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NONDISCRIMINATION POLICY

The Massachusetts Institute of Technology is committed to the principle of equal opportunity in education and employment. The Institute prohibits discrimination against individuals on the basis of race, color, sex, sexual orientation, gender identity, pregnancy, religion, disability, age, genetic information, veteran status, 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; the Institute may, however, favor US citizens or residents in admissions and financial aid.¹

The Vice President for Human Resources is designated as the Institute's Equal Opportunity Officer. Inquiries concerning the Institute's policies, compliance with applicable laws, statutes, and regulations, and complaints may be directed to Lorraine Goffe, Vice President for Human Resources, Room NE49-5000, 617-253-6512. In addition, inquiries about Title IX (which prohibits discrimination on the basis of sex) may be directed to the Institute's Title IX coordinator, Sarah Rankin, Room W31-223, 617-324-7526, titleIX@mit.edu. Inquiries about the laws and about compliance may also be directed to the United States Department of Education, Office for Civil Rights, Region I, 5 Post Office Square, 8th Floor, Boston, MA 02109-3921, 617-289-0111, OCR.Boston@ed.gov.

¹ 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 is committed to providing alternative financial assistance under a needs-based assessment to any MIT student who loses ROTC financial aid because of these DoD policies and regulations.

Last updated April 2018.
## Academic Calendar

### 2018–2019

#### August

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<td><strong>Deadline for Doctoral Students</strong> to submit application, signed by department, to the Office of Graduate Education, 3-138, for Fall Term Non-Resident status. $100 Late Fee.</td>
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<td><strong>Last Day to Go Off the September Degree List</strong></td>
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<td>Last day of classes for Regular Summer Session</td>
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<td>Last day to petition for September Advanced Standing Exam</td>
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<td><strong>Final Deadline for Continuing Students to Preregister for Fall</strong>, 5 pm. $85 Late Fee.</td>
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<td>First Year Student Orientation begins</td>
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<td><strong>Grade Deadline</strong>. Grades for Summer Session must be submitted by this date.</td>
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<td><strong>Registration Opens</strong> for all students</td>
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<td>English Evaluation Test for new international graduate students, 9 am–12 pm</td>
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<td>31</td>
<td>Fri</td>
<td>Last day to waive coverage or sign up for family health insurance for fall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Undergraduate Registration opens for First Quarter Physical Education classes, 8:00 am</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advanced standing Exams and Postponed Finals.</td>
</tr>
</tbody>
</table>

#### September

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Number of class days (Wed, Sep 5 through Wed, Dec 12): 12 Mon, 13 Tue, 15 Wed, 13 Thu, 12 Fri = 65 days</strong></td>
</tr>
<tr>
<td>3</td>
<td>Mon</td>
</tr>
<tr>
<td>4</td>
<td>Tue</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Wed</td>
</tr>
<tr>
<td>7</td>
<td>Fri</td>
</tr>
</tbody>
</table>

---

### October

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><strong>Add Date</strong>. Last day to add subjects to Registration.</td>
</tr>
<tr>
<td></td>
<td>Last day for juniors/seniors to change an elective to or from P/D/F grading</td>
</tr>
<tr>
<td></td>
<td>Last day for graduate students to change a subject to or from P/D/F grading</td>
</tr>
<tr>
<td></td>
<td>Last day to drop half-term subjects offered in first half of term (H1)</td>
</tr>
<tr>
<td>8–9</td>
<td>Mon–Tue</td>
</tr>
<tr>
<td>10</td>
<td>Wed</td>
</tr>
<tr>
<td>15–19</td>
<td>Mon–Fri</td>
</tr>
<tr>
<td>16</td>
<td>Tue</td>
</tr>
<tr>
<td>Date</td>
<td>Day</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>19</td>
<td>Fri</td>
</tr>
<tr>
<td>22</td>
<td>Mon</td>
</tr>
<tr>
<td>26–27</td>
<td>Fri–Sat</td>
</tr>
<tr>
<td>29</td>
<td>Mon</td>
</tr>
<tr>
<td>2018–2019</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Fri</td>
</tr>
<tr>
<td>22</td>
<td>Mon</td>
</tr>
<tr>
<td>26–27</td>
<td>Fri–Sat</td>
</tr>
<tr>
<td>29</td>
<td>Mon</td>
</tr>
</tbody>
</table>

**November**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Fri</td>
<td>Last day to add half-term subjects offered in second half of term (H2)</td>
</tr>
<tr>
<td>12</td>
<td>Mon</td>
<td>Veterans Day—Holiday</td>
</tr>
<tr>
<td>21</td>
<td>Wed</td>
<td>DROP DATE. Last day to cancel subjects from Registration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to change a subject from Credit to Listener.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to add a time-arranged subject that started after beginning of the term</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to petition for December Advanced Standing Exam (given during Final Exam Period)</td>
</tr>
<tr>
<td>22–23</td>
<td>Thu–Fri</td>
<td>Thanksgiving Vacation</td>
</tr>
<tr>
<td>28</td>
<td>Wed</td>
<td>Last day to drop half-term subjects offered in second half of term (H2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Undergraduate Registration opens for IAP Physical Education classes, 8:00 am</td>
</tr>
</tbody>
</table>

**December**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Mon</td>
<td>PREREGISTRATION for Spring Term and IAP begins</td>
</tr>
<tr>
<td>4</td>
<td>Tue</td>
<td>Graduate Registration opens for IAP Physical Education classes, 8:00 am</td>
</tr>
<tr>
<td>7</td>
<td>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></td>
<td></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 regularly scheduled class period in the subject.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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>12</td>
<td>Wed</td>
<td>LAST DAY OF CLASSES</td>
</tr>
<tr>
<td>14</td>
<td>Fri</td>
<td>Last day to submit or change Advanced Degree Thesis Title. $85 Late Fee.</td>
</tr>
<tr>
<td>17–21</td>
<td>Mon–Fri</td>
<td>FINAL EXAM PERIOD</td>
</tr>
<tr>
<td>18–Jan 3</td>
<td>Tue–Thu</td>
<td>GRADE DEADLINE. Grades must be submitted according to due date indicated.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Thu</td>
<td>SPRING PREREGISTRATION DEADLINE. Continuing students must initiate preregistration by 5 pm on this date. $50 Late Fee ($85 after January 17).</td>
</tr>
</tbody>
</table>

**January**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Fri</td>
<td>Term summaries of Fall Term grades available to departments</td>
</tr>
<tr>
<td>7</td>
<td>Mon</td>
<td>First day of January Independent Activities Period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEADLINE FOR DOCTORAL STUDENTS to submit application, signed by department, to the Office of Graduate Education, 3-138, for Spring Term Non-Resident status. $100 Late Fee. Not needed if Spring Term approved with Fall Term application.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IAP Physical Education classes begin</td>
</tr>
<tr>
<td>8</td>
<td>Tue</td>
<td>Graduate Academic Performance Grades Meeting</td>
</tr>
<tr>
<td>9–10</td>
<td>Wed–Thu</td>
<td>CAP Grades Meetings</td>
</tr>
<tr>
<td>11</td>
<td>Fri</td>
<td>IAP PREREGISTRATION DEADLINE. Deadline for all students to preregister for IAP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>THESIS DUE for doctoral degrees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to petition for January Advanced Standing Exam</td>
</tr>
<tr>
<td>17</td>
<td>Thu</td>
<td>5:00 PM FINAL DEADLINE FOR CONTINUING STUDENTS TO PREREGISTER FOR SPRING. $85 Late Fee.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEADLINE FOR CONTINUING STUDENTS to select preferences for Spring CI-H/CI-HW subjects</td>
</tr>
<tr>
<td>18</td>
<td>Fri</td>
<td>THESIS DUE for degrees other than doctoral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LAST DAY TO GO OFF THE FEBRUARY DEGREE LIST</td>
</tr>
<tr>
<td>21</td>
<td>Mon</td>
<td>Martin Luther King, Jr. Day—Holiday</td>
</tr>
<tr>
<td>23–24</td>
<td>Wed–Thu</td>
<td>CAP Deferred Action Meetings</td>
</tr>
<tr>
<td>28</td>
<td>Mon</td>
<td>REGISTRATION OPENS for all students</td>
</tr>
<tr>
<td>30</td>
<td>Wed</td>
<td>Undergraduate Registration opens for Third Quarter Physical Education classes, 8:00 am</td>
</tr>
<tr>
<td>31</td>
<td>Thu</td>
<td>Last day to waive coverage or sign up for family health insurance for spring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>English Evaluation test for International students 9:00 am–12:00 pm</td>
</tr>
</tbody>
</table>

**February**

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SPRING TERM Number of class days (Tue, Feb 5, through Thu, May 16): 12 Mon, 12 Tue, 14 Wed, 14 Thu, 13 Fri = 65 days</td>
</tr>
<tr>
<td>1</td>
<td>Fri</td>
<td>Last day of January Independent Activities Period</td>
</tr>
</tbody>
</table>
## Academic Calendar

### January

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Mon</td>
<td><strong>REGISTRATION DAY—SPRING TERM</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DEADLINE</strong> to change a Fall Term Exploratory subject to Listener status</td>
</tr>
<tr>
<td>5</td>
<td>Tue</td>
<td><strong>FIRST DAY OF CLASSES</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Graduate Registration opens for Third Quarter Physical Education classes, 8:00 am</td>
</tr>
<tr>
<td>6</td>
<td>Wed</td>
<td><strong>GRADE DEADLINE.</strong> Grades for IAP must be submitted by this date.</td>
</tr>
<tr>
<td>7</td>
<td>Thu</td>
<td>Term Summaries of Grades for IAP available to departments</td>
</tr>
<tr>
<td>8</td>
<td>Fri</td>
<td><strong>REGISTRATION DEADLINE.</strong> Registration for all students must be submitted by this date. $50 Late Fee.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DEGREE APPLICATION DEADLINE</strong> for June SB and Advanced Degrees. $50 Late Fee ($85 Late Fee after April 3).</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DEADLINE FOR SECOND-TERM JUNIORS</strong> to submit the HASS Concentration Proposal form. $50 Late Fee.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>DEADLINE FOR FINAL-TERM SENIORS</strong> to submit the HASS Concentration Completion form. $50 Late Fee.</td>
</tr>
<tr>
<td>11</td>
<td>Mon</td>
<td>Third quarter Physical Education classes begin</td>
</tr>
<tr>
<td>12</td>
<td>Tue</td>
<td>Graduate Academic Performance Meeting</td>
</tr>
<tr>
<td>15</td>
<td>Fri</td>
<td>Last day to add half-term subjects offered in first half of term (H3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CAP February Degree Candidates Meeting</td>
</tr>
<tr>
<td>18</td>
<td>Mon</td>
<td>Presidents Day—Holiday</td>
</tr>
<tr>
<td>19</td>
<td>Tue</td>
<td><strong>MONDAY SCHEDULE OF CLASSES TO BE HELD</strong></td>
</tr>
<tr>
<td>20</td>
<td>Wed</td>
<td>Faculty Officers recommend degrees to Corporation (Degree Award Date)</td>
</tr>
<tr>
<td>22</td>
<td>Fri</td>
<td><strong>MINOR COMPLETION DATE.</strong> Deadline for submission of Minor Completion form for final-term seniors. $50 Late Fee.</td>
</tr>
</tbody>
</table>

