsolved clinical problems are sought by each student in a biomedical area of their interest and presented to the class. Interactions with academic physicians who have successfully developed technologies and drugs that are approved by the FDA and in widespread clinical use. How, where, when and why biomedical enterprise and medical practice can successfully intersect is explored. Students can interact with academic physicians engaged in the development of novel technology and drugs, analyze successes and autopsy failed biomedical enterprises.

W. Zapol, R. Anderson

HST.220 Introduction to the Care of Patients
Prereq: Permission of instructor
G (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: 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.

E. Edelman

HST.299 Research in Health Sciences and Technology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F]

For research assistants in HST where the assigned research is approved for academic credit by the department. Hours are arranged with research supervisor. Restricted to HST MD students in clinical phase of program.

HST Staff
HST.410J Projects in Microscale Engineering for the Life Sciences
(Same subject as 6.07J)
Prereq: None
U (Spring)

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.450J Biological Physics
(Same subject as 8.593J)
Prereq: 8.044 recommended but not necessary
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit


M. Kardar, L. Mirny

HST.460J Statistics for Neuroscience Research
(Same subject as 9.073J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9

See description under subject 9.073J.

E. N. Brown

HST.500J 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
G (IAP)
Not offered regularly; consult department
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)
Prereq: Biology (GIR); 18.440 or 6.041
G (Spring)
3-0-9 H-LEVEL Grad Credit

See description under subject 6.874J.

D. K. Gifford, T. S. Jaakkola

HST.507J Advanced Computational Biology: Genomes, Networks, Evolution
(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

See description under subject 6.878J.

M. Kellis

HST.508 Quantitative Genomics
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

Provides in-depth quantitative understanding of evolutionary and population genetics, comparative and clinical genomics. Each module consists of a series of lectures, a journal club discussion of high impact publications, and lectures that provide clinical correlates. Homework assignments and final projects aim to develop understanding of genomic data from evolutionary principles.

L. Mirny, G. Kryukov, S. Sunyaev

HST.509 Computational and Functional Genomics
Prereq: Permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit

Experimental functional genomics and proteomics; DNA and protein sequence analysis; cellular regulatory networks; phenotypic analysis; human genetic variation. Primarily critical reading and discussion. Molecular biology, solid understanding of basic probability and statistics recommended. Follows Harvard FAS calendar.

M. L. Bulyk, S. R. Sunyaev, S. Gaudet

HST.510 Genomics and Computational Biology
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: 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 multi-disciplinary 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 16.430)
Prereq: Neuroscience or systems engineering or permission of instructor
G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 16.430).
L. Young, C. Oman

HST.515J Aerospace Biomedical and Life Support Engineering
(Same subject as 16.423), ESD.65J)
Prereq: 16.400, 16.06, 16.060, or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-1-8 H-LEVEL Grad Credit
See description under subject 16.423).
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.

C. A. Creisler

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 key biological concepts; biofunctional/bioactive materials, drug delivery, and pertinent advances in nanotechnology; technical issues in design, development, fabrication and clinical evaluation; novel research directions and applications of materials to medicine; and ethical, economic and regulatory considerations.

F. J. Schoen, A. Khademhosseini

HST.522J Biomaterials: Tissue Interactions
(Same subject as 2.79J, 3.96J, 20.441J)
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 20.441).
I. V. Yannas, M. Spector

HST.523J Cell-Matrix Mechanics
(Same subject as 2.785J, 3.97J, 20.411J)
Prereq: 2.001, or 2.01 and 2.02A; Chemistry (GIR), Biology (GIR); or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
See description under subject 2.785).
I. V. Yannas, M. Specto

HST.524J Design of Medical Devices and Implants
(Same subject as 2.782), 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 2.782).
I. V. Yannas, M. Specto

HST.525J Tumor Pathophysiology and Transport Phenomena: A Systems Biology Approach
(Same subject as 10.548J)
Prereq: 18.03; 10.301
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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, evolutionary (Darwinian) principles, and complexity theory. Knowledge of introductory biology or physiology, and biochemistry or molecular biology required.

W. Aird, G. Garcia-Cardena

HST.531 Medical Physics of Proton Radiation Therapy
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.

J. Unkelback, J. Schuemann
HST.535 Principles and Practice of Tissue Engineering
Prereq: None
G (Spring)
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 studies. All sessions are webcast to the world and archived for open access review at any time.
M. Spector

HST.540J 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.541J Cellular Biophysics
(Same subject as 2.794J, 6.521J, 20.470J)
(Same subject 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
Meets with undergraduate subject 6.021J. Requires the completion of more advanced home problems and/or an additional project.
D. M. Freeman, J. Han, T. Heldt, J. Voldman, M. F. Yanik

HST.542J Quantitative Systems Physiology
(Same subject as 2.792J, 6.022J, 20.371J)
(Same subject 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.
T. Heldt, R. G. Mark, C. M. Stultz

HST.543 Cardiac Biophysics
Prereq: 6.021
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9 H-LEVEL Grad Credit
In depth review of contemporary theories in the physics of the heart. Overview of cardiac physiology, including an in depth examination of cardiac excitation and excitation-contraction coupling. Cardiac membrane channels, the action potential (Hodgkin-Huxley and Luo-Rudy models), and action potential propagation (cable and bidomain models). Arrhythmias, drugs, and defibrillation. Relies heavily on the current literature in the field. Follows Harvard FAS schedule.
K. K. Parker

HST.544J Fields, Forces, and Flows in Biological Systems
(Same subject as 2.795J, 6.561J, 10.539J, 20.430J)
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, R. D. Kamm

HST.545J Physiological Systems Analysis
Prereq: 18.03, 18.06
U (Fall)
3-3-6
D. M. Merfeld

HST.546J Radiation Biophysics
(Same subject as 22.55J)
(Same subject with 22.055)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.55J.
Staff

HST.547J Imaging and Sample Processing in Biology and Medicine
Prereq: Biology (GIR), 5.12; or permission of instructor
G (Fall)
3-1-8
Discusses basic principles and concepts of bioimaging and sample processing. Topics include optical imaging modalities; optical/physical/chemical properties of a broad range of biological samples, including clinical tissues and sample handling-processing technologies; underlying engineering principles; and basic image analysis. Provides experience with optical microscopy and tissue processing technique (CLARITY). Limited to 15.
K. Chung

HST.548J Imaging Biophysics and Clinical Applications
Prereq: 18.03, 8.03; or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
2-1-9 H-LEVEL Grad Credit
Introduction to the connections and distinctions among various imaging modalities (x-ray, optical, ultrasound, MRI, PET, SPECT, EEG), common goals of biomedical imaging, broadly defined target of biomedical imaging, and the current practical and economic landscape of biomedical imaging research. Emphasis on applications of imaging research. Final project consists of student groups writing mock grant applications for biomedical imaging research project, modeled after an exploratory National Institutes of Health (NIH) grant application.
C. Catana, A. Kumar, A. Guimaraes

HST.550J 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 22.56J.
A. Jasanoff

HST.560J Radiation Biophysics
(Same subject as 22.55J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit
See description under subject 22.55J.
Staff

HST.561J 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 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit
See description under subject 22.56J.
A. Jasanoff

HST.562 Imaging and Sample Processing in Biology and Medicine (New)
Prereq: Biology (GIR), 5.12; or permission of instructor
G (Fall)
3-1-8
Discusses basic principles and concepts of bioimaging and sample processing. Topics include optical imaging modalities; optical/physical/chemical properties of a broad range of biological samples, including clinical tissues and sample handling-processing technologies; underlying engineering principles; and basic image analysis. Provides experience with optical microscopy and tissue processing technique (CLARITY). Limited to 15.
K. Chung

HST.563 Imaging Biophysics and Clinical Applications
Prereq: 18.03, 8.03; or permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
2-1-9 H-LEVEL Grad Credit
Introduction to the connections and distinctions among various imaging modalities (x-ray, optical, ultrasound, MRI, PET, SPECT, EEG), common goals of biomedical imaging, broadly defined target of biomedical imaging, and the current practical and economic landscape of biomedical imaging research. Emphasis on applications of imaging research. Final project consists of student groups writing mock grant applications for biomedical imaging research project, modeled after an exploratory National Institutes of Health (NIH) grant application.
C. Catana, A. Kumar, A. Guimaraes
HST.565 Medical Imaging Sciences and Applications  
Prereq: None  
G (Fall)  
3-0-9  
Covers the biophysical, mathematical and instrumentation basics of positron emission tomography (PET), x-ray and computed tomography (CT), magnetic resonance imaging (MRI), 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. Consider the ways in which these imaging techniques are rooted in physics, engineering, and mathematics as well as their respective role in anatomic and physiologic/molecular imaging.  
G. El Fakhri, M. Normandin

HST.569 Biomedical Optics  
Prereq: Calculus  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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. Appropriate for upper-level undergraduates and graduate students in life sciences as well as engineering. Includes lectures, seminars, and occasional guest lectures. Grading based on midterm and final report. Report analyzes a specific technological need in medicine or biology and proposes a solution. Opportunity to pursue 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.576J Topics in Neural Signal Processing  
(Same subject as 9.272J)  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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)  
3-4-5 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.  
J. Greenberg, E. Adalsteinsson, W. Wells

HST.583 Functional Magnetic Resonance Imaging: Data Acquisition and Analysis  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: 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 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
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, K. Setsompop

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.  
HST Faculty

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, S. S. Ghosh, 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 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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)
4-1-8 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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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)
2-2-2 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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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 acoustics, mechanics, 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 Biology of the Inner Ear
Prereq: Permission of instructor
G (Fall)
3-1-8 H-LEVEL Grad Credit
Reviews the normal biology, biophysics, physiology and morphology of the inner ear and auditory nerve, as well as the mechanisms underlying sensorineural hearing loss.
M. C. Liberman, S. F. Maison

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. Follows Harvard FAS calendar.

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 room; laboratory experience in audiology, voice and speech evaluation, evaluation of balance disorders; lectures and discussion groups. Prior completion of HST.714 and HST.721 is recommended.
K. Stankovic, J. Nadol

HST.725 Music Perception and Cognition
Prereq: HST.723 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-1-8 H-LEVEL Grad Credit
See description under subject 6.345J.
V. W. Zue, J. R. Glass
HST.730 Molecular Biology of the Auditory System
Prereq: Biology (GIR)
G (Fall)
3-0-9 H-LEVEL Grad Credit
Focuses on molecular approaches to cochlear development and function, based on readings and discussion of research literature. Lectures by course director and local experts in the field. Includes discussion of gene expression, cell fate determination, deafness mutations, stem cells and regeneration of the cochlea.
L. D. Braida

HST.750 Modeling Issues in Hearing and Speech
Prereq: HST.714, HST.721
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)
Units arranged H-LEVEL Grad Credit
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.
Consult 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.914J Frontiers in Therapeutics and Drug Delivery
(Same subject as 10.644j)
(Subject meets with 10.444)
Prereq: 7.05 or permission of instructor
G (Fall)
3-0-6
See description under subject 10.644j.
D. G. Anderson

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.691j)
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, A. J. Sinskey, G. K. Raju

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.923)
Prereq: None
G (Spring)
0-3-0
Student tutorial provides an opportunity for interactive discussion covering emerging information technologies (IT) used in healthcare. Practicum: HMS and MIT graduate students in medicine, business, law, education, engineering, computer science, public health, and government collaborate in interdisciplinary teams to design an innovative IT application. Student projects presented during the final class. Students ordinarily also register for HST.921 or HST.922, the lecture component of the subject. Undergraduates require permission of instructor. Only HST students may register under HST.923, 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
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
2-0-7
See description under subject ESD.69J.
S. Finkelstein, J. Moses, J. Coughlin

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, B. J. Good

HST.936 Global Health Informatics to Improve Quality of Care
(Subject meets with HST.937, HST.938)
Prereq: None
G (Spring)
2-2-8
Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik, M. Somai

HST.937 Global Health Informatics to Improve Quality of Care
(Subject meets with HST.936, HST.938)
Prereq: None
G (Spring)
2-2-2
Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik, M. Somai

HST.938 Global Health Informatics to Improve Quality of Care
(Subject meets with HST.936, HST.937)
Prereq: None
G (Spring)
2-2-8
Addresses issues related to how health information systems can improve the quality of care in resource poor settings. Discusses key challenges and real problems; design paradigms and approaches; and system evaluation and the challenges of measuring impact. Weekly lectures led by internationally recognized experts in the field. Students taking HST.936, HST.937 and HST.938 attend common lectures; assignments and laboratory time differ. HST.936 has no laboratory.
L. G. Celi, H. S. Fraser, V. Nikore, K. Paik, M. Somai

HST.939J Designing and Sustaining Technology Innovation for Global Health Practice
(Same subject as 15.127J)
Prereq: None
G (Spring)
Not offered regularly; consult department
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.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.
G. Alterovitz, P. Szolovits

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: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-6
Involves critical analysis of new biomedical business ideas. Inventors or principals of early stage companies present their ideas to the class and provide background material including scientific papers and patents. A team of students is assigned to evaluate each business idea. Students interact with the companies, potential customers, other stakeholders and experts to develop a series of analyses concerning the critical issues that each business idea would face. Company and student presentations supplemented by topic-specific lectures and presentations by biomedical entrepreneurs. Enrollment limited. Enrollment limited.
C. Berke, R. Anders, R. J. Cohen

HST.975J Clinical Trials in Biomedical Enterprise
(Same subject as 15.121J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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, J. Karp

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.
HST Faculty

HST.UR Undergraduate Research in Health Sciences and Technology
(Same subject as 15.122J)
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Opportunity for group study of advanced subject areas that have been or could become sources of entrepreneurial activity. Students 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
Can be repeated for credit
Units arranged
G (Fall, IAP, Spring, Summer)
Prereq: Permission of instructor
Sciences and Technology
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Group study of subjects related to health sciences and technology not otherwise included in the curriculum. 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.S52 Special Subject: Medical Engineering and Medical Physics (New)
Prereq: Permission of instructor
G (Fall, IAP, Spring)
Units arranged
Can be repeated for credit
Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included
in the curriculum. Offerings are initiated by 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.S54–HST.S55 Special Subject: Medical Engineering and Medical Physics (New)**
Prereq: None
G (Fall, IAP, Spring)
Units arranged [P/D/F]
Can be repeated for credit

Opportunity for group study of advanced subjects related to the Medical Engineering and Medical Physics Program not otherwise included in the curriculum. Offerings are initiated by 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.S56–HST.S57 Special Subject: Medical Engineering and Medical Physics**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

**HST.S58–HST.S59 Special Subject: Medical Engineering and Medical Physics**
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**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit

**HST Faculty**

**HST.S78–HST.S79 Special Subject: Speech and Hearing Sciences**
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 SHBT faculty on an ad hoc basis subject to program approval. Prerequisites may vary by topic; consult faculty at time of offering.

**SHBT Faculty**

**HST.S96–HST.S97 Special Subject: Biomedical Enterprise**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

**HST.S98–HST.S99 Special Subject: Biomedical Enterprise**
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit

Opportunity for group study of advanced subjects relating 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.

**HST Faculty**
**UNDERGRADUATE SUBJECTS**

**MAS.110 Fundamentals of Computational Media Design**
Prereq: None  
U (Fall)  
3-3-6 HASS-A; CI-H

History of modern art and design from the perspective of the technologist. Exploration of visual analysis, typography, and technologies for audio/visual expression. Enrollment limited; preference to students in MAS freshman program.  
*V. M. Bove, Jr.*

**MAS.111 Introduction to Doing Research in Media Arts and Sciences**
Prereq: None  
U (Spring)  
1-4-1 [P/D/F]

Intended for students pursuing research projects at the Media Laboratory, particularly freshmen and sophomores. Exercises and discussions on topics including Media Lab research areas; documenting research progress; ethical issues in research; patents, copyrights, intellectual property; and giving oral, written, and online presentations of results. A final oral presentation is required. Enrollment limited; preference to students in the Media Arts and Sciences freshman program.  
*V. M. Bove, Jr.*

**MAS.131 Computational Camera and Photography**
(Subject meets with MAS.531)  
Prereq: Permission of instructor  
U (Fall)  
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 Mathematical Methods in Imaging**
(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.330J Design Across Scales, Disciplines and Problem Contexts**
(Same subject as 4.110J)  
(Subject meets with MAS.650)  
Prereq: None  
U (Spring)  
2-2-8 HASS-A

See description under subject 4.110J.  
*N. Oxman, J. M. Yoon*

**MAS.490 Independent Study in Media Arts and Sciences**
Prereq: Permission of instructor  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit

A series of modular classes designed to provide basic foundations in the skills needed to perform research at the Media Lab. Introduces the technology tool sets and research techniques used broadly at the Media Lab. Students choose from a series of modules that include: hardware basics, I-O and interconnecting, design and fabrication, programming, analyzing data, machine learning, signals and systems, applied control, testing and evaluation methods, documentation and communication methods. Proportional credit will be assigned to each module successfully completed.  
*V. M. Bove, K. Larson, J. Paradiso*

**MAS.491 Independent Study in Media Arts and Sciences**
Prereq: Permission of instructor  
U (Fall, Spring)  
Units arranged  
Can be repeated for credit

**MAS.500 Hands on Foundations in Media Technology**
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F] H-LEVEL Grad Credit

GRADUATE SUBJECTS

**MAS.500 Hands on Foundations in Media Technology**
Prereq: Permission of instructor  
G (Fall, Spring)  
Units arranged [P/D/F] H-LEVEL Grad Credit

A series of modular classes designed to provide basic foundations in the skills needed to perform research at the Media Lab. Introduces the technology tool sets and research techniques used broadly at the Media Lab. Students choose from a series of modules that include: hardware basics, I-O and interconnecting, design and fabrication, programming, analyzing data, machine learning, signals and systems, applied control, testing and evaluation methods, documentation and communication methods. Proportional credit will be assigned to each module successfully completed.  
*V. M. Bove, K. Larson, J. Paradiso*

**MAS.531 Computational Camera and Photography**
(Subject meets with MAS.131)  
Prereq: Permission of instructor  
G (Fall)  
3-0-9 H-LEVEL Grad Credit

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.532 Mathematical Methods in Imaging
(Subject meets with MAS.132)
Prereq: Permission of instructor
G (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.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 emergent imaging innovations. Students analyze the landscape of imaging developments, plan business strategies and brainstorm towards a start-up, business unit, non-profit or citizen sector organization; they are encouraged to form teams and craft a business plan to gain practical experience in imaging research. Includes case studies of established and emerging businesses, and talks by invited business speakers. Surveys commercialization and the innovation landscape in all imaging arenas. Topics include mobile camera phones, cameras in developing countries, image-search, medical imaging, online photo sharing, and computational photography. Enrollment limited.