### March

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Wed</td>
<td>Undergraduate Registration opens for Fourth Quarter Physical Education classes, 8:00 am</td>
</tr>
<tr>
<td>8</td>
<td>Fri</td>
<td><strong>ADD DATE.</strong> Last day to add subjects to Registration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day for juniors/seniors to change an elective to or from P/D/F grading</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day for graduate students to change a subject to or from P/D/F grading</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to change a subject from Listener to Credit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to drop half-term subjects offered in first half of term (H3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day for sophomores to change a subject to or from Exploratory</td>
</tr>
<tr>
<td>1</td>
<td>Wed</td>
<td><strong>PREREgISTRATION</strong> for Fall Term and Summer Session begins</td>
</tr>
<tr>
<td>2</td>
<td>Thu</td>
<td>Last day to drop half-term subjects offered in second half of term (H4)</td>
</tr>
<tr>
<td>3</td>
<td>Fri</td>
<td><strong>THESIS DUE</strong> for doctoral degrees</td>
</tr>
<tr>
<td>10</td>
<td>Fri</td>
<td><strong>SUBJECTS WITH FINAL EXAMS</strong>—No test may be given and no assignment, term paper, or oral presentation shall fall due after this date.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>SUBJECTS WITH NO FINAL EXAM</strong>—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.</td>
</tr>
</tbody>
</table>

### April

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mon</td>
<td>First day of classes for half-term subjects offered in second half of term (H4)</td>
</tr>
<tr>
<td>3</td>
<td>Wed</td>
<td>Fourth quarter Physical Education classes begin</td>
</tr>
<tr>
<td>5</td>
<td>Fri</td>
<td>Last day to submit Advanced Degree Thesis Title. $85 Late Fee.</td>
</tr>
<tr>
<td>11–14</td>
<td>Thu–Sun</td>
<td>Campus Preview Weekend</td>
</tr>
<tr>
<td>12</td>
<td>Fri</td>
<td>Last day to add half-term subjects offered in second half of term (H4)</td>
</tr>
<tr>
<td>15–16</td>
<td>Mon–Tue</td>
<td>Patriots Day—Vacation</td>
</tr>
<tr>
<td>25</td>
<td>Thu</td>
<td><strong>DROP DATE.</strong> Last day to cancel subjects from Registration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to change a subject from Credit to Listener</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to add time-arranged subject that started after beginning of the term</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Last day to petition for May Advanced Standing Exam (given during Final Exam Period)</td>
</tr>
</tbody>
</table>

### May

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wed</td>
<td><strong>PREREgISTRATION</strong> for Fall Term and Summer Session begins</td>
</tr>
<tr>
<td>2</td>
<td>Thu</td>
<td>Last day to drop half-term subjects offered in second half of term (H4)</td>
</tr>
<tr>
<td>3</td>
<td>Fri</td>
<td><strong>THESIS DUE</strong> for doctoral degrees</td>
</tr>
<tr>
<td>10</td>
<td>Fri</td>
<td><strong>SUBJECTS WITH FINAL EXAMS</strong>—No test may be given and no assignment, term paper, or oral presentation shall fall due after this date.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>SUBJECTS WITH NO FINAL EXAM</strong>—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.</td>
</tr>
</tbody>
</table>
### 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>16</td>
<td>Thu</td>
<td>LAST DAY OF CLASSES</td>
</tr>
<tr>
<td>20–24</td>
<td>Mon–Fri</td>
<td>FINAL EXAM PERIOD</td>
</tr>
<tr>
<td>21–28</td>
<td>Tue–Tue</td>
<td>GRADE DEADLINE. Grades must be submitted according to due date indicated.</td>
</tr>
<tr>
<td>24</td>
<td>Fri</td>
<td>LAST DAY TO GO OFF THE JUNE DEGREE LIST</td>
</tr>
<tr>
<td>27</td>
<td>Mon</td>
<td>Memorial Day—Holiday</td>
</tr>
<tr>
<td>29</td>
<td>Wed</td>
<td>Term Summaries of Spring Term Grades available to Departments</td>
</tr>
<tr>
<td>30</td>
<td>Thu</td>
<td>DEPARTMENT GRADES MEETINGS</td>
</tr>
</tbody>
</table>

### SUMMER SESSION PREREGISTRATION DEADLINE.
Deadline for all students to preregister for Summer Session. $50 Late Fee.

### June

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Mon</td>
<td>CAP June Degree Candidates Meeting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CAP Grades Meeting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Graduate Academic Performance Meeting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faculty Officers recommend degrees to Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REGISTRATION OPENS for all students</td>
</tr>
<tr>
<td>4</td>
<td>Tue</td>
<td>CAP Grades Meeting</td>
</tr>
<tr>
<td>6</td>
<td>Thu</td>
<td>Doctoral Hooding Ceremony</td>
</tr>
<tr>
<td>7</td>
<td>Fri</td>
<td>COMMENCEMENT</td>
</tr>
<tr>
<td>10</td>
<td>Mon</td>
<td>First day of classes for Regular Summer Session</td>
</tr>
<tr>
<td>12–13</td>
<td>Wed–Thu</td>
<td>CAP Deferred Action Meetings</td>
</tr>
<tr>
<td>14</td>
<td>Fri</td>
<td>DEGREE APPLICATION DEADLINE for September SB and Advanced Degrees. $50 Late Fee ($85 after July 12).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REGISTRATION DEADLINE. Registration for all students must be submitted by this date. $50 Late Fee.</td>
</tr>
<tr>
<td>17</td>
<td>Mon</td>
<td>FALL PREREGISTRATION DEADLINE. Continuing students must initiate preregistration by this date. $50 Late Fee ($85 after August 22).</td>
</tr>
</tbody>
</table>

### DEADLINE FOR CONTINUING STUDENTS
to select preferences for fall CI-H/CI-HW subjects

June 10 (Monday)–August 20 (Tuesday) Summer Session (including Exam Period). Theses due for all September Degree candidates, Friday, August 9.

The official Academic Calendar (https://registrar.mit.edu/calendar) is published by the Registrar; consult the Registrar’s website for information about projected key dates for future academic years (https://registrar.mit.edu/calendar/projected-key-dates).
Here’s a quick look at what makes MIT tick—the ingredients of a world-class educational institution.
OVERVIEW

On February 20, 1865, four years after approval of its founding charter, the Massachusetts Institute of Technology opened its doors to admit the first class of 15 students. The event marked the culmination of an effort by William Barton Rogers, MIT’s founder and first president, to create a new kind of educational institution relevant to the times and to the nation’s need, where students would be educated in the application as well as the acquisition of knowledge. A distinguished natural scientist, Rogers stressed the importance of basic research and believed that professional competence was best fostered by the coupling of teaching and research and attention to real-world problems.

Teaching and research—with relevance to the practical world as a guiding principle—continue to be MIT’s primary purpose. The Institute is independent, coeducational, and privately endowed. Its five schools—architecture and planning; engineering; humanities, arts, and social sciences; management; and science—encompass numerous academic departments, institutes, and degree-granting programs, as well as interdisciplinary research centers, laboratories, and programs whose work extends beyond traditional departmental boundaries.

Mission Statement

The mission of MIT is to advance knowledge and educate students in science, technology, and other areas of scholarship that will best serve the nation and the world in the 21st century.

The Institute is committed to generating, disseminating, and preserving knowledge, and to working with others to bring this knowledge to bear on the world’s great challenges. MIT is dedicated to providing its students with an education that combines rigorous academic study and the excitement of discovery with the support and intellectual stimulation of a diverse campus community. We seek to develop in each member of the MIT community the ability and passion to work wisely, creatively, and effectively for the betterment of humankind.

AROUND CAMPUS

Through an integrated educational program focused on academics, research, and community, MIT prepares students to address complex global challenges in service to the nation and the world.

In our classrooms, students gain an understanding of the fundamentals of science, technology, and other areas of scholarship, with a deep commitment to developing problem-solving skills, excellence in quantitative and qualitative analysis, historical and literary insight, and an appreciation for the scientific method. Hands-on research opportunities provide students with a foundation for professional competence and opportunities to learn by doing. And with a mission that charges us to work “effectively for the betterment of humankind,” MIT presents its students with opportunities to engage meaningfully with their communities, hone their leadership and communication skills, and develop an appreciation for the application and impact of their work.

The continuous renewal and renovation of MIT’s physical facilities, guided by a commitment to strengthening campus community and supporting innovation, is essential to the Institute’s mission to advance knowledge and educate students. The MIT campus is undergoing significant change, with smart residence halls and common spaces developed to inspire innovative collaborations; cutting-edge laboratories to support the emergence of new technologies; and centers to reinforce the curiosity that drives us.

Students and Faculty

MIT enrolled 11,466 students in 2017–2018, including 4,547 undergraduates and 6,919 graduate students. These MIT students came from all 50 states, the District of Columbia, four territories, and 129 foreign countries. The broad international student representation of 3,338 students made up 10 percent of the undergraduate and 41 percent of the graduate population.

In the same year, there were 1,047 faculty members in MIT’s professorial ranks, including 239 women. The total teaching staff numbered 1,914. Most faculty members at MIT teach both undergraduate and graduate students. Undergraduates frequently register for graduate classes, and many undergraduates and graduate students participate, often together, in advanced research.

The confluence of ages, disciplines, and nationalities so characteristic of MIT brings together students and teachers, biologists and architects, humanists and engineers, young and old, and deeply influences the life and experience of every member of the academic community. The result is an academic environment with a strong focus on excellence and a diverse range of interests.

The Campus

In 1916, MIT moved from its Boston location to Cambridge, and the current campus (http://whereis.mit.edu) now encompasses 168 acres that extend more than a mile along the Cambridge side of the Charles River Basin. The heart of campus is anchored by an historic group of interconnecting buildings, designed by architect W. Welles Bosworth (Class of 1889), which facilitate interaction and communication among MIT’s schools and departments.

In addition to the Bosworth buildings, the MIT campus now showcases a range of architectural styles, from neoclassical through modernist, brutalist, and deconstructivist. Among the remarkable landmarks on campus are buildings designed by leading architects such as Alvar Aalto, Frank Gehry, Steven Holl, Fumihiko Maki, I. M. Pei ’40, and Eero Saarinen. Meticulous renewal efforts have
preserved the iconic structures on campus and have resulted in no fewer than nine preservation awards from the Cambridge Historical Commission.

Student life (http://studentlife.mit.edu) on campus is anchored by 18 undergraduate and graduate residence halls, each with its own distinctive personality and community. While planning is underway for an additional graduate residence, construction has started on a new undergraduate residence and the full renovation of an existing undergraduate residence is nearing completion. In their academic and research endeavors, students benefit from state-of-the-art facilities ranging from wet labs and clean rooms to collaboration areas and makerspaces. Specialized equipment on campus includes 3D printers, laser cutters, wind tunnels, and drone and robot test labs. In every field, innovation and entrepreneurship are fostered by cross-disciplinary facilities like the MIT Media Lab, the Koch Institute for Integrative Cancer Research, and the newly constructed MIT.nano (http://mitnano.mit.edu), a 200,000-square-foot nanotechnology and advanced imaging center. At its edges, the campus merges with various Cambridge neighborhoods, including Kendall Square, where the close association of industry and research expertise has made this area the most innovative square mile on the planet.

In light of its commitment (http://climateaction.mit.edu) to decrease its carbon footprint, MIT encourages a multi-modal approach to transportation around campus. As a whole, the campus is urban and walkable, with about 30 gardens and greenspace areas and more than 60 publicly sited works of art to enjoy along the way. MIT also offers free shuttles around campus, bicycle benefits including a bike-share program and fix-it stations, carpool coordination services, and public transportation subsidies.

As the campus continues to evolve, MIT actively pursues measures that improve sustainability and conservation. To date, one building on campus has achieved LEED-Platinum certification (the Morris and Sophie Chang Building, E52) and 9 buildings have achieved LEED-Gold certification, including Fariborz Maseeh Hall (Wx), Building E62 (home of MIT Sloan), the Simons Building (2), and the Koch Institute for Integrative Cancer Research (76). For existing buildings, MIT’s proactive Capital Renewal program (http://capitalprojects.mit.edu) is engaged in continuous renewal and renovation projects that promote energy efficiency while ensuring that the campus will support the community’s broad spectrum of educational, research, and student life activities.

The Boston and Cambridge Environment

MIT is in Cambridge, Massachusetts, on the north bank of the Charles River, facing the city of Boston. With over 110,000 people located within a 6.5 square mile area, Cambridge is a unique community with a strong mix of cultural, demographic, and social diversity; intellectual vitality; and technological innovation. The city’s diversity is reflected in its international community, with nine percent of residents being foreign born. Well known as the residence of MIT and Harvard, Cambridge is home to many students and professionals. About 21 percent of its residents are college and graduate students.

The city’s largest employment sectors are higher education, government, biotechnology, and healthcare. Cambridge is home to more than 300 life-science and technology-related companies. The Kendall Square neighborhood is a renowned hub of innovation of entrepreneurship.

Boston’s Museum of Science and Museum of Fine Arts, the Isabella Stewart Gardner Museum, the New England Conservatory of Music, Symphony Hall, the New England Aquarium, and the Boston Public Library, as well as Fenway Park and TD Garden for professional baseball, basketball, hockey, and concerts are all within a two-mile radius of the MIT campus. Students can also travel easily to Boston’s theater district, where Broadway plays are previewed and local productions are staged.

Among the cultural organizations enriching life in the area are the Boston Symphony Orchestra, the Boston Pops, the Boston Ballet Company, the Opera Company of Boston, the Boston Center for the Arts, Boston University’s Huntington Theatre Company, the Loeb Drama Center, and the American Repertory Theater.

MIT is one of more than 50 schools located in the Boston area, including Boston College, Boston University, Brandeis University, Harvard University, Lesley University, Northeastern University, Simmons College, Tufts University, Wellesley College, and many specialized professional art and music schools. The concentration of academic, cultural, and intellectual activity in this area is one of the most significant in the country.

An hour or two away from MIT by car are the mountains of Vermont and New Hampshire, the ocean beaches of Cape Cod, the lakes and rivers of Maine, the small clusters of fishing towns along the New England coast, and many places of historical interest in Massachusetts alone—Salem, Sturbridge, Lexington, Concord, and Plymouth. With its varied landscapes and four distinct seasons, New England offers unlimited possibilities for recreation—skiing, mountain climbing, hiking, sailing, canoeing, kayaking, swimming, and camping.

ACADEMIC PROGRAM

The purpose of the academic program at MIT is to give students a solid command of basic principles, a versatility of insight and perspective concerning natural and social phenomena, the habit of continued learning, and the power that comes from a thorough and systematic approach to learning. From these attributes comes the best assurance for continued professional and personal growth, especially in today’s rapidly changing world.

The undergraduate academic program (p. 31) is based on a core of General Institute Requirements (p. 36) and on the specific
curricula offered by departments for undergraduate majors. All undergraduate Courses at MIT lead to the Bachelor of Science (SB) degree. For most undergraduates, degree-granting programs require four years of full-time study.

Graduate degrees (p. 61) include Master of Architecture (MArch), Master of Science (SM), Master of Applied Science (MASc), Master of Business Administration (MBA), Master of Business Analytics (MBAn), Master in City Planning (MCP), Master of Engineering (MEng), Master of Finance (MFin), Engineer, Doctor of Philosophy (PhD), and Doctor of Science (ScD). Graduate students may also take advantage of a number of standing interdisciplinary programs (p. 367) or develop individually tailored programs in consultation with the faculty.

Engineer degrees include Civil Engineer (CE), Electrical Engineer (EE), Engineer in Aeronautics and Astronautics (EAA), Engineer in Computer Science (ECS), Environmental Engineer (EnvE), Materials Engineer (MatE), Mechanical Engineer (MechE), Naval Engineer (NavE), and Nuclear Engineer (NuclE).

Each of the academic departments and units listed below offers one or more degree-granting programs, as described in the Schools (p. 116) and Interdisciplinary Programs (p. 337) sections of this Bulletin (additional degree-granting programs are described in the Interdisciplinary Programs section). More detailed information can be obtained from the program and department offices.

**School of Architecture and Planning**
- Architecture
- Media Arts and Sciences
- Urban Studies and Planning

**School of Engineering**
- Aeronautics and Astronautics
- Biological Engineering
- Chemical Engineering
- Civil and Environmental Engineering
- Electrical Engineering and Computer Science
- Materials Science and Engineering
- Mechanical Engineering
- Nuclear Science and Engineering
- Institute for Data, Systems, and Society
- Institute for Medical Engineering and Science

**School of Humanities, Arts, and Social Sciences**
- Anthropology
- Comparative Media Studies/Writing
- Economics
- Global Studies and Languages
- History
- Humanities
- Linguistics and Philosophy
- Literature
- Music and Theater Arts
- Political Science
- Science, Technology, and Society

**Sloan School of Management**
- Management

**School of Science**
- Biology
- Brain and Cognitive Sciences
- Chemistry
- Earth, Atmospheric, and Planetary Sciences
- Mathematics
- Physics

**Accreditation**

MIT is accredited by the New England Association of Schools and Colleges, Inc., through its Commission on Institutions of Higher Education.

Inquiries regarding MIT’s accreditation status should be directed to the Office of the President, Massachusetts Institute of Technology. Individuals may also contact:

Commission on Institutions of Higher Education  
New England Association of Schools and Colleges  
3 Burlington Woods Drive, Suite 100  
Burlington, MA 01803-4514  
telephone 781-425-1001  
email cihe@neasc.org

Many degree programs at MIT are accredited by specialized professional accrediting bodies, including ABET, the Association to Advance Collegiate Schools of Business, the American Chemical Society, the National Architectural Accrediting Board, and the Planning Accreditation Board. Academic departments can provide information on the accreditation of the specific degree programs they offer.

**ADMINISTRATION**

**MIT Corporation**

The Institute’s board of trustees is known as the Corporation (http://web.mit.edu/corporation). Its membership includes approximately 70 distinguished leaders in engineering, science, industry, education, and other professions, and (ex officio) the Chairman of the Corporation, the President, the Executive Vice President and
Treasurer, the Secretary of the Corporation, the President of the Alumni Association, and three representatives of the Commonwealth of Massachusetts. As of March 2018, the Corporation also includes 37 emeritus life members. Approximately 73 percent of Corporation members are MIT alumni.

Between quarterly meetings, the Corporation functions through its officers and executive committee. The Corporation appoints visiting committees for each academic department and for certain other major activities at the Institute. These committees, whose members are leaders in their respective professions, make recommendations to the Institute administration and the Corporation concerning departmental activities and, in turn, provide counsel to the departments.

**Academic and Administrative Organization**

The Institute’s chief executive officer is the president. Senior academic and administrative officers include the provost; chancellor; executive vice president and treasurer; senior vice president and secretary of the Corporation; deans; vice presidents; vice chancellor; chancellor for academic advancement; associate provosts; director of libraries; CEO of the MIT Alumni Association; Institute community and equity officer; and deputy executive vice president. For a detailed view of the Institute’s organizational structure, see the MIT Organization Chart (http://orgchart.mit.edu).

The Institute’s academic departments and institutes—each under the leadership of a head or director—are organized within five schools. In addition, numerous interdisciplinary laboratories and centers have been organized to facilitate research in fields that extend across traditional boundaries; administration of each laboratory or center is the responsibility of the faculty member who serves as its director. Research projects sponsored by government, industry, or foundations are administered through the Office of Sponsored Programs.

Educational policy for the Institute is determined by the MIT Faculty (as defined by the Rules and Regulations of the Faculty). The Faculty meets monthly during the academic year and conducts much of its business through a number of elected standing committees. The Faculty Policy Committee (FPC), which includes student members, maintains a broad overview of the Institute’s academic programs, deals with a wide range of policy issues of concern to the Faculty, and coordinates the work of the Faculty committees. The chair of the Faculty chairs the FPC.

**ALUMNI**

**MIT Alumni Association**

The MIT Alumni Association (https://alum.mit.edu/home), founded by alumni in 1875, provides multiple ways for the Institute’s 136,079 former students to stay in touch with one another and maintain their connections to the Institute. In partnership with the volunteer alumni board, the Association staff helps alumni organize more than 1,200 events a year, communicate with one another, and raise funds for MIT.

In addition to programs such as regional clubs and reunions, the Association offers an opportunity for alumni to make a virtual Infinite Connection to the MIT community through its website (http://alum.mit.edu). Alumni are also using Email Forwarding for Life, the online alumni directory, alumni email lists, online mentoring services, events registration, and online Annual Fund giving. Social media channels such as LinkedIn, Facebook, Twitter, and the Slice of MIT blog are also very popular. More than 15,889 alumni and friends volunteer their services for MIT each year, with many serving as class and club officers, educational counselors, and members of the MIT Corporation and its visiting committees. Other popular alumni programs include Faculty Forum Online, Alumni Travel Program, Tech Reunions, Alumni Leadership Conference, and Toast to IAP.