R. Raskar

MAS.552] City Science
(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 led 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, R. Chin

MAS.580 Crafted By Nature: Bio-Inspired Digital Design and Fabrication
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-6-3 H-LEVEL Grad Credit

Presents a foundation for understanding biologically inspired digital design and fabrication through an introduction to the theory and literature of biomimicry. Focuses on various material processes, such as weaving, folding and layering in micro- and macro-scales. Reviews the formal logic, mechanical behavior, and environmental impacts of a range of natural and synthetic materials, as well as ways by which to shape them, inherent to their physical properties. Through physical and digital form-finding exercises, explores the relationships between materials and their shaping processes in the generation of form. Students invent novel fabrication methods inspired by nature and reconsider the way things are designed and made in the 21st century. Intended for advanced students with an interest in bio-inspired design and some background in fabrication-based design. Competence in computational geometry and some command of parametric design software and basic programming desirable, as is general knowledge of CAD, CAM and CAE platforms. Enrollment limited; a short interest statement is required upon registration.

N. Oxman

MAS.581 Networks, Complexity, and Their Applications
Prereq: None
G (Spring)
2-0-10

Develops a conceptual understanding of the basic properties of networks and their implications. Networks are studied in the context of the empirical analysis of large systems and big data. Systems studied include technical systems, such as the internet and the world wide web, and socioeconomic systems, such as social networks and industry-location networks. Taught as a mixture of lectures and group projects. Limited to 25.

C. Hidalgo

MAS.600 Human 2.0
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 persons with either unusual or normal physiologies that wish to extend their cognitive, emotion, social or physical capability to new levels. Topics include robotic exoskeletons and powered orthoses, external limb prostheses, neural implant technology, social-emotional prostheses, and cognitive prostheses. Requires student presentations, critiques of class readings, and a final project including a publication-quality paper. Enrollment limited.

H. Herr

MAS.622] Pattern Recognition and Analysis
(Same subject as 1.126J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
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.650 Design Across Scales, Disciplines and Problem Contexts  
(Subject meets with 4.110J, MAS.330J)  
Prereq: None  
G (Spring)  
2-2-8  
Explores the reciprocal relationships among design, science, and technology across scales. Covers a wide range of topics, from visualization, fabrication, computation, material ecology, interaction, and architecture to games and performance. Examines how transformations in science and technology have influenced design thinking and vice versa. Students collaborate on interdisciplinary design projects and creative opportunities. Additional work is required of students taking the graduate version of the subject.  
N. Oxman, J. M. Yoon

MAS.664J Media Ventures  
(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 big data, mobile, and the use of personal data.  
A. Pentland, J. Bonsen

MAS.665J Development Ventures  
(Same subject as 15.375J, EC.731J)  
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.  
A. Pentland, J. Bonsen

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.700 Future of News and Participatory Media  
Prereq: Permission of instructor  
G (Spring)  
1-2-9 H-LEVEL Grad Credit  
Studies the news as an engineering challenge in light of recent, rapid, and ongoing changes to the way news is delivered and spread. Considers how we discover what events are taking place in different parts of the world and how we explain the importance of these events to readers or viewers, as well as how readers of a story respond to events. Explores the systems journalists and others have used to report and share the news. Focuses on developing one’s own tools and methods to address these challenges through weekly reporting assignments and a final project in which students build tools for journalists (professional and otherwise) to use. Limited to 18.  
E. Zuckerman

MAS.712 Learning Creative Learning  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
3-0-9 [P/D/F] H-LEVEL Grad Credit  
Can be repeated for credit  
An introduction to ideas and strategies underlying the design of new learning technologies. Focuses especially on technologies that support interest-driven, project-based, collaborative learning experiences. Students analyze innovative learning technologies, discuss underlying educational ideas, examine design principles, create new prototypes and applications.  
M. Resnick

MAS.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 (Fall)  
2-0-10 H-LEVEL Grad Credit  
See description under subject 6.868J.  
M. Minsky

MAS.750 Human-Robot Interaction  
Prereq: Permission of instructor  
G (Fall)  
Not offered regularly; consult department  
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.  
C. Breazeal

MAS.771 Autism Theory and Technology  
Prereq: Permission of Instructor  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
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
MA 8366.3 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

MA 836 Sensor Technologies for Interactive Environments
Prereq: Permission of instructor
G (Fall)
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

MA 834 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
Opportunity for independent study under regular supervision by a faculty member. Registration subject to prior arrangement of subject matter and supervision by staff.
T. Machover

MA 825 Musical Aesthetics and Media Technology
(Same subject as 21M.580J)
Prereq: Permission of instructor
G (Fall)
3-3-3 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.
T. Machover

MA 826 Musical Aesthetics and Media Technology
(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

MA 864 The Nature of Mathematical Modeling
Prereq: Permission of instructor
G (Spring)
Not offered regularly; consult department
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 data-driven inference. Emphasis on efficient practical implementation of these ideas.
N. Gershenfeld
MAS.881 Principles of Neuroengineering
(Same subject as 9.422J, 20.452J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Covers how to innovate technologies for brain analysis and engineering, for accelerating the basic understanding of the brain, and leading to new therapeutic insight and inventions. Focuses on using physical, chemical and biological principles to understand technology design criteria governing ability to observe and alter brain structure and function. Topics include optogenetics, noninvasive brain imaging and stimulation, nanotechnologies, stem cells and tissue engineering, and advanced molecular and structural imaging technologies. Design projects by students.
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
Special seminar focusing on envisioning, launching, and building start-ups that are commercializing innovations from neuroscience and neuroengineering. Topics include neuroimaging, diagnostics, motor rehabilitation, affective computing, novel scientific tools, and novel therapeutics including neuropharmaceuticals, neuromodulation, neuropsychotics, regenerative medicine, and more. Each class is devoted to a specific topic area, often with invited speakers, exploring issues from the deeply technical through the market opportunity. Working in small groups students prepare a business plan executive summary for a new neurotechnology start-up.
J. Bonsen, E. S. Boyden, R. Ellis-Behnke

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 limited by 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.
D. Roy

MAS.940 Preparation for SM Thesis
Prereq: Permission of instructor
G (Fall, IAP, Spring, Summer)
2-0-10 [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.
S. Kamvar, C. Schmandt

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, Summer)
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-MAS.964 Special Subject in Media Technology
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.965-MAS.969 Special Subject in Media Technology
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] 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.995 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
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.)

ROTC PROGRAMS

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, officer 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.

R. Rivera

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.201
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.

M. Parry

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.

M. Parry

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]

Emphasizes development of techniques used to direct and inform. Students are assigned leadership and management positions in the AS.111 programs described above. AS.212 is a continuation of AS.211.

M. Parry

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.

K. Dillard

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]

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.

M. Parry

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

Examines the national security process, regional studies, advanced leadership ethics, and Air Force doctrine. Special topics of interest focus on the military as a profession, officer professionalism, military justice, civilian control of the military, preparation for active duty, and current issues affecting military professionalism. Within this structure, continued emphasis on refining communication skills. AS.402 is a continuation of AS.401.

K. Dillard
Examines in depth why America fought each armed conflict the way they did. Then covers perspective on how and why Americans viewed involvement around the world, and the social effects of the United States, US military strategy and history in the context of the broader history of the United States, US military strategy and involvement around the world, and the social effects of the American society on the military. Begins with a survey of world military history, including the organization, techniques, resources, and capabilities involved in conducting small-unit tactical operations. Students serve as junior leaders in Leadership Labs designed to reinforce classroom concepts.

J. Myers

AS.412 Leadership Laboratory
Prereq: AS.411 or permission of instructor
Coreq: MS.401
U (Fall)
0-2-4 [P/D/F]

Consists of activities classified as advanced leadership experiences to continue developing critical leadership, managerial and communication skills along with maintaining an active, physical lifestyle needed in today's Air Force. AS.512 is a continuation of AS.411.

M. Parry

AS.511 Leadership Laboratory
Prereq: AS.412 or permission of instructor
U (Fall)
0-2-4 [P/D/F]

Consists of activities classified as advanced leadership experiences to continue developing critical leadership, managerial and communication skills along with maintaining an active, physical lifestyle needed in today's Air Force. AS.512 is a continuation of AS.411.

M. Parry

MILITARY SCIENCE

MS.001 American Military History
Prereq: None
U (Fall, Spring)
3-0-3

Thematic exploration of American military history in the context of the broader history of the United States, US military strategy and involvement around the world, and the social effects of the American society on the military. Begins with a survey of world military history, up to the American colonial period, offering perspective on how and why Americans viewed armed conflict the way they did. Then covers the growth and development of the US military, from the colonial period to the modern day. Examines in depth why America fought each conflict the way it did and how it arrived at those ways of fighting. Investigates the usually subtle, yet profound, social effects the US military and American society have on each other. Includes readings, oral and written presentations, and oral and written quizzes and exams.

A. Edwards

MS.101 Leadership and Personal Development
Prereq: None
U (Fall)
2-2-2

Foundational course provides instruction on the basic aspects of the officer corps of the United States Army. Introduces students to the personal challenges and competencies critical for effective leadership. Covers personal development of life skills, such as critical thinking, goal setting, time management, physical fitness, and stress management in relation to leadership, Officership, and the Army profession. Also covers the organization of the United States Army, the role of the military in today's society, and customs and traditions. Students apply classroom instruction during labs.