In fiscal year 2017, the Annual Fund reported $81.9 million in gifts, contributed by 44,031 alumni donors, students, parents, and friends.
CAMPUS LIFE

Life at MIT is anything but dull, and opportunities to engage in activities beyond academics abound. Housing and dining, fraternities and sororities, student clubs and sports are but a few of the topics addressed in this section that provide a glimpse into the non-academic aspects of life at the Institute.

ACTIVITIES

There is much more to an MIT education than study and research in classrooms and laboratories. Numerous activities and groups are available that complement academic pursuits and provide opportunities for students to grow and develop new interests or lifelong pursuits. This section describes just a few of the activities that add to campus life.

There are approximately 500 co-curricular student organizations at MIT (many open to both faculty and students), including the Outing Club, the Solar Electric Vehicle Team, the Debate Team, the FM local broadcasting station (WMBR), the MIT Society for Women Engineers, the Student Art Association, Model UN, and interest groups focusing on dance, chess, ham radio, and strategic games, to name just a few.

Many students are actively engaged in service work either through the Priscilla King Gray Public Service Center or on their own. Groups such as Alpha Phi Omega, the national service fraternity, Amphibious Achievement, and the Educational Studies Program sponsor active social service programs. For example, the Educational Studies Program provides opportunities for MIT students to work with area high school students.

MIT also has a number of cultural and identity groups including the Black Students’ Union, the Latino Cultural Center, the Asian American Association, and the South Asian American Students Association. Over 30 international student organizations sponsor a rich array of programs, including discussion groups and social events. The International Students’ Association, for example, sponsors a newsletter, assemblies, and other events. For members and allies of MIT’s LGBTQ+ community, G@MIT organizes weekly awareness programs and discussion groups, and sponsors social events throughout the year. The Graduate Women at MIT (GWAMIT) works to promote the personal and professional development of women in graduate school at MIT.

For more information, contact the Association of Student Activities (http://web.mit.edu/asa/www), Room W20-401, or the Student Activities Office (http://studentlife.mit.edu/sao), Room W20-549, 617-253-6777.

ARTS AT MIT

The arts (http://arts.mit.edu) are a fundamental component of MIT’s core curriculum and research community, reflecting and enhancing the Institute’s creativity, innovation, and excellence while advancing the self-discovery, problem solving, and collaborative skills needed by leaders meeting the challenges of the 21st century.

Over 50 percent of all MIT undergraduates enroll in arts courses each year—with nearly half of students participating in music and theater classes or performance groups—and many major or minor in arts-related subjects. MIT’s arts faculty includes eminent artists such as Pulitzer Prize recipients composer John Harbison and writer Junot Díaz, as well as composer and musician Evan Ziporyn, composer Tod Machover, director Jay Scheib, architect Antón García-Abril, designer Neri Oxman, and visual artist Renée Green.

Each year MIT’s performing groups and outside artists present over 300 music, theater, and dance events. Productions range from chamber music to electronic “hyperinstruments,” and from Shakespearean plays to science theater. MIT’s world music program features Boston’s only Balinese gamelan, a Senegalese drumming ensemble, and an acclaimed South Asian performance series.

Art, Culture and Technology. The Department of Architecture’s Program in Art, Culture and Technology (ACT) (http://act.mit.edu) operates as a critical production- and education-based laboratory focusing on artistic research, advanced visual studies, and transdisciplinary collaboration within the context of MIT’s technological community. Its weekly lecture series is open to the public.

Dance. Extracurricular dance activities at MIT are sponsored by the Folk Dance Club, Tech Squares, Ballroom Dancing Club, Dance Troupe, and various international student groups, providing regular opportunities for dancers at all levels of ability. Access their websites (http://theaterarts.mit.edu) for additional information.

Literary Arts. The Comparative Media Studies/Writing (CMS/W) Program (p. 243) offers courses in fiction, nonfiction prose, poetry, science writing, and digital media, taught by award-winning faculty. Its own publications and the Ilona Karmel Writing Prizes help highlight and distribute the very best in MIT graduate and undergraduate writing. The Literature Section (p. 266) sponsors readings by visiting authors that are open to the MIT community as well as the public. Its Pleasures of Poetry series meets every weekday during IAP, bringing together faculty, staff, students, and others from the community who share a love of poetry. Together with the MIT Libraries, Literature also sponsors the MIT Literary Society, an undergraduate reading group focused on literary discussion outside the classroom.

Media Arts. An international leader in the development of innovative digital media and information technologies, MIT’s Media Lab (http://
media.mit.edu) is a uniquely flexible organization where faculty members, research staff, and students from numerous, seemingly unrelated disciplines—with backgrounds ranging from computer science to psychology, music to graphic design, and architecture to mechanical engineering—work together "atelier style," doing the things that conventional wisdom says can't or shouldn't be done. The goal is to develop technologies and concepts that foster creativity—empowering people of all ages, from all walks of life, in all societies, to design and invent new possibilities for themselves and the communities around them. Research opportunities for students are available through the Program in Media Arts and Sciences (p. 130), based in the School of Architecture and Planning, and through the Undergraduate Research Opportunities Program.

CMS/W (p. 243) offers an innovative program that applies critical analysis, collaborative research, and design across a variety of media arts, forms, and practices. Through its undergraduate and graduate programs and hands-on research groups, it develops thinkers who understand the dynamics of media change and can apply their insights to contemporary problems. It cultivates practitioners and artists who can work in multiple forms of contemporary media.

Music. MIT’s music (p. 269) faculty includes internationally acclaimed composers, performers, and musicologists. Students can choose to pursue a full or joint major, a minor, or a HASS concentration in music. They can also take private lessons with financial support from the Emerson scholarship program; music subjects in theory, composition, history, jazz, and world music; or participate (for credit or not) in faculty-led performance ensembles. These include the MIT Symphony Orchestra, Wind Ensemble, Festival Jazz Ensemble, Chamber Music Society, Concert Choir, Chamber Chorus, Balinese Gamelan Galak-Tika, and Rambax MIT (a Senegalese drumming ensemble). In addition to ensemble performances and student recitals, concerts are also presented as part of the MIT Faculty, Affiliated Artists, Guest Artists, and MIT Heritage of the Arts of South Asia (MITHAS). Artists of national and international stature frequently come to perform at MIT and to interact with students in and out of the classroom.

In addition to the performance opportunities offered by the music program within the School of Humanities, Arts, and Social Sciences, there are many student-directed ensembles and a capella groups that perform on campus as well. Visit the website (http://arts.mit.edu/groups/performance-groups) for more information.

Theater. MIT’s programs in theater arts (p. 269) afford opportunities for serious study and training in acting, directing, playwriting, dramaturgy, stagecraft, and design. Classes are small, and students work directly with renowned faculty and guest artists, or initiate independent student workshop productions. Students may choose a minor or HASS concentration in theater; it is also possible to create an individually tailored theater major. A wide variety of theatrical performances are presented by MIT Dramashop and Dance Theater Ensemble, the co-curricular student production group of MIT Theater Arts. These productions, directed by professionals in their fields, often offer interested students opportunities to further develop their work in professional settings. Extracurricular student organizations such as Shakespeare Ensemble, Musical Theatre Guild, Gilbert & Sullivan Players, and the improv group Roadkill Buffet offer additional performance and production experience.

The new theater arts building opened in 2017, and houses a two-story flexible blackbox theater with 150–180 seats, state-of-the-art rehearsal spaces and design studios, offices, and dressing rooms. The building was designed with production in mind and to maximize the possibilities for experimentation with new theater technologies. Other studios in the building provide space for smaller performances, faculty and student workshops, rehearsals, and classes in theatrical practice, design, and technical arts.

An annual Theater Arts Open House on Registration Day in early September allows students to meet the people who produce theater events and to learn more about opportunities to get involved in various productions.

Visual Arts. From large-scale public art to film and photography, the visual arts are celebrated in innovative ways at MIT. Excellent opportunities exist for members of the MIT community to view and create art in a variety of media (see Student Art Association, List Visual Arts Center, and MIT Museum below). The Program in Art, Culture and Technology offers undergraduate classes in public, installation, and media arts, and has a prominent master’s program. MIT students can take classes in traditional fine arts at Harvard, the Massachusetts College of Art and Design, and Wellesley College through cross-registration programs (https://registrar.mit.edu/registration-academics/registration-information/cross-registration).

The Office of the Arts at MIT oversees, coordinates, supports, and facilitates arts activities. The office’s branches include the Council for the Arts, Student Programs, Visiting Artists Program, and Arts Communications. For general information on arts programs and activities at MIT, visit the website (http://arts.mit.edu) and see the arts calendar (http://arts.mit.edu/events-visit/calendar).

The MIT Center for Art, Science & Technology (CAST) (http://arts.mit.edu/cast), established in 2012, facilitates and creates opportunities for exchange and collaboration for artists with engineers and scientists. A joint initiative of the Office of the Provost, the School of Architecture and Planning, and the School of Humanities, Arts, and Social Sciences, the center is committed to fostering a culture where the arts, science, and technology thrive as interrelated, mutually informing modes of exploration, knowledge, and discovery. As an umbrella organization, CAST’s activities include soliciting and supporting cross-disciplinary curricular initiatives; managing visiting artist residencies; overseeing undergraduate, graduate, and postdoctoral research; and organizing programs...
such as performances, exhibitions, installations, and a biennial symposium.

A flourishing Visiting Artists Program complements the curriculum, allowing students to engage with distinguished visiting artists, including visual artists Tomás Saraceno, Vik Muniz, Anicka Yi, and Trevor Paglen; architect Santiago Calatrava; filmmaker Katerina Cizek; violinist Johnny Gandelsman; and jazz pianist Jason Moran. For more information, visit the website (http://arts.mit.edu/visiting-artists).

The Eugene McDermott Award in the Arts at MIT (http://arts.mit.edu/mcdermott) recognizes rising, innovative talents and offers its recipients a $100,000 cash prize and campus residency. Past recipients include singer/actress Audra McDonald, composer Tan Dun, video artist Bill Viola, conductor Gustavo Dudamel, multidisciplinary performance and media artist Robert Lepage, visual artist Olafur Eliasson, and architect David Adjaye.

The Council for the Arts at MIT is a volunteer group of alumni and friends established in 1972 by MIT president Jerome B. Wiesner to support the visual, literary, and performing arts. The Council for the Arts recognizes distinguished artists from all disciplines with one of the country’s most esteemed arts prizes, the Eugene McDermott Award in the Arts at MIT. Since its inception, the council has awarded over 3,500 individual grants; it also administers annual student prizes in the arts, including the Sudler Prize, the Laya and Jerome B. Wiesner Student Art Awards, and the Harold and Arlene Schnitzer Prize in the Visual Arts.

Council programs directly benefit MIT students by providing free tickets to the Boston Symphony Orchestra, Boston Chamber Music Society, Boston Modern Orchestra Project, and Radius Ensemble, free admission to the Boston Museum of Fine Arts, the Institute of Contemporary Art/Boston, and the Isabella Stewart Gardner Museum, and discount tickets to a number of concerts, theater, and ballet performances throughout the year.

The Council for the Arts’ Grants Program encourages the dreams and talents of the MIT community, providing the opportunity for students, faculty, and staff to apply for funding for arts projects in all disciplines. Grants range from a few hundred to several thousand dollars.

Student Programs. Several programs encourage students to engage in the arts. First-year undergraduate seminars led by MIT faculty and staff introduce participants to the many academic and performance programs in the arts at MIT and the Boston area. Arts Scholars (http://arts.mit.edu/participate/arts-scholars) is an honors program that enables students who are active in the arts to attend exhibitions, plays, and concerts with experts in the respective arts disciplines. The Grad Arts Forum (http://arts.mit.edu/groups/grad-arts-forum) encourages interdisciplinary communication among graduate students through a series of presentations and informal discussions of artistic work by grad students. Student Programs also administers the annual mural competition for currently enrolled MIT students, as well as the $15K Creative Arts Competition, which awards $15,000 to the team whose business plan has arts at its core.

The Student Art Association (http://arts.mit.edu/saa) offers noncredit classes and facilities for many visual arts activities including animation, ceramics, photography, painting, drawing, printmaking, and machine art.

List Visual Arts Center (http://listart.mit.edu), just as MIT pushes the frontiers of scientific and intellectual inquiry, the mission of the List Visual Arts Center is to explore contemporary art in all media. Each year, the center presents a challenging exhibition program that looks beyond art’s traditional aesthetic functions to examine the cultural, social, political, scientific, or economic contexts that inform the work. Exhibitions are presented in three galleries on the first floor of the I. M. Pei-designed Wiesner Building (Building E15) and the Dean’s Gallery in the Sloan School (Building E60). All are free and open to the public. Nationally distributed catalogs, artist talks, gallery tours, and symposia accompany the exhibitions.

The List Center also manages MIT’s permanent collection of artworks, including a student loan art program of approximately 500 works that enables students to borrow original pieces of art, such as prints and photographs, for up to a year, and a sizable collection of paintings, sculpture, drawings, prints, and photos sited throughout the campus.

The MIT Museum’s (http://web.mit.edu/museum) mission is to make research and innovation accessible to all. The museum collects and preserves artifacts that are significant in the life of MIT, creates exhibitions, face-to-face programs, and online services that are firmly rooted in MIT’s areas of endeavor, and engages MIT faculty, staff, and students with the wider community. Nearly 150,000 people visit the museum and its galleries each year.

The Mark Epstein Innovation Gallery features interactive displays from a variety of departments and research labs at MIT, and a popular public programs space. Regularly changing exhibitions are mounted in the Thomas Peterson Gallery and the Kurtz Gallery for Photography, which presents the rich legacy of work in photography at MIT by luminaries such as Minor White, Harold Edgerton, and Berenice Abbott, as well as contemporary photographers from outside MIT. Other galleries show ongoing exhibitions on robotics and artificial intelligence, holography and spatial imaging, and the kinetic sculptures of Arthur Ganson.

In addition to the main collection of over 1 million items at 265 Massachusetts Avenue, which is used by MIT students and faculty for research and teaching, the MIT Museum directs the Hart Nautical Gallery in Building 5 and the Museum Studio at the Compton Gallery in Building 10. The Museum Studio connects MIT undergraduate and graduate students with the unique learning opportunities of the museum. Here, students can pursue original technology projects for display in the galleries. The studio supports project-
based coursework including an undergraduate subject, "Exhibiting Science," offered through the STS Program.

ATHLETICS

Athletics (http://www.mitathletics.com/landing/index) and recreation (http://mitrecsports.com) are an important part of campus life for many students at MIT, and the Institute encourages everyone to participate in some type of athletic activity.

The Institute supports a broad intercollegiate athletic program offering 33 varsity sports, the largest NCAA Division III program in the nation. While the Engineers’ rowing programs compete at the Division I level, MIT’s primary league affiliation lies with the New England Women’s and Men’s Athletic Conference (NEWMAC) as a Division III member of the NCAA. Although crew is the only classified Division I program, water polo, sailing, rifle, track and field, squash, cross country, fencing, and men’s volleyball all compete against Division I opponents.

MIT features one of the nation’s most expansive club programs, with approximately 900 participants and 33 teams, a quarter of which are martial arts clubs. All club teams are led and organized by MIT students and are governed by the student-led Club Sports Council. The Institute places all of its club programs into two categories: instructional and competitive. Instructional clubs offer formal training under the supervision of professional instructors, while competitive clubs compete in regional and national-level tournaments, with many ranking in the nation’s top 10. The most successful clubs at MIT include sport taekwondo, triathlon, wrestling, ultimate frisbee, rugby, and cycling.

The MIT intramural sports program offers competition in 20 sports of various competition levels, with participation of approximately 3,000 students, faculty, staff, and alumni. Ultimate frisbee, soccer, ice hockey, and badminton are among the most competitive and popular activities.

MIT’s athletic complex, with its 10 buildings and 26 acres of playing fields, is one of the most expansive in New England. Steinbrenner Stadium contains Roberts Field, which features a FieldTurf artificial playing surface and lights, to go along with the Sherie and Don (1961) Morrison Track that was dedicated in 2016. Adjacent to Steinbrenner Stadium is Jack Barry Field. Another FieldTurf venue, it was renovated in 2011 into one of the top facilities of its kind in New England. Fran O’Brien Field (baseball) and Briggs Field (softball) were also fully renovated in 2016, along with various intramural fields. The Johnson Athletic Center houses an indoor track and ice rink. The J.B. Carr Tennis Center features a bubble structure that houses four indoor courts, with the duPont Tennis Courts adding 12 outdoor playing surfaces. The duPont Athletic Center is equipped with a pistol and rifle range, fencing room, wrestling room, squash courts, the Rudovsky Indoor Golf Range, and additional instructional rooms for dance and martial arts. The Zesiger Sports and Fitness Center features two swimming pools, a fitness center, international-scale squash courts, and a multiactivity court. The Stata Center is home to the Alumni Pool and the Wang Fitness Center. Briggs Field, one of the largest outdoor recreation facilities in the area, provides numerous outdoor recreational opportunities. MIT’s athletic facilities extend to the Charles River with the Wood Sailing Pavilion and the Pierce Boathouse.

The General Institute Requirements for all undergraduate degrees include a Physical Education Requirement (p. 36); see that section for further details.

CAMPUS MEDIA

Student publications at MIT include The Tech, a student newspaper published weekly; Technique, the senior yearbook; the ANNO, a publication of the Graduate Student Council; and The Byte, an online publication of the Undergraduate Association. Students may also contribute their talents to a variety of departmental, organizational, and residence hall publications and websites.

On the air, WMBR is MIT’s commercial-free radio station operating under a license held by the Technology Broadcasting Corporation, and MIT Student Cable Television broadcasts original and syndicated programming 24 hours per day.

The MIT Press

The MIT Press (https://mitpress.mit.edu) is one of the largest and most respected university presses in the world. It is a major publishing presence in diverse fields, including art and architecture; cognitive science; computer science; economics; environmental studies; game studies; linguistics; neuroscience; new media; philosophy; and science, technology, and society. The Press publishes journals, scholarly monographs, trade books, textbooks, and reference works, in print and electronic formats.

MIT Press authors are drawn from the worldwide academic community. The Press is known for its work in emerging fields of scholarship, for its strong international distribution, and for pioneering projects such as CogNet (http://cognet.mit.edu), an online resource for the cognitive sciences, and ARTECA (http://arteca.mit.edu). Author talks and book release events occur regularly at the MIT Press Bookstore (http://mitpressbookstore.mit.edu), which also features an Espresso Book Machine for complex printing and self-publishing needs.

DINING

MIT Dining (http://studentlife.mit.edu/dining) venues are located throughout the campus and are open to the entire MIT community. They provide a broad range of diverse and healthy options prepared from fresh quality ingredients. MIT Dining offers comprehensive
FRATERNITIES, SORORITIES, AND INDEPENDENT LIVING GROUPS

MIT recognizes 41 fraternities, sororities, and independent living groups (FSILGs). Of these, 28 are nationally affiliated fraternities and two are local. There are five independent living groups, four of which are co-ed and one is for women only. All eight sororities are nationally affiliated; six are residential. Most FSILGs have residential facilities located off campus in Boston, Brookline, or Cambridge, that are owned by the respective organization’s house corporation. The Interfraternity Council (IFC) acts as the governing body for 26 fraternities, the Panhellenic Association (Panhel) represents seven sororities, the Multicultural Greek Council (MGC) represents three of the multicultural fraternities and sororities, and the Living Group Council (LGC) represents the five independent living groups.

The oldest fraternity on campus was founded at MIT in 1873. Forty percent of the undergraduate population is affiliated with a fraternity, sorority, or living group. FSILGs play an active role on campus, and members hold leadership positions in various clubs and organizations. FSILG members also take part in a number of intramural sports, as well as volunteer their time with many charitable and nonprofit organizations.

The espoused values of the FSILG community include leadership, scholarship, citizenship, and service. Each organization is self-governing in a shared-governance model, managing its operations and maintenance, and developing its own academic, social, membership, recreational, and external policies and programs. These organizations provide a unique experience in leadership, community planning, and group interactions.

Each residential fraternity, sorority, or living group has a live-in resident advisor hired and trained by MIT who is a graduate student. Graduate Resident Advisors serve as mentors, guides, and resources for students and act as a liaison between the undergraduate chapter, the alumni/ae, and MIT.

MIT students have opportunities to learn more about each of the fraternities, sororities, and living groups throughout the academic year. The primary recruitment period for fraternities and sororities is usually held in September. However, many fraternities, sororities, and ILGs host recruitment events year round. In addition, incoming students receive information about the FSILGs during Orientation and Campus Preview Weekend. For more information about FSILGs, contact the Fraternity, Sorority, and Living Group Office (FSILG-Office@mit.edu), located in W59-200, 617-253-7546.

HOUSING

Undergraduate Housing

At the undergraduate level, MIT is a residential university. Of the total undergraduate student body of 4,547, about 3,300 students live in a residence hall on campus, and about 1,100 students take advantage of living in MIT-approved fraternities, sororities, and independent living group residences (FSILGs). Transfer students may be able to obtain housing on a space-available basis after the housing lottery for first-year students is complete.