Staff

MS.102 Introduction to Tactical Leadership
Prereq: MS.101 or permission of instructor
U (Spring)
2-2-2

Provides an overview of leadership fundamentals, such as setting direction, problem-solving, listening, presenting briefs, providing feedback, and effective writing skills. Explores dimensions of leadership values, attributes, skills, and actions in the context of practical, interactive exercises. Introduces land navigation and basic tactics. Students apply classroom instruction during Leadership Laboratories designed to reinforce classroom concepts.

A. Edwards, J. Myers

MS.201 Fundamentals of Military Science
Prereq: MS.201 or permission of instructor
U (Fall)
2-2-2

Explores the dimensions of creative tactical leadership using historical case studies and interactive exercises. Students practice aspects of personal motivation, team-building and peer leadership fundamentals in various situations and environments. Introduces creative problem-solving techniques and procedures. Covers the organization, techniques, resources, and capabilities involved in conducting small-unit tactical operations. Students serve as junior leaders in Leadership Labs designed to reinforce classroom concepts.

J. Myers

MS.202 Fundamentals of Army Operations
Prereq: MS.201 or permission of instructor
U (Spring)
2-2-2

Examines the challenges of leading teams in the Contemporary Operating Environment. Presents the critical thinking and problem-solving skills necessary for adaptive leaders in administrative, training, and tactical environments. Explores Army leadership, mission-planning techniques, and small-unit operations in order to develop and hone decision-making skills. Throughout the term, cadets demonstrate their knowledge through a series of situational exercises. Covers fundamentals of military topography, including the use of military maps to determine topographic features, to conduct land navigation, and to perform terrain analysis. Cadets who successfully complete the subject possess fundamental tactical planning and decision-making skills that prepare them for more challenging training in the field and in future military science subjects. Students apply classroom instruction during labs in which they train and lead small units. They also develop greater self-awareness as they assess their own leadership styles and practice communication and team-building skills.

A. Edwards

MS.301 Planning Small Unit Operations
Prereq: MS.202 or permission of instructor
U (Fall)
3-2-4

Focuses on small unit tactics and the military planning process. Emphasizes application of Troop Leading Procedures (TLPs) as a guide for planning, executing, and making decisions for complex operations. Students study military order formats and advanced communication skills to effectively present their plans. Synthesizes the various components of training, leadership, and team-building. Upon completion, cadets will possess the fundamental confidence and competence of leadership in a small unit setting. Labs present opportunities to plan and conduct individual and collective training, providing leadership and tactical experience. Students delegate, supervise, and plan for/adapt to unexpected changes in organizations under stress. Students receive ongoing assessment designed to highlight their strengths and weaknesses and improve their leadership skills.

Staff
MS.302 Foundations of Tactical Leadership
Prereq: MS.301
U (Spring)
3-2-4
Explores leadership from the military perspective. Surveys basic principles for successfully managing and leading people, particularly in public service and the military. Develops skills in oral and written communication, planning, team-building, motivation, ethics, decision-making, and managing change. Features interactive, experiential classes with case studies, student presentations, role plays, and discussion. During labs, students face challenging scenarios to help develop self-awareness and critical thinking skills. Cadets receive systematic and specific feedback on their leadership activities. Cadets begin to analyze and evaluate their own leadership values, attributes, skills, and actions.

A. Edwards

MS.311 Leadership Laboratory I
Prereq: MS.202 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.

M. Lutkevich, A. Dombroski

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.

M. Lutkevich, A. Dombroski

MS.401 Leadership, Management, and Ethics
Prereq: MS.302
U (Fall)
2-3-4
Develops proficiency in planning and executing complex operations, functioning as a member of a staff, assessing risk, making ethical decisions, and leading fellow students. First half of term covers how higher-level military organizations are organized and managed. Includes an overview of mission analysis, training management, risk management, logistics, maintenance, and medical systems. Second half examines military law and ethics, covering separation of powers, law of land warfare, equal opportunity, privacy, individual rights, searches and inspections, administrative discipline processes, and military law. Case studies, scenarios, and other exercises prepare students to face the complex ethical and practical demands of leading as commissioned officers in the US Army. Labs are designed to assess officership potential. Through assignment to leadership positions in the ROTC Battalion, students plan and lead the execution of labs, direct and control the corps of cadets, enhance their oral and written communications, and improve their application of troop-leading procedures and mission analysis.

A. Edwards

MS.402 Officership
Prereq: MS.401
U (Spring)
2-3-4
Examines the importance of understanding the culture in which the Army operates, as well as how to establish a positive climate within the organization by accounting for the diverse cultural influences present. First half of term focuses on how to operate successfully within the contemporary operating environment. Emphasizes the role of cultural awareness in successful military operations. Also covers counter-insurgency, terrorism, interacting with non-governmental organizations, civilians on the battlefield, and host nation support. Second half focuses inward on the management and care of subordinates. Explores the Army culture, setting a positive climate in organizations, counseling, and providing leadership-performance feedback to subordinates. Case studies, scenarios, and other exercises prepare students to face the complex ethical and practical demands of leading as commissioned officers in the US Army. Labs are designed to develop technical, tactical, and leadership skills while assessing officership potential. Through assignment to leadership positions in command and staff capacities, students actively participate in planning and executing training within the program, direct and control the corps of cadets, enhance oral and written communications, and improve their application of troop-leading procedures and mission analysis. Students examine leaders of the past through a battle analysis exercise and a staff ride to the battlefields of Lexington and Concord.

A. Edwards

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.

A. Edwards

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.

A. Edwards

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 discus-
Electromagnetic radiation pertaining to maritime
Overview of the properties and behavior of electromagnetic radiation pertaining to maritime applications. Topics include communications, radar detection, electro-optics, tracking and guidance systems. Sonar and underwater sound propagation also discussed. Examples taken from systems found on naval ships and aircraft. Selected readings on naval weapons and fire control systems. Physics I (GIR) and Calculus II (GIR) recommended.

C. Giorgis

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. Completion of MIT NROTC Orientation Program strongly recommended.
S. Smith

NS.102 Naval Ships Systems
Prereq: NS.202
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.
M. Minck

NS.200 Seapower and Maritime Affairs
Prereq: None
U (Fall, Spring) 0-2-2 [P/D/F]
A study of the US Navy and the influence of sea power upon history. Incorporates both a historical and political science process to explore the major events, attitudes, personalities, and circumstances which have imbued the US Navy with its proud history and rich tradition. Deals with issues of national imperatives in peacetime as well as war, varying maritime philosophies which were interpreted into naval strategies/doctrines, budgetary concerns which shaped force realities, and the pursuit of American diplomatic objectives, concluding with the current search for direction in the post-Cold War era and beyond.
S. Smith

NS.300 Naval Science Leadership Seminar
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. Giorgis

NS.301 Navigation
Prereq: NS.202
U (Spring) 2-2-4
Comprehensive study of the theory, principles, and procedures of piloting and maritime navigation, including mathematics of navigation, practical work involving navigational instruments, sight reduction by pro forma and computerized methods, charts, publications, and voyage planning. CORTRAMID cruise recommended.
D. Lueck

NS.302 Navigation and Naval Operations
Prereq: Recommended first 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. Lueck

NS.310 Evolution of Warfare
Prereq: None
U (Spring) 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. Giorgis

NS.400 Naval Science Leadership Seminar
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. Giorgis
**NS.401 Leadership and Management I**
Prereq: NS.202
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.

*J. Scislowicz*

**NS.402 Leadership and Ethics**
Prereq: NS.302
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.

*S. Benke*

**NS.410 Amphibious Warfare**
Prereq: None
U (Spring)
2-0-4

This seminar course is an introduction to the fundamental concepts and history of amphibious warfare, from the classical period to the present day. Emphasis is placed on analytical study and critical thought rather than memorization of historical facts. Students will trace the evolution of amphibious warfare through analysis of case studies using amphibious and maneuver doctrine as a framework. By the end of this course, students will comprehend modern employment concepts and challenges relating to the use of amphibious forces.

*C. Giorgis*
INTERPHASE: PRE-FRESHMAN SUMMER PROGRAM

SP.100 Interphase
Prereq: Commitment to register as a freshman in the Fall
U (Summer)
Units arranged [P/D/F]

Interphase is a seven-week program designed to enhance the academic success of students entering MIT. The program has a dual focus: it gives students an introduction to the MIT experience by exposing them to the rigors of a full subject load while simultaneously preparing them for academic success beyond MIT. The program includes calculus; chemistry; physical education; physics; writing, oral presentation and teamwork skills; and supporting academic activities, including small-group learning. Students can earn transcript credit for subjects taken in the program, sometimes resulting in advanced placement in corresponding subjects taken in the Fall. Activities include day trips to area cultural, recreational, and business sites. Students participate in a range of personal and educational development seminars and activities designed to ensure their smooth transition to college life.

S. Mtingwa

SEMINAR XL

SP.110 Program XL: You Can Be a Success at MIT
Prereq: First-year undergraduate standing
U (Fall)
Units arranged [P/D/F]

SP.120 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.

T. Stevens

TERRASCOPE

SP.35UR Undergraduate Research in Terrascope
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

SP.360 Terrascope Radio
Prereq: None. Coreq: 1.016
U (Spring)
3-3-6 HASS-A; CI-H

An exploration of radio as a medium of expression and communication, particularly the communication of complex scientific or technical information to general audiences. Examines the ingredients of effective radio programming, drawing extensively on examples from both commercial and public radio. Student teams produce, assemble, narrate, record and broadcast/webcast radio programs on topics related to the complex environmental issue that is the focus of the year’s Terrascope subjects. Includes multiple individual writing assignments that explore the constraints and opportunities in radio as a medium. Limited to 12. Terrascope students only.

A. W. Epstein

SP.3550 Special Subject: Terrascope
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit

Covers areas of study not included in the regular Terrascope curriculum. Preference to students in Terrascope.

Staff

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.

C. Capozzola

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.

C. Capozzola
UNDERGRADUATE SUBJECTS

Tier I Subjects

STS.001 Technology in American History
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H
A survey of America’s transition from a rural, agrarian, and artisan society to one of the world’s leading industrial powers. Treats the emergence of industrial capitalism: the rise of the factory system; new forms of power, transport, and communication; the advent of the large industrial corporation; the social relations of production; and the hallmarks of science-based industry. Views technology as part of the larger culture and reveals innovation as a process consisting of a range of possibilities that are chosen or rejected according to the social criteria of the time.
M. R. Smith

STS.003 The Rise of Modern Science
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H; CI-H
Covers the development of major fields in the physical and life sciences, from 18th-century Europe through 20th-century America. Examines ideas, institutions, and the social settings of the sciences, with emphasis on how cultural contexts influence scientific concepts and practices.
Staff

STS.004 Intersections: Science, Technology, and the World
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H
Introduces students to multidisciplinary studies in Science, Technology, and Society (STS), using four case studies to illustrate a broad range of approaches to basic principles of STS studies. Case studies vary from year to year, but always include a current MIT event. Other topics are drawn from legal and political conflicts, and arts and communication media. Teaching modes include guest presenters, discussion groups, field activities, visual media, and a practicum style of learning. Enrollment limited.
R. H. Williams

STS.006j Bioethics
(Same subject as 24.06j)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H
See description under subject 24.06j.
V. Urbanek, N. Schüll

STS.007 Technology in History
Prereq: None
U (Fall)
3-0-9 HASS-H; CI-H
Covers theories of the interactions between historical and technological change; relations between the histories of science and of technology; purported turning points such as the Neolithic, Industrial, and Information Revolutions; case studies from a wide range of times and places; and connections across time and space. Lectures supplemented by student presentations. Frequent writing, rewriting, and small group work. Enrollment limited.
C. Mavhunga

STS.008 Technology and Experience
Prereq: None
U (Spring)
3-0-9 HASS-H; 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. Enrollment limited.
N. Schüll

STS.009 Evolution and Society
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H; CI-H
Provides a broad conceptual and historical introduction to scientific theories of evolution and their place in the wider culture. Embraces historical, scientific and anthropological/cultural perspectives grounded in relevant developments in the biological sciences since 1800 that are largely responsible for the development of the modern theory of evolution by natural selection. Students read key texts, analyze key debates (e.g. Darwinian debates in the 19th century, and the creation controversies in the 20th century) and give class presentations.
J. Durant

STS.010 Neuroscience and Society
Prereq: None
U (Fall)
3-0-9 HASS-S; 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 neumarketing; 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

Tier II Subjects

STS.023J Science, Caste and Gender in India
(Same subject as WGS.226j)
Prereq: None
U (Spring)
3-0-9 HASS-H
See description under subject WGS.226j.
A. Sur
STS.025J Making the Modern World: The Industrial Revolution in Global Perspective
(Same subject as 21H.285J)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Global survey of the great transformation in history known as the "Industrial Revolution." Topics include origins of mechanized production, the factory system, steam propulsion, electrification, mass communications, mass production and automation. Emphasis on the transfer of technology and its many adaptations around the world. Countries treated include Great Britain, France, Germany, the US, Sweden, Russia, Japan, China, and India. Includes brief reflection papers and a final paper.

M. R. Smith

STS.026 History of Manufacturing in America (New)
(Subject meets with STS.425)
Prereq: None
Acad Year 2014–2015: U (Fall)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Introductory survey of fundamental innovations and transitions in American manufacturing from the colonial period to the mid-twentieth century. Primary emphasis on textiles and metalworking, with particular attention to the role of the machine tool industry in the American manufacturing economy. Students taking graduate version are expected to explore the material in greater depth.

M. R. Smith

STS.027J The Civil War and the Emergence of Modern America: 1861–1890
(Same subject as 21H.205J)
(Subject meets with STS.427)
Prereq: Permission of instructor
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Using the American Civil War as a baseline, considers what it means to become "modern" by exploring the war's material and manpower needs, associated key technologies, and how both influenced the United States' entrance into the age of "Big Business." Readings include material on steam transportation, telegraphic communications, arms production, naval innovation, food processing, medicine, public health, management methods, and the mass production of everything from underwear to uniforms — all essential ingredients of modernity. Students taking graduate version complete additional assignments.

M. R. Smith

STS.032 Energy, Environment, and Society
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H; 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. Enrollment limited.

C. Mavhunga

STS.034 Science Communication: A Practical Guide
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H; CI-H

Develops students' abilities to communicate science effectively in a variety of real-world contexts. Covers strategies for dealing with complex areas like theoretical physics, genomics and neuroscience, and addresses challenges in communicating about topics such as climate change and evolution. Projects focus on speaking and writing, being an expert witness, preparing briefings for policy-makers, writing blogs, giving live interviews for broadcast, and creating a prospectus for a science exhibit in the MIT Museum. Enrollment limited.

J. Durant

STS.035 Exhibiting Science
Prereq: One CI-H/CI-HW subject, permission of instructor
U (Spring)
2-2-8 HASS-A

Project-based seminar covers key topics in museum communication, including science learning in informal settings, the role of artifacts and interactives, and exhibit evaluation. Students work on a term-long project, organized around the design, fabrication, and installation of an original multimedia exhibit about current scientific research at MIT. Concludes with the project's installation in the MIT Museum's Mark Epstein Innovation Gallery. Limited to 20; preference to students who have taken STS.034.

J. Durant

STS.042J Einstein, Oppenheimer, Feynman: Physics in the 20th Century
(Same subject as 8.225J)
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H

Explores the changing roles of physics and physicists during the 20th century. Topics range from relativity theory and quantum mechanics to high-energy physics and cosmology. Examines the development of modern physics within shifting institutional, cultural, and political contexts, such as physics in Imperial Britain, Nazi Germany, US efforts during World War II, and physicists' roles during the Cold War. Enrollment limited.

D. I. Kaiser

STS.043 Technology and Self: Science, Technology, and Memoir
(Subject meets with STS.443)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-0-7 HASS-S

Focuses on the memoir as a window onto the relationship of the scientist, engineer, and technologist to his or her work. Studies the subjective side of technology and the social and psychological dimensions of technological change. Students write about specific objects and their role in their lives—memoir fragments. Readings concern child development theory and the role of technology in development. Explores the connection between material culture, identity, cognitive and emotional development. Students taking graduate version complete additional assignments. Limited to 15; no listeners.

S. Turkle

STS.044 Technology and Self: Things and Thinking
(Subject meets with STS.444)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-0-7 HASS-S

Explores emotional and intellectual impact of objects. The growing literature on cognition and "things" cuts across anthropology, history, social theory, literature, sociology, and psychology and is of great relevance to science students. Examines the range of theories, from Mary Douglas in anthropology to D.W. Winnicott in...
psychoanalytic thinking, that underlies “thing” or “object” analysis. Students taking graduate version complete additional assignments. Limited to 15; no listeners.
S. Turkle

STS.046J The Science of Race, Sex, and Gender
(Same subject as 21A.103J, WGS.225J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
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
A survey of the contributions of African Americans to science, technology, and medicine from colonial times to the present. Examines 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
Examines the history of MIT, from its founding to the present, through the lens of the history of science and technology. Topics include William Barton Rogers; the modern research university and educational philosophy; campus, intellectual, and organizational development; changing laboratories and practices; MIT’s relationship with Boston, the federal government, and industry; and notable activities and achievements of students, alumni, faculty, and staff. Includes guest lecturers, on-campus field trips, and interactive exercises.
D. Douglas

STS.056 Science on Screen
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-1-9 HASS-A
Examines the linked histories of science, engineering, and documentary film from 1895 to present. In addition to historical study and visual analysis, students produce their own short videos based on archival footage. Provides opportunities to interact with both antiquated and modern technologies of media production and projection. Readings cover topics in film studies, the history of technology, STS, and material culture studies. Includes mandatory weekly screenings and media production assignments, as well as several short writing assignments. Limited to 15.
H. R. Shell

STS.060J The Anthropology of Biology
(Same subject as 21A.303J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
See description under subject 21A.303J.
S. Helmreich

STS.064J DV Lab: Documenting Science through Video and New Media
(Same subject as 21A.550J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-3-12 HASS-S
See description under subject 21A.550J.
C. Walley, C. Boebel

STS.065J The Anthropology of Sound
(Same subject as 21A.505J)
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-S
Credit cannot also be received for CMS.407
See description under subject 21A.505J.
S. Helmreich

STS.066J Advanced DV Lab: Documenting Science through Video and New Media
(Same subject as 21A.551J)
Prereq: 21A.550 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-3-6 HASS-S
See description under subject 21A.551J.
C. Walley, C. Boebel

STS.070J Language and Technology
(Same subject as 24.913J, 21A.503J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
See description under subject 21A.503J.
G. Jones

STS.071J Cross-Cultural Investigations: Technology and Development
(Same subject as EC.702J, 21A.801J)
(Subject meets with EC.792J, 21A.839J, STS.481J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
See description under subject 21A.801J.
C. Walley