The residential system provides an environment conducive to personal development and academic achievement. The achievement of both goals relies greatly on individual initiative and responsibility, as well as on effective shared governance in the residences. Students work with the professional staff in the Division of Student Life to support and create conditions that enhance student learning and personal development.

Faculty families chosen for their understanding of and interest in students live in each of the Institute residence halls as heads of house. They are not charged with formal academic or operational responsibilities; instead, they welcome informal associations with their residents. Area directors reside in most of our undergraduate residences as a support person for the students. They are charged with programmatic responsibilities and are on call for any concerns in the evenings and weekends. In all of the Institute residence halls, graduate resident tutors support the faculty residents in providing personal assistance to undergraduates.

With the exception of the all-female McCormick Hall, Institute residence halls have coeducational living facilities. Although first-year students are not guaranteed an assignment to a particular residence hall or single-gender area, every effort is made to assign students to one of their top choices.
Student governing groups establish and administer many residence hall regulations and maintain acceptable standards of community behavior. Residential student governments also organize social, athletic, and intellectual programs for residence hall members. In each Institute residence hall, a tax determined by the residents is collected by MIT and made available to the residence hall government to help support such activities. Individual fraternity, sorority, and independent living group chapters have similar charges to support their extracurricular programs.

The Institute believes that it is to the great advantage of all new students to reside on campus—that is, to live in a residence hall. First-year undergraduates particularly gain from associations with upper-level students and participation in residential programs. Therefore, all first-year students are required to live in one of the undergraduate residence halls on campus for the duration of their first year. This excludes any fraternity, sorority, or independent living group housing. Exceptions to this requirement are rare and are made through a petition process reviewed by Housing & Residential Services, the Office of the Vice President for Student Life, and the Office of Undergraduate Education.

Institute Houses (Undergraduate)

<table>
<thead>
<tr>
<th>House</th>
<th>Location</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker House</td>
<td>Cambridge</td>
<td>Offers a rich living environment in a number of different formats, including suites, kitchen suites, and apartments. All of the buildings have active student governments that plan and facilitate social and cultural events. All of the buildings have a faculty member in residence who, along with the house manager, support the students. All units are gender inclusive but single gender units are available upon request. All buildings except for Edgerton House are furnished.</td>
</tr>
<tr>
<td>Burton Conner House</td>
<td>Cambridge</td>
<td></td>
</tr>
<tr>
<td>East Campus</td>
<td>Cambridge</td>
<td></td>
</tr>
<tr>
<td>MacGregor House</td>
<td>Cambridge</td>
<td></td>
</tr>
<tr>
<td>Maseeh Hall</td>
<td>Cambridge</td>
<td></td>
</tr>
<tr>
<td>McCormick Hall</td>
<td>Cambridge</td>
<td></td>
</tr>
<tr>
<td>Next House</td>
<td>Cambridge</td>
<td></td>
</tr>
<tr>
<td>Random Hall</td>
<td>Cambridge</td>
<td></td>
</tr>
<tr>
<td>Simmons Hall</td>
<td>Cambridge</td>
<td></td>
</tr>
</tbody>
</table>

Rooms in the Institute houses are engaged for the full academic year. For 2018–2019, the rents for the houses range from $3,905 to $5,590 per term. Rates typically increase 3.5% per year.

Fraternities, Sororities, and Independent Living Groups

Undergraduates affiliated with a fraternity, sorority, or independent living group have the option of residing in their FSILG facility after their first year. These houses are located in the cities of Cambridge, Boston, and Brookline, and are conveniently accessed by public or MIT transportation. Many FSILGs have their own meal plan, some are cook-for-yourself, and others have chefs that cook for the entire group. In addition, members share responsibility for chapter house duties and work closely with alumni and the FSILG Office on the general maintenance and upkeep of the chapter facility. Room and board at FSILGs varies per term and is determined by each FSILG. Each FSILG hosts a live-in graduate residence advisor (a graduate student hired and trained by MIT) who serves as a mentor and support person for the group members in residence. With the exception of Kappa Alpha Theta, Kappa Sigma, and Pi Beta Phi, MIT Housing does not own or operate the FSILG chapter facilities. These houses are independently owned and operated by the individual alumni house corporations for each FSILG.

Additional Information

Additional information on undergraduate housing and application procedures is contained in The Guide to Residences and is updated every May. Additional information may be found on our website (http://studentlife.mit.edu/housing/undergraduate-housing) or by contacting Housing & Residential Services, Room W59-200, 617-253-2811. Information about fraternities, sororities, and independent living groups also may be obtained on the FSILG website (http://studentlife.mit.edu/fsilg) and by contacting the FSILG Office, Room W59-200, 617-253-7546.

Graduate Single Student Housing

Approximately 35 percent of MIT’s single graduate students reside on campus in Avery Allen Ashdown House, Ping Yuan Tang Residence Hall, Harold Edgerton House, The Warehouse (NW30), Sidney-Pacific Residence Hall, and 70 Amherst Street. Students must be registered each term (not including the summer) in order to reside in on-campus student housing. MIT attempts to house all new graduate students who desire to live on campus. New single student assignments are for one year. Returning students who receive housing through the Continuing Student Allocation Process may remain in housing continuously until they graduate, as long as they are registered each term. Students sign a new license agreement each year they are in residence.

These residence halls provide a rich living environment in a number of different formats, including suites, kitchen suites, and apartments. All of the buildings have active student governments that plan and facilitate social and cultural events. All of the buildings have a faculty member in residence who, along with the house manager, support the students. All units are gender inclusive but single gender units are available upon request. All buildings except for Edgerton House are furnished.

The rent for all graduate residences is charged on a monthly basis and the licenses are from the date of occupancy until August 15 each year. Housing termination policies can be found on the Housing & Residential Services website (https://housing.mit.edu/graduate-family/graduate_family_housing). All rents include heat, hot water, electricity, internet, and basic cable, as well as all building amenities, such as low-cost laundry, gym facilities, and front desk services. Some residences have a $5–$6 monthly tax to cover residence hall social activities.

Rents for the 2018–2019 academic year range from $800 to $2,003 per month, per student. Rates typically increase 3.5% per year. Details about each of the residences can be found on the graduate
and family housing website (https://studentlife.mit.edu/housing/graduate-family-housing).

MIT graduate housing is assigned through an allocation process administered by the Housing Office. Students can enter the allocation for fall term housing between March and early May. Assignments are available in late May. A spring allocation takes place in November for spring term housing. Rooms that become available outside the allocation process are made available through a waiting list that runs from July through October and December through May. Details of the allocation and waiting list are available on the Housing & Residential Services website (https://studentlife.mit.edu/housing/graduate-family-housing).

Housing & Residential Services (graduatehousing@mit.edu), located in W59-200, can be reached at 617-253-5148.

Student Family Housing

Approximately 400 graduate and undergraduate families reside in MIT Family Housing. Family Housing is provided in the Eastgate Apartments, a high-rise apartment building, and the Westgate Apartments, which consist of a high-rise building and several garden-style buildings. Both communities have an active student government that plans and facilitates social and cultural events for the entire family. Apartments range from efficiencies to 2-bedroom apartments and are all unfurnished.

Residence in student family housing is limited to regular undergraduates and graduate students who are registered and attending MIT (on-campus) full time, and whose families reside together on a full-time basis, and to single parents with at least one child in residence. Except during the summer, students must be registered each term in order to reside in on-campus student housing. New graduate student assignments are either for one and a half or two years depending on the start date of the student’s program, with a new license agreement signed each year. Married undergraduates or undergraduates with children may live in family housing during their eight semesters of guaranteed housing.

Returning students who receive housing through the Continuing Student Allocation Process may remain in housing continuously until they graduate, as long as they are registered each term. They will also sign a new license agreement each year.

Eastgate and Westgate each have an MIT staff person in residence to provide active support to the community. Each building has a playground and Cambridge school buses stop at the buildings.

The rent for all family residences is charged on a monthly basis and the licenses are from the date of occupancy until August 15 each year. Family Housing’s strict termination policies can be found on the Housing & Residential Services website (https://studentlife.mit.edu/housing/graduate-family-housing). All rents include heat, hot water, electricity, internet, and basic cable. Building amenities include low-cost laundry, playrooms, barbecues, and other common spaces.

Rents for the 2018–2019 academic year range from $1,459 to $2,075 per month, per apartment. Rates typically increase 3.5% per year. Details about each of the residences can be found on the graduate and family housing website (https://studentlife.mit.edu/housing/graduate-family-housing).

Student family housing is managed by Housing & Residential Services and is assigned through an allocation process. Students can enter the allocation for fall term housing between March and early May. Assignments are available in late May. A spring allocation takes place in November for spring term housing. Apartments that become available outside the allocation process are made available through a waiting list that runs from July through October and December through May. Details of the allocation and waiting list are available on the website (https://studentlife.mit.edu/housing/graduate-family-housing).

Housing & Residential Services (https://studentlife.mit.edu/housing), located in W59-200, can be reached at 617-253-5148.

Off-Campus Housing

Students who do not live on campus can consult the Off-Campus Housing Office, which maintains listings of available rentals in the greater Boston area. The staff provides students with resources for accommodations that suit individual preferences and finances, and advises and assists them during their tenancy if difficulties arise.

Housing & Residential Services (https://studentlife.mit.edu/housing), located in W59-200, can be reached at 617-253-1493, or visit the off-campus housing website (http://www.mitoffcampus.com).

MEDICAL SERVICES

MIT Medical

To meet the health care needs of MIT community members, MIT Medical (https://medical.mit.edu) offers a single, centralized source of comprehensive health insurance, care and treatment at its own medical centers, and an extensive roster of health promotion programs. Convenient, on-campus access to a broad range of clinical services and medical and dental specialties is delivered by highly qualified health care professionals. Affiliations with many of the Boston area’s leading hospitals allow clinicians to refer patients with more serious conditions to the most appropriate specialists.

Visits to MIT Medical are by appointment, except for urgent care, which is available seven days a week (for hours, please visit the website (https://medical.mit.edu/services/urgent-care)). MIT community members should call 617-253-4481 or 617-258-0656.
(TTY) day or night for medical advice; for regular appointments, call 617-253-4481 during regular business hours. MIT Medical is located in Building E23.

MIT Medical’s Mental Health and Counseling Service (https://medical.mit.edu/services/mental-health-counseling) offers assistance to students dealing with personal concerns including anxiety, depression, relationship problems, or stress. They provide evaluations and consultations, brief treatment, referrals, and group counseling. All services at the Mental Health and Counseling Service are available free of charge to MIT students. For more urgent issues, visit during walk-in hours on weekday afternoons from 2–4 pm. For very urgent issues, a mental health clinician is on call and available 24 hours a day, seven days a week: on weekdays (Monday–Thursday, 8 am–7 pm; Friday, 8 am–5 pm) call 617-253-2916; nights/weekends call 617-253-4481.

For more information about MIT Medical, including appointment hours, phone numbers, and clinician profiles, visit the website (https://medical.mit.edu).

**MIT Student Health Plan**

The MIT Student Health Plan (https://medical.mit.edu/mit-health-plans/student-health-plans) consists of two plans, the MIT Student Medical Plan and the MIT Student Extended Insurance Plan. Further information on both can be found under Medical Requirements (p. 57).

**PARKING**

Parking facilities at MIT are extremely limited. Students are advised to avoid bringing an automobile to MIT if possible. In general, the Institute cannot provide parking for first-year undergraduates. Students may obtain information about parking on campus and request a parking permit at the MIT Parking and Transportation Office website (http://web.mit.edu/facilities/transportation/parking/student). Students with disabilities who have parking requests should see the Medical Department or Student Disability Services for approval.

Students who plan to bring motor vehicles to Cambridge should take careful note of the information regarding pertinent Massachusetts laws distributed with registration material. In addition, since the rate of car thefts in this state is one of the highest in the nation, serious consideration should be given to equipping automobiles with anti-theft devices.

Information about parking and other transportation resources at MIT is available on the website (http://web.mit.edu/facilities/transportation) or at the Atlas Service Center, Room E17-106.

**PRISCILLA KING GRAY PUBLIC SERVICE CENTER**

With a creative student body, world-class faculty, and hands-on, problem-solving culture, MIT is an institution with the ability to “build a better world.” MIT’s Priscilla King Gray Public Service Center (PKG Center) (http://studentlife.mit.edu/pkgcenter) helps MIT students realize that potential by connecting them with a wide variety of rigorous, experiential opportunities to make a difference at home and around the globe.

Whether students want to tackle climate change or chronic disease, staff at the center help them explore their interests and apply their skills to pressing social problems. Through PKG Center programs, students can work with local and global communities to develop and build sustainable programs in healthcare, energy and environment, education, and more. Some students volunteer for an afternoon, teaching seniors to use digital devices or serving meals at a local homeless shelter. Others explore their entrepreneurial talents through social ventures, developing and testing new technologies in communities around the world.

The PKG Center works with MIT students from every school and department, both graduate and undergraduate. By giving students the opportunity to apply their knowledge and ingenuity in real-world contexts, public service experiences can complement and enhance their education, regardless of their field of study.

To learn more about public service at MIT, visit the PKG Center website (http://studentlife.mit.edu/pkgcenter), send an email (pkgcenter@mit.edu), or visit the office in Room W20-549.

**RELIGIOUS ORGANIZATIONS**

There are currently about 25 active and long-standing religious organizations on campus that are based in Building W11, the Religious Activities Center (http://studentlife.mit.edu/rl). Chaplains representing major faith communities devote all or a large part of their time to on-campus activities, counseling individual students, and advising student religious organizations. In addition, there are para-church groups served by chaplains and interns working on campus during the school year. These groups are all supported by outside funding.

Religious, moral, and ethical convictions are important personal identity markers, and the Institute provides all members of the MIT community the opportunity to freely express their beliefs. The chaplain to the Institute monitors that responsibility and offers support and counsel in times of loss and trauma.
STUDENT GOVERNMENT

Undergraduate Student Government

The Undergraduate Association (UA) (http://ua.mit.edu), the major governmental body to which all undergraduates belong, works to improve the quality of undergraduate life. It is assisted by a variety of committees. The Financial Board coordinates budgets and allocates funds to student organizations. The Committee on Education provides student feedback to departments and the Institute to improve the undergraduate academic experience. The Nominations Committee recommends student representatives for more than 50 administrative and faculty committees.

Each class at MIT annually elects a president and executive committee for its class council, which plans and coordinates programs and social events throughout the year.

The Association of Student Activities (http://web.mit.edu/asa), a joint committee of the UA and the Graduate Student Council (see below), is responsible for recognizing student groups and activities, allocating student office space, and organizing Activities Midways, which take place during orientation in August and Campus Preview Weekend (CPW) each April.

All living groups maintain governing structures responsible for the internal functioning of their houses, including sponsoring social events and promoting house culture. To deal with issues of common concern, the fraternities have the Interfraternity Council (IFC), the sororities are organized under the Panhellenic Council, the independent living groups are members of the Living Group Council (LGC), and undergraduate residence are represented by the Dormitory Council (DormCon). The IFC, Panhellenic Council, and LGC also promote good relations among their houses and their host communities in Boston’s Back Bay, Brookline, and Cambridge. DormCon coordinates common house activities including Residence Exploration (REX), CPW, and the Interactive Introduction to the Institute (i3).

Graduate Student Government

The Graduate Student Council (GSC) exists to enhance the overall graduate experience at MIT by promoting the general welfare and concerns of the graduate student body, creating new programs and initiatives, and communicating with the MIT faculty and administration on behalf of graduate students. The GSC seeks to emphasize, in all its activities, the core values of representation, communication, collaboration, transparency, and accountability.

The council accomplishes its goals through a structure of elected representatives, standing committees, and officers. GSC representatives facilitate communication between the council and their constituency (a department, academic program, living group, or demographic group). The standing committees span all facets of the graduate experience, including orientation for all incoming graduate students; career exploration events and a variety of academic seminars throughout the year; large social and cultural activities; advocacy on student-related issues at the local, state, and federal levels; and even the Muddy Charles Pub.

On issues such as housing, stipends, health care, sustainability, and advising, as well as nearly any other academic or student-life related issue, the GSC serves as the primary voice and advocate for the graduate student body. In addition, the GSC nominates individuals to serve on a number of Institute committees, to ensure that there is a student voice in decisions made throughout the Institute.

The GSC also interfaces with graduate student groups through the Association of Student Activities (http://web.mit.edu/asa) (a joint committee of the GSC and the Undergraduate Association) and the GSC funding board, which allocates event funding to these groups. Additionally, the GSC maintains relations with other graduate student organizations both locally and nationally so as to share ideas about how to best address graduate students’ needs.

The GSC office is located in Room 50-220, Walker Memorial, above the Muddy Charles Pub. To keep students apprised of the council’s activities, it maintains a comprehensive website (http://gsc.mit.edu) which serves as a repository for a large amount of information relevant to graduate students; it also publishes the Anno, its weekly newsletter, reaching all graduate students on campus.

WORK/LIFE AND FAMILY RESOURCES

The MIT Work-Life Center

The MIT Work-Life Center (http://hrweb.mit.edu/worklife/welcome) offers a range of work-life programs and services to help manage school, work, life, and family responsibilities while at MIT. The center provides support and helps graduate students, faculty, staff, postdoc associates and postdoc fellows (along with their partners and families) meet their personal and professional needs in all phases of life. For more information, email worklife@mit.edu, call 617-253-1592, or visit the center in NE49-5000, Monday through Friday, 9:00 am to 5:00 pm.

Work-Life Center Resources and Referrals

Personalized assistance, resources, and referrals on a broad range of issues are available at no cost to MIT graduate students (and their partners and families) through MIT GAIN (http://hrweb.mit.edu/worklife/mitgain)—the Graduate Assistance and Information Network. MIT GAIN services include:

- Legal consultation
- Financial consultation
- Child care resources and personalized research and referrals
- Elder care resources and personalized research and referrals
• Relocation guidance
• School/summer camp selection for children in grades K–12
• Nutrition counseling
• Career assessment
• Resources for other life concerns, such as moving services, home repair and cleaning services, pet care, fitness programs and trainers, and more.

Personalized assistance, resources, and referrals are available online and by phone, 24 hours a day, seven days a week for graduate students and their household members.

Seminar Series and Webinars
The MIT Work-Life Center offers research-based seminars and webinars (http://hrweb.mit.edu/worklife/seminars) throughout the year on topics related to parenting children of all ages, work-life balance, navigating work and life as a young professional, and senior care.

Backup Child Care for Students
MIT offers a program of subsidized backup child care (http://hrweb.mit.edu/worklife/backup-child-care-students) for MIT graduate students as part of our support for student families. This program is sponsored by the Office of Graduate Education and administered by the MIT Work-Life Center.

Subsidized backup child care is available through Care.com at a cost of $5.00 per hour for in-home care and $10.00 per day for in-center care. MIT graduate students can request up to 10 days of backup child care per academic year (July 1–June 30). Unused days of care will not carry forward into the new academic year.

Backup child care providers or in-center care can assist when normal child care or school arrangements are disrupted by school closings, vacations, provider illness, or when a child is mildly ill. Backup care can also help cover child care needs at times when care is not normally available, for example, to allow students to attend MIT events, student government meetings or conferences, or to study for exams.

Registration is required. Learn more and register online (http://hrweb.mit.edu/worklife/backup-child-care-students).

Technology Childcare Centers
MIT’s child care system, Technology Childcare Centers (TCC), includes five locations—four centers on campus and one near MIT Lincoln Laboratory in Lexington—that together accommodate a combined total of 388 infants, toddlers, and preschoolers.

Each TCC child care center is a dynamic and nurturing multicultural environment where children participate in adventures that promote invention and discovery. TCC is managed by Bright Horizons Family Solutions in partnership with the MIT Work-Life Center.

Lactation Support
MIT is dedicated to meeting the needs of nursing mothers. The MIT Work-Life Center spearheads efforts to create lactation rooms across campus (there are currently ~20 rooms) and has put together helpful breastfeeding tips and resources online (http://hrweb.mit.edu/worklife/child-care-parenting/breastfeeding-support/mothers).
A variety of resources and services are available to students to help them be successful at MIT. Students are encouraged to familiarize themselves with and utilize them to support their educational and personal needs in order to achieve their academic goals at the Institute.

**ACADEMIC RESOURCES**

The Institute offers a variety of resources for advising and personal support. Students are free to choose the resource that appears to be most helpful, and support is available in many forms, including walk-in conversations as well as scheduled appointments, and with goals ranging from information dissemination to skilled psychotherapy.

All students have an academic advisor. The Office of the First Year (http://mit.edu/uapp) assigns advisors to first-year undergraduate students. Academic departments assign faculty advisors to students who have declared a major. In addition, there are faculty undergraduate and graduate officers in each academic department, as well as academic administrators who consult with students about their academic programs.