STS.072J Nuclear Forces and Missile Defenses
(Same subject as 17.475S)
(Subject meets with 17.476J, STS.435J)
Prereq: None
U (Fall)
3-0-9 HASS-S
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. Postol

STS.074J Art, Craft, Science
(Same subject as 21A.501J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
Credit cannot also be received for 21A.509, STS.474
See description under subject 21A.501J.
H. Paxson

STS.075J Technology and Development
(Same subject as 21A.500J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-0-7 HASS-S
See description under subject 21A.500J.
S. Helmreich, H. Paxson

STS.077J Technology and Development
(Same subject as 21A.500J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
2-0-7 HASS-S
STS.076J Technology and Policy of Weapons Systems
(Same subject as 17.477J)
Prereq: None
U (Fall)
3-0-9 HASS-S
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.082J Science, Technology, and Public Policy
(Same subject as 17.309J, ESD.082J)
(Subject meets with 17.310J, ESD.103J, STS.482J)
Prereq: None
U (Fall)
4-0-8 HASS-S; CI-H
See description under subject 17.309J.
K. Oye

STS.084J Social Problems of Nuclear Energy (New)
(Same subject as 22.04J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
See description under subject 22.04J.
R. S. Kemp

STS.085J Foundations of Information Policy
(Same subject as 6.805J)
(Subject meets with STS.487)
Prereq: Permission of instructor
U (Fall)
3-0-9 HASS-S
See description under subject 6.805J.
H. Abelson, M. Fischer, D. Weitzner

STS.086J Cultures of Computing
(Same subject as 21A.504J, WGS.276J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
See description under subject 21A.504J.
S. Helmreich

STS.087 Biography in Science
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
An examination of biography as a literary genre to be employed in the history of science. The use of biography in different historical periods to illuminate aspects of the development of science. A critical analysis of autobiography, archival sources, and the oral tradition as materials in the construction of biographies of scientists. Published biographies of scientists constitute the major reading, but attention is given to unpublished biographical sources as well. Comparison is drawn between biography as a literary form in the history of science and in other disciplines.
K. Manning

STS.089 Technology and Innovation in Africa
Prereq: None
U (Fall)
3-0-9 HASS-H
Examines development, environment, public health, and politics in Africa, past and present. Studies indigenous innovations, such as plant/animal domestication, fire making, ecology, mining/metallurgy, architecture, textiles, music, medicine, and finance. Explores impact of incoming factors (e.g., slave trade, colonialism, development aid) on indigenous innovation. Discusses the uses Africans assign to incoming technologies (such as guns, cameras, and information and communication technology) and ideas like democracy and human rights.
C. Mavhunga

STS.090A Critical Issues in STS
Prereq: One STS Tier I subject or permission of instructor
U (Fall)
2-0-10 HASS-E
Can be repeated for credit
Analyzes current events and issues from the perspective of Science, Technology and Society. Students explore a chosen topic and develop their own unique analysis, applying the ideas and concepts of STS. Draws on the recent work of STS faculty, along with the concepts and methods that inspired them. Includes current and classic readings in STS; frequent short writing assignments, oral presentations, and collective discussion; and an independently defined research project. Occasional guest visits by STS faculty and advanced graduate students.
R. H. Williams

Special Subjects

STS.S20, STS.S21 Special Subject: Science, Technology and Society
Prereq: None
U (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Addresses subject matter in Science, Technology and Society that is not offered in the regular curriculum.
Staff

Research

STS.095, STS.096 Independent Study in Science, Technology, and Society
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For students who wish to pursue special studies or projects with a member of the Program in Science, Technology, and Society. STS.095 is letter-graded; STS.096 is P/D/F.
Staff

STS.URG Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
For students who wish to pursue special studies or projects with a member of the Program in Science, Technology, and Society. STS.095 is letter-graded; STS.096 is P/D/F.
Staff

STS.UR Undergraduate Research
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Undergraduate research opportunities in the STS Program.
Staff
Advanced Seminars

STS.310 History of Science
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
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.

STS.320J Environmental Conflict and Social Change
(Same subject as 21A.429J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9 H-LEVEL Grad Credit

See description under subject 21A.429J.

C. Walley

STS.330J History and Anthropology of Medicine and Biology
(Same subject as 21A.319J)
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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 2014–2015: G (Fall)
Acad Year 2015–2016: Not offered
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.

D. Mindell, J. S. Light

STS.360J Ethnography
(Same subject as 21A.829J)
Prereq: Permission of instructor; Coreq: 21A.859
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.413 Energy: Humanistic Perspectives
Prereq: None
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
3-0-9

Explores energy from a humanities perspective, including its place in history and society, architectures, security, conflicts, politics, climate change, and pollution. Covers all continents and time periods, from the invention of fire to present. Emphasizes the different energy cultures and practices as reflected in anthropology, history, literature, philosophy, religious studies, art history, and the arts.

C. Mamphunga

STS.419 Global Science, Technology and Society
Prereq: Permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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.425 History of Manufacturing in America (New)  
(Subject meets with STS.026)  
Prereq: None  
Acad Year 2014–2015: G (Fall)  
Acad Year 2015–2016: Not offered  
3-0-9  
Introductory survey of fundamental innovations and transitions in American manufacturing from the colonial period to the mid-twentieth century. Primary emphasis on textiles and metalworking, with particular attention to the role of the machine tool industry in the American manufacturing economy. Students taking graduate version are expected to explore the material in greater depth.  
M. R. Smith

STS.427 The Civil War and the Emergence of Modern America: 1861–1890  
(Subject meets with 21H.205J, STS.027)  
Prereq: None  
Acad Year 2014–2015: G (Spring)  
Acad Year 2015–2016: Not offered  
3-0-9  
See description under subject STS.027).  
M. R. Smith

STS.429 Food and Power  
(Subject same as 21A.439J)  
Prereq: Permission of instructor  
G (Spring)  
Not offered regularly; consult department  
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  
G (Spring)  
Not offered regularly; consult department  
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 and Global Society  
Prereq: None  
G (Spring)  
Not offered regularly; consult department  
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.435 Nuclear Forces and Missile Defenses  
(Same subject as 17.476)  
(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.440 Self as Data  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Fall)  
3-0-9  
Examines cases in which individuals treat their own habits, bodies, moods, and thoughts as objects of scrutiny, analysis, and intervention. Explores what shifting modes of self-tracking, self-care, and self-governance reveal about changing understandings of the self, and how they remake subjectivity. Topics range from 19th century diary writing and Benjamin Franklin’s self-monitoring practices to contemporary diet techniques and the Quantified Self movement’s digital data collection apps.  
N. Schüll

STS.441 Technology and Self: Technology and Conversation  
Prereq: None  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
2-0-10  
Explores the relationship between technology and conversation, with an emphasis on conversation in our digital age when so many say they would rather text than talk. Topics center on the psychology of online life, such as the way in which we both share and withhold information about the self. Discussion about the ways new kinds of online conversation are playing out in education, the workplace, and in families and what the changes in conversation mean for collaboration, innovation, and leadership. Readings include works in history, literature, anthropology, psychology, and linguistics. Open to undergraduates by permission of instructor. Limited to 15; no listeners.  
S. Turkle

STS.443 Technology and Self: Science, Technology, and Memoir  
(Subject meets with STS.043)  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
2-0-7 H-LEVEL Grad Credit  
Focuses on the memoir as a window onto the relationship of the scientist, engineer, and technologist to his or her work. Studies the subjective side of technology and the social and psychological dimensions of technological change. Students write about specific objects and their role in their lives—memoir fragments. Readings concern child development theory and the role of technology in development. Explores the connection between material culture, identity, cognitive and emotional development. Students taking graduate version complete additional assignments. Limited to 15; no listeners.  
S. Turkle

STS.444 Technology and Self: Things and Thinking  
(Subject meets with STS.044)  
Prereq: Permission of instructor  
Acad Year 2014–2015: Not offered  
Acad Year 2015–2016: G (Spring)  
2-0-7 H-LEVEL Grad Credit  
Explores emotional and intellectual impact of objects. The growing literature on cognition and “things” cuts across anthropology, history, so-
STOS.449 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, B. J. Good

STOS.452 Living in a Technological World
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9

Explores the consequences when human beings dwell in a predominantly self-constructed environment, from the standpoint of humanistic inquiry. Topics include the concept of life-world; the end of the world frontier; advancing edges and empty places; the visible landscape as a register of technological change; world alienation; loss of human habitat; redefining exploration; and imagining a rehumanized world. Readings, both fiction and non-fiction, include works by authors such as H. Arendt, M. Berman, T. J. Clark, L. Marx, W. Morris, J. Verne, and R. L. Stevenson.
R. H. Williams

STOS.454 Science and Technology in the Museum Environment
Prereq: None
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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.
J. Durant

STOS.460 Histories of Information, Communication, and Computing Technologies (New)
Prereq: None
G (Spring)
3-0-9

Introduction to the historical study of information, communication, and computing technologies with a focus on the United States. Pairs analysis of a multidisciplinary reading list with in-depth discussions of research methods and writing for academic publications. Later weeks of the course adapt to student interests and are determined by students in consultation with the instructor. Limited to 15.
J. S. Light

STOS.462 Social and Political Implications of Technology
Prereq: None
Acad Year 2014–2015: G (Fall)
Acad Year 2015–2016: 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

STOS.467J The History of Aviation
(Same subject as 16.707J)
Prereq: Permission of Instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9 H-LEVEL Grad Credit

Reading course in the history of aviation, focusing on science and technology and cultural and political context. Themes include: the science of aeronautics, pilots and piloting, control systems and electronics, engineering epistemology, infrastructure, industry, government and politics, evolution of aeronautics research, culture and experience, automation and autonomy, role of MIT, literature and film. Case studies of specific systems and engineering projects. Emphasis is on book-length texts, close reading, historical methods of analyzing technological change. Study of social and political dimensions of engineering projects, examination of aviation institutions. Students prepare weekly response papers to readings, make extended presentations to class twice per term, and submit a final research paper.
D. Mindell

STOS.470J Research Seminar: Human, Remote and Autonomous Systems in Air, Sea, and Space
(Same subject as 16.440J)
Prereq: 16.400, 16.453, or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit

See description under subject 16.440J.
D. A. Mindell

STOS.471J Engineering Apollo: The Moon Project as a Complex System
(Same subject as 16.895J, ESD.30J)
Prereq: Permission of instructor
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
4-0-8 H-LEVEL Grad Credit

Detailed technical and historical exploration of the Apollo project to fly humans to the moon and return them safely to Earth as an example of a complex engineering system. Emphasizes how the systems worked, the technical and social processes that produced them, mission operations, and historical significance. Guest lectures by MIT-affiliated engineers who contributed to and participated in the Apollo missions. Students work in teams on a final project analyzing an aspect of the historical project to articulate and synthesize ideas in engineering systems.
D. Mindell

STOS.474J Art, Craft, Science
(Same subject as 21A.509J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9

Credit cannot also be received for 21A.501, STS.074
See description under subject 21A.509J.
H. Paxson

STOS.477J Writing: Science, Technology, and Society
(Same subject as 21W.820J)
Prereq: 21H.991J
Acad Year 2014–2015: G (Spring)
Acad Year 2015–2016: Not offered
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.481J Cross-Cultural Investigations:**

Technology and Development
(Same subject as EC.792J, 21A.839J)
(Subject meets with EC.702J, 21A.801J, STS.071J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall)
3-0-9
See description under subject 21A.839J.

C. Walley

**STS.482J Science, Technology, and Public Policy**
(Same subject as 17.310J, ESD.103J)
(Subject meets with 17.309J, ESD.082J, STS.082J)
Prereq: Permission of instructor
G (Fall)
4-0-8 H-LEVEL Grad Credit
See description under subject 17.310J.

K. Oye

**STS.487 Foundations of Information Policy**
(Subject meets with 6.805J, STS.085J)
Prereq: Permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Studies the growth of computer and communica-
tions technology and the new legal and
ethical challenges that reflect tensions between
individual rights and societal needs. Topics
include computer crime; intellectual property re-
strictions on software; encryption, privacy, and
national security; academic freedom and free
speech. Students meet and question technolo-
gists, activists, law enforcement agents, journal-
ists, and legal experts. Instruction and practice
in oral and written communication provided.
Students taking graduate version complete ad-
ditional assignments. Enrollment limited.

H. Abelson, M. Fischer, D. Weitzner

---

**Special Subjects**

**STS.591, STS.592 Special Subject: Science, Technology and Society**
Prereq: None
G (Fall, IAP, Spring)
Not offered regularly; consult department
Units arranged
Can be repeated for credit
Addresses a special topic in Science, Technology
and Society which is not offered in the regular
curriculum.

Staff

---

**Research and Teaching**

**STS.800 Teaching Science, Technology and Society**
Prereq: None
G (Fall, Spring)
Units arranged [P/D/F]
Can be repeated for credit
For qualified graduate students serving as either
a teaching assistant or instructor for subjects in
Science, Technology and Society (STS). Enroll-
ment 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, 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(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</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology</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

- One STS Tier I subject: 51–54
- One STS Tier II subject:
  - STS.491 Critical Issues in STS, 12, HASS-E, CI-M *
  - STS.ThT Undergraduate Thesis Tutorial, 6
  - STS.ThU Undergraduate Thesis, 12, CI-M *

### Restricted Electives

A coherent group of five elective subjects in STS, plus four subjects related to the historical and social study of science and technology, in consultation with the STS undergraduate officer: 102–108

## Departmental Program Units That Also Satisfy the GIRs

(72)

## Unrestricted Electives

90-99

## 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.

(1)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).
SWE ENGINEERING SCHOOL-WIDE ELECTIVES

Engineering Systems Analysis for Design
(Offered under: 1.146, 16.861, ESD.71)
(Subject meets with ESD.710)
Prereq: 1.145 or permission of instructor
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: 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

Ethics for Engineers
(Offered under: 1.082, 2.900, 10.01)
Prereq: None
U (Fall)
2-0-4
Integrates classical readings that provide an overview of ethics with a survey of case studies that focus on ethical problems arising in the practice of engineering. Readings taken from a variety of sources, such as Aristotle, Machiavelli, Bacon, Hobbes, Locke, the Founding Fathers, and the Bible. Case studies include written analyses and films that address engineering disasters, biotechnology, court cases, ethical codes, and the ultimate scope and aims of engineering.
D. Doneson, B. L. Trout

Introduction to Modeling and Simulation
(Offered under: 1.021, 3.021, 10.333, 22.00)
Prereq: 18.03, 3.016, or permission of instructor
U (Fall)
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, M. Demkowicz

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, J.-H. Chun

UPOP Engineering Practice Experience
(Offered under: 1.EPE, 2.EPE, 3.EPE, 6.EPE, 10.EPE, 16.EPE, 20.EPE, 22.EPE)
Prereq: 2.EPW or permission of instructor
U (Fall, Spring)
0-0-1 [P/D/F]
Provides sophomores with guided practice in finding opportunities and excelling in the world of practice. Building on the skills and relationships acquired in the Engineering Practice Workshop, students receive coaching to articulate goals, invoke the UPOP network of mentors and employers, identify and pursue opportunities and negotiate terms of their summer assignment. Students complete a 10-12 week internship, which includes filing three progress reports, conducting one informational interview, and possibly hosting a site visit by MIT staff. Returning to campus as juniors, UPOP students take part in reflective exercises that aid assimilation of learning objectives and reinforce the cognitive link between all aspects of the UPOP experience and disciplinary fields of study. Sequence begins in the spring of sophomore year and ends in the fall of junior year.
Staff

UPOP Engineering Practice Workshop
(Offered under: 1.EPW, 2.EPW, 3.EPW, 6.EPW, 10.EPW, 16.EPW, 20.EPW, 22.EPW)
Prereq: None
U (Fall, IAP)
1-0-0 [P/D/F]
Develops foundational skills for the world of practice in science, technology, and engineering. Sophomores receive classroom instruction, and one-on-one and small-group coaching in basics of professional identity building. They attend field trips to local employers and receive job interview practice, coached by industry volunteers. Over IAP, students attend a weeklong Team Training Camp of experiential learning modules led by MIT faculty with the help of MIT alums and other senior professionals in business, engineering, and science where students participate in creative simulations, team problem-solving challenges, and oral presentations, and practice networking with employers. Enrollment limited.
Staff
UNDERGRADUATE SUBJECTS

WGS.101 Introduction to Women’s and Gender Studies
Prereq: None
U (Fall, Spring)
3-0-9 HASS-H; CI-H

Drawing on multiple disciplines—such as literature, history, economics, psychology, philosophy, political science, anthropology, media studies and the arts—to examine cultural assumptions about sex, gender, and sexuality. Integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the ways sex and gender interact with race, class, nationality, and other social identities. Students are introduced to recent scholarship on gender and its implications for traditional disciplines.
A. Walsh

WGS.109 Women and Global Activism in Media and Politics
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

An interdisciplinary subject that examines questions of feminism, international women’s issues, and globalization through the study of novels, films, critical essays, painting and music. Considers how women redefine the notions of community and nation, how development affects their lives, and how access to the internet and to the production industry impacts women’s lives. Primary topics of interest include transformations of traditional values, social change, gender role distribution, identity formation, migration flows, globalization and development, popular culture, urban life, 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
Prereq: None
U (Fall)
3-0-9 HASS-H

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.111J Gender and Media Studies
(Same subject as CMS.619J)
Prereq: None
U (Fall)
3-0-9 HASS-H

Examines representations of race, gender, and sexual identity in the media. Considers issues of authorship, spectatorship, and the ways in which various media (film, television, print journalism, advertising) enable, facilitate, and challenge these social constructions in society. Studies the impact of new media and digital media through analysis of gendered and racialized language and embodiment online in blogs and vlogs, avatars, and in the construction of cyberidentities. Provides introduction to feminist approaches to media studies by drawing from work in feminist film theory, cultural studies, gender and politics, and cyberfeminism.
K. Surkan

WGS.115 Gender and Technology
Prereq: None
U (Spring)
3-0-9 HASS-H

Considers a wide range of issues related to the contemporary and historical use of technology, the development of new technologies, and the cultural representation of technology, including the role women have played in the development of technology and the effect of technological change on the roles of women and ideas of gender. Discusses the social implications of technology and its understanding and deployment in different cultural contexts. Investigates the relationships between technology and identity categories, such as gender, race, class, and sexuality. Examines how technology offers possibilities for new social relations and how to evaluate them.
K. Surkan

WGS.125J Games and Culture (New)
(Same subject as 21W.768J, CMS.616J)
(Subject meets with CMS.868)
Prereq: None
U (Fall)
3-0-9 HASS-S

See description under subject CMS.616J.
T. L. Taylor

WGS.140J Race and Identity in American Literature
(Same subject as 21L.504J)
Prereq: Permission of instructor
U (Spring)
3-0-9 HASS-H
Can be repeated for credit
See description under subject 21L.504J.
S. Alexandre

WGS.141J International Women’s Voices
(Same subject as 21F.022J, 21L.048J)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H

See description under subject 21L.048J.
M. Resnick

WGS.142 Narrative and Identity: Writing and Film by Contemporary Women of Color
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Explores the diverse voices and experiences reflected in writing and film by and about women of color. Examines the roles that culture, community, and kinship play in the development of the writer’s individual voice, and compares the similarities and differences of the writer experience across texts and genres. Discussion and assignments, including an independent research presentation, consider the social and
political contexts that inform each work, with an emphasis on gender, race, and economic status. Includes works by a variety of novelists, poets, and filmmakers.

Staff

WGS.150 Gender, Power, Leadership, and the Workplace (New)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S

Provides an analytic framework to understand the roles that gender, race, and class play in defining and determining access to leadership and power in the United States, especially in the context of the workplace. Explores women and men in leadership positions within the corporate, political and non-profit sectors, focusing on women of color and immigrant women. Looks at specific policies, such as affirmative action, parental leave, child care, and working-time, and the role they play or could play in achieving parity. Students further investigate ways in which these policies address gender, racial, and class inequities, and develop their ability to think critically about mechanisms for change.

Limited to 25.

M. Fried

WGS.161J Gender and the Law in US History
(Same subject as 21H.320J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H

See description under subject 21H.320J.

C. Capozzola

WGS.175J Reproductive Politics and Technologies
(Same subject as 21A.304J)
Prereq: None
U (Fall)
Not offered regularly; consult department
3-0-9 HASS-S

See description under subject 21A.304J.

H. Paxson

WGS.190J Black Matters: Introduction to Black Studies
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-A, HASS-H; CI-H

See description under subject 24.912J.

Staff

WGS.220 Women and Gender in the Middle East and North Africa
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Provides an overview of key issues and themes in the study of women and gender relations in the Middle East and North Africa. Includes readings from a variety of disciplines, e.g., history, anthropology, sociology, literature, religious studies, and media studies. Addresses themes such as the relationship between the concepts of nation and gender; women's citizenship; Middle Eastern women's activism and the involvement of their Western "sisters" to this movement; gendered interpretations of the Qur'an and the example of the Prophet Muhammad; and the three H's of Orientalism (hijab, harem, and hamam).

L. Ekmekcioglu

WGS.221 Women in the Developing World
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S

Can be repeated for credit

Study of women and gender in the developing world. Interdisciplinary approaches highlight relationships between gender and public policy, economics, art, education, health care, and scientific research. Topics vary by term.

A. Sur

WGS.222J Women and War
(Same subject as 21H.381J)
Prereq: None
U (Fall)
3-0-9 HASS-S

See description under subject 21H.381J.

L. Ekmekcioglu

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

Examines the role of science and medicine in the origins and evolution of the concepts of race, sex, and gender from the 17th century to the present. Focus on how biological, anthropological, and medical concepts intersect with social, cultural, and political ideas about racial, sexual, and gender difference in the US and globally. Approach is historical and comparative across disciplines emphasizing the different modes of explanation and use of evidence in each field.

A. Sur, S. Helmreich

WGS.226J Science, Caste and Gender in India
(Same subject as STS.023J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H

Examines the influence of social and cultural determinants (colonialism, nationalism, caste, class, and gender) on modern science and technology in British colonial and postcolonial India. Discusses the relationship of scientific progress to colonial expansions and nationalist aspirations. Explores the nature of scientific institutions within a social, cultural, and political context, and how science and technology have impacted Indian society.

A. Sur

WGS.228J Psychology of Gender and Race
(Same subject as 9.75J)
Prereq: None
U (Fall, Spring)
3-0-9 HASS-S

See description under subject 9.75J.

C. Kapungu
WGS.231J Writing about Race
(Same subject as 21W.742J)
Prereq: None
U (Spring)
3-0-9 HASS-H; CI-H
See description under subject 21W.742J.
K. Ragusa

WGS.233J New Culture of Gender: Queer France
(Same subject as 21F.325J)
Prereq: One intermediate subject in French Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-H
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
(Same subject as 21F.068J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-H
See description under subject 21F.068J.
B. Perreau

WGS.235J Classics of Chinese Literature in Translation
(Same subject as 21F.044J, 21L.044J)
Subject meets with 21F.195
Prereq: None
U (Spring)
Not offered regularly; consult department
3-0-9 HASS-H
See description under subject 21F.044J.
E. Teng

WGS.236J Introduction to East Asian Cultures: From Zen to K-Pop
(Same subject as 21F.030J)
Subject meets with 21F.193
Prereq: None
Acad Year 2014–2015: U (Spring)
Acad Year 2015–2016: Not offered
3-0-9 HASS-H
See description under subject 21F.030J.
E. Teng

WGS.240J Jane Austen
(Same subject as 21L.473J)
Prereq: One subject in Literature
U (Fall)
3-0-9 HASS-H
See description under subject 21L.473J.
R. Perry

WGS.270J Violence, Human Rights, and Justice
(Same subject as 21A.442J)
Prereq: None
U (Fall)
3-0-9 HASS-S
See description under subject 21A.442J.
E. C. James

WGS.271J Dilemmas in Biomedical Ethics: Playing God or Doing Good?
(Same subject as 21A.302J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
See description under subject 21A.302J.
E. C. James

WGS.272J Slavery and Human Trafficking in the 21st Century
(Same subject as 21A.445J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
See description under subject 21A.445J.
M. Buyandelger

WGS.274J Images of Asian Women: Dragon Ladies and Lotus Blossoms
(Same subject as 21A.141J, 21F.048J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
See description under subject 21A.141J.
M. Buyandelger

WGS.276J Cultures of Computing
(Same subject as 21A.504J, STS.086J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
See description under subject 21A.504J.
S. Helmreich

WGS.278J Slavery and Human Trafficking in the 21st Century
(Same subject as 21A.445J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Spring)
3-0-9 HASS-S
See description under subject 21A.445J.
M. Buyandelger

WGS.279J Dilemmas in Biomedical Ethics: Playing God or Doing Good?
(Same subject as 21A.302J)
Prereq: None
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: U (Fall)
3-0-9 HASS-S
See description under subject 21A.302J.
E. C. James

WGS.301J Feminist Thought
(Same subject as 17.007J, 24.237J)
(Same subject as 17.007J, 24.237J)
Prereq: None
U (Fall)
3-0-9 HASS-H
Analyzes theories of gender and politics, especially ideologies of gender and their construction; definitions of public and private spheres; gender issues in citizenship, the development of the welfare state, experiences of war and revolution, class formation, and the politics of sexuality. Graduate students are expected to pursue the subject in greater depth through reading and individual research.
S. Haslanger

WGS.400 WGS Undergraduate Independent Study
Prereq: Permission of instructor
U (Fall, Spring)
Units arranged
Can be repeated for credit
Individual supervised work for undergraduate students who wish to study topics not covered in the regular Women’s and Gender Studies curriculum. Before registering for this subject, students must plan a course of study with a member of the WGS faculty and secure the Director’s approval. Normal maximum credit is 6 units, but exceptional 9-unit projects occasionally approved.
Staff

WGS.UR Undergraduate Research in Women’s and Gender Studies
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit

WGS.URG Undergraduate Research in Women’s and Gender Studies
Prereq: Permission of instructor
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
Undergraduate research opportunities in the Women’s and Gender Studies Program.
Staff
WGS.S10 Special Subject in Women’s and Gender Studies
Prereq: None
U (Fall, Spring)
3-0-9
Can be repeated for credit with permission of instructor
Covers topics not included in regular curriculum; taught in seminar format.
Staff

SUBJECTS OFFERED BY OTHER PROGRAMS

Each of the following may be taken for credit as a Women’s and Gender Studies (WGS) subject when its content meets WGS criteria. The full description of each subject appears with its designated Course listing. For more information, contact the program office, 14E-316, 617-253-8844, wgs@mit.edu.

21L.430 Popular Culture and Narrative
21L.460 Medieval Literature
21L.512 American Authors
21L.701 Literary Interpretation
21L.702 Studies in Fiction
21L.704 Studies in Poetry
21L.705 Major Authors
21L.707 Problems in Cultural Interpretation
21L.715 Media in Cultural Context
21W.745 Advanced Essay Workshop

GRADUATE SUBJECTS

WGS.600 Workshop for Dissertation Writers in Women’s and Gender Studies
Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall, Spring)
3-0-9
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

WGS.605 WGS Graduate Independent Study
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.610 Seminar in Feminist Issues
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

WGS.615 Feminist Inquiry: Strategies for Effective Scholarship
Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Spring)
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 distinctly feminist lies in the complex connections between epistemologies, methodologies and research methods. Explore how these connections are formed in the traditional disciplines and raise questions about why they are inadequate and/or problematic for feminist inquiry and what, specifically, are the feminist critiques of these intersections.
Information: Graduate Program in Women’s Studies

WGS.640 Studies in Women’s Life Narratives
Prereq: Must apply to the Graduate Consortium in Women’s Studies
G (Fall)
3-0-9 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
Prereq: Application to the Graduate Consortium in Women’s Studies
G (Fall)
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
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
Prereq: Must apply to the Graduate Consortium in Women’s Studies
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring)
3-0-9
Can be repeated for credit
Syllabi vary depending on instructors.
Information: Graduate Consortium in Women’s Studies