Student Support and Wellbeing (SSAW) (https://studentlife.mit.edu/wellness-and-support), in the Division of Student Life, supports all MIT students by providing individualized services, coordinating resources, and offering innovative prevention and education programs. SSAW is composed of five offices that partner closely with other Institute resources to provide coordinated care for all MIT students. The offices in SSAW include Student Support Services, Student Disability Services, Violence Prevention & Response, Alcohol and Other Drug Services, and the CARE Team. Brief descriptions of each of these offices is provided below:

- **Student Support Services** assists undergraduates who cannot meet academic obligations for personal or medical reasons, facilitates the processing of OX grades, processes leaves and returns to the Institute, and advocates on behalf of students.
- **Student Disability Services** ensures that all students with disabilities have access to MIT's programs, activities, and services.
- **Violence Prevention & Response** works with the entire campus to educate and raise awareness on sexual assault, dating and domestic violence, stalking, and sexual harassment. Victim advocates are available 24 hours a day to support survivors by calling the hotline at 617-253-2300.
- **Alcohol and Other Drug Services** prevents high-risk behaviors and promotes healthy communities by working with the community to develop and sustain prevention programming, provide early intervention services, and build coalitions to address MIT-related health issues.
- **The CARE Team** supports students through hospitalizations and transitions back to campus, as well as facilitating wellbeing checks and offering general support to students who are in crisis.

At MIT Medical (https://medical.mit.edu), the Mental Health and Counseling Service (https://medical.mit.edu/services/mental-health-counseling) provides individual and group counseling for a broad array of problems and concerns. The staff are most helpful with such issues as test anxiety, lonesomeness, problems with making and keeping friends and relationships, drinking and using substances, and worry. In addition, Community Wellness (https://medical.mit.edu/services/community-wellness) at MIT Medical runs seminars ranging from stress management and smoking cessation to weight control and nutrition education. For more information, call 617-253-2916.

Several campus offices specialize in particular areas, such as Student Financial Services (http://mit.edu/sfs) (including student employment), Religious Life (http://studentlife.mit.edu/rl/mit-chaplains), Career Advising and Professional Development (http://gecd.mit.edu) (which also offers prehealth advising), and the Office of the First Year (http://mit.edu/uapp). The MIT Police (https://police.mit.edu) can also be helpful to students in many ways.

**DIGITAL LEARNING**

**MITx and edX**

MITx (https://openlearning.mit.edu/beyond-campus/mitx-edx-moocs/courses) is the Institute’s interactive learning initiative that offers online versions of MIT courses on edX (https://www.edx.org/school/mitx), a partnership in online education between MIT and Harvard University. MIT instructors teach these MITx courses to learners around the world.

Many people refer to MITx courses as MOOCs—massive, open, online courses. The learning experience features multimedia and video content, embedded quizzes with immediate feedback, online laboratories, and peer-to-peer communications. Course materials are organized and presented in ways that enable students to learn at their own pace and that allow for the individual assessment of each student’s work. Students who demonstrate their mastery of subjects may earn certificates of completion. MITx operates on a cost-free, open-source, scalable software infrastructure. MITx and edX are building a global community of online learners.

The vast array of data gathered through MITx global and residential uses is helping educational researchers better understand how students learn and how technology can facilitate effective teaching both on campus and online. Research findings are then introduced into new generations of learning tools, creating a continuous loop of educational innovation.
MIT also offers MicroMasters programs (https://micromasters.mit.edu). MicroMasters is a professional and academic credential for online learners from anywhere in the world. Learners who pass an integrated set of MITx graduate-level courses on edX.org, and one or more proctored exams, will earn a MicroMasters credential from MITx, and can then apply for an accelerated, on-campus, master's degree program at MIT or other top universities.

MIT OpenCourseWare

MIT OpenCourseWare (OCW) (http://ocw.mit.edu) is a free, open, publicly accessible web-based resource that offers high-quality educational materials from more than 2,400 MIT courses—virtually the entire MIT graduate and undergraduate curriculum—reflecting the teaching in all five MIT schools and 33 academic units. This near-total coverage in all disciplines makes OCW unique among open education offerings around the world. MIT continually updates OCW, adding new courses as they become available and refreshing existing courses with new materials. More than 1,000 MIT OCW courses have been independently translated into at least 10 other languages.

Through OCW, MIT faculty share their teaching materials with a global audience of teachers and learners. Educators use these resources for teaching and curriculum development, while students and self-learners draw upon the materials for self-study or supplementary use. OCW attracts about 2.5 million visits in a typical month, and to date more than 300 million people from virtually every country in the world have accessed these resources.

Beyond its service to a worldwide audience, OCW has significant impact on campus at MIT, where both faculty and students embrace it. Students use OCW resources such as problem sets and exams for study and practice. New first-year students often report that they checked out MIT by looking at OCW before deciding to apply. Instructors often refer students to OCW for part of their coursework. OCW staff work extensively with faculty to develop and refine course materials for publication, and faculty frequently use these updated materials in their classroom teaching. Alumni access OCW materials to continue their lifelong learning.

OCW course content includes thousands and thousands of individual resources such as syllabi, lecture notes, course calendars, problem sets and solutions, exams, reading lists, selected readings, videos, simulations, animations, sample programming code, and more. More than 100 courses include complete, captioned video lectures for the entire course. Beyond core academic content, a relatively new feature known as OCW Educator allows MIT faculty to share their pedagogical insights, with tips on how they teach their courses to students on campus.

Course materials contained on the OCW website are offered under a Creative Commons license and may be freely used, copied, distributed, translated, and modified by anyone, anywhere in the world for noncommercial educational purposes.

INFORMATION SYSTEMS AND TECHNOLOGY

MIT’s computing environment consists of a rich array of technologies and information resources for academic, research, and administrative use. MIT Information Systems and Technology (IS&T) provides services and facilities available to every member of the MIT community, including MITnet (the campus network), the Athena Computing Environment (centrally provided hardware and software resources), the on-campus telephone system, co-location services for high-performance research computers, centrally licensed and downloadable software, cloud-based offerings, and a variety of support services.

MITnet connects tens of thousands of computers across the campus and connects MIT to networks around the world. All buildings on the MIT campus offer high-speed wireless connectivity in addition to wired network connections.

Athena, used for academic computing, is available in computer labs (“the clusters”) and on departmental and personal machines throughout campus. Based on the Linux operating system, Athena provides a large collection of third-party software, including popular scientific and engineering software such as MATLAB, Maple, and Mathematica.

Graphics software such as SolidWorks, LabVIEW, and Tableau is available through IS&T’s software grid, along with operating systems and math, programming, database, and security software. Online training on software and technology is available through lynda.mit.edu.

Cloud-based services at MIT include Dropbox, the file-hosting service; CrashPlan, the recommended backup solution for desktops and laptops; and Office 365 for mobile devices, which includes integration with Dropbox.

Even though a laptop is not required, most students use a laptop on campus in addition to MIT-provided computers. IS&T provides recommendations, advice, and discounts from recommended vendors for laptop bundles that meet MIT’s course and software requirements.

IS&T provides full support for recommended hardware and software through its Service Desk, which offers email, web, and phone support, a walk-in center, and assistance with connecting to and using the MIT network in the residence halls. The Service Desk also provides certified warranty repair for Apple, Dell, and Lenovo ThinkPad hardware.

Visit the website (http://ist.mit.edu) for more information on IS&T and computing at MIT or for details on getting started with IT as a student (http://ist.mit.edu/students), including an overview of
LIBRARIES

With access to the Libraries' friendly staff, welcoming spaces, and the best scholarly information available, MIT students never have to get stuck working on a problem alone.

The Libraries can connect students to information from wherever they happen to be, with more than five million items in print and digital formats. Partnerships with Harvard (https://libraries.mit.edu/borrow/non-mit-access/harvard), Wellesley (https://libraries.mit.edu/borrow/non-mit-access/area-libraries), and other Ivy Plus institutions (https://libraries.mit.edu/borrow/borrowdirect) allow students to visit and use their collections, and MIT's WorldCat (http://mit.worldcat.org) lets students request materials from other libraries worldwide. Consulting a librarian is often the quickest route to help students find what they need, and we encourage them to Ask Us (http://libraries.mit.edu/ask). We've got experts in every subject (https://libraries.mit.edu/experts) from aeronautics to urban studies, plus specialists in geographic information systems, research data management, copyright, and much more.

Any student is welcome in any of our libraries, whether they are looking for expert help, to collaborate on a group project, or simply take a study break. Our five locations (https://libraries.mit.edu/locations) offer some of the campus's most sought-after study spaces (https://libraries.mit.edu/study), offering extreme quiet, secure 24/7 access, flexible furniture, or comfortable seats with a river view.

The Libraries are a portal to the knowledge produced at MIT and beyond. The Institute Archives and Special Collections (http://libraries.mit.edu/archives) contain MIT's founding documents, the personal papers of noted faculty such as "Doc" Edgerton and Norbert Wiener, and rare books like Newton's Principia. Students can explore the digital repository DSpace@MIT (https://dspace.mit.edu) to access decades of MIT theses and scholarly works by MIT faculty and researchers.

The Libraries are more than just a place for students to consume information—we invite them to engage through hackathons, exhibits, an audio lab, an all-campus reading program, and dozens of workshops during Independent Activities Period (IAP) (http://catalog.mit.edu/mit/undergraduate-education/academic-research-options/independent-activities-period) and throughout the year. Find all our upcoming classes and events at libraries.mit.edu/events.

STUDENT DISABILITY SERVICES

Student Disability Services (SDS) (https://studentlife.mit.edu/sds) is responsible for coordinating the Institute's efforts to comply with the Americans with Disabilities Act of 1990, the Americans with Disabilities Amendments Act of 2008, and Section 504 of the Rehabilitation Act of 1973. SDS provides qualified students with disabilities equal access to all Institute programs, activities, and services. The goals of SDS's support services are to encourage students to be self-sufficient, to enhance the educational process, and to support overall personal and professional development of students without compromising existing academic standards.

These services include receiving and reviewing disability-related documentation and determining the appropriate accommodations required, communicating with faculty (with the student's permission), and developing plans for accommodations. Student Disability Services also provides, or arranges, a variety of auxiliary services for qualified students with disabilities, such as coordination of sign language interpreters, text alternatives, and other academic accommodations. Student Disability Services is located in Room 5-104, 617-253-1674.

STUDENT SERVICES CENTER

The Student Services Center, conveniently located along the Infinite Corridor in Room 11-120, provides students and their parents with information about their student bills, financial aid, loans, payment plans, registration, transcripts, and a variety of other academic and financial matters. Students can also pick up or drop off many Institute forms.

The Student Services Center is open Monday, Wednesday, and Friday from 9 am to 5 pm, and Tuesday and Thursday from 10 am to 5 pm. For further information, call 617-258-8600 or email (sfs@mit.edu). Visit the website (http://sfs.mit.edu/about-us) for a complete description of the financial services available to students.

WEBSIS

WebSIS (http://student.mit.edu) is the web-based student information system for students, faculty, and staff. Through WebSIS students can preregister and register for classes, check grades, maintain personal information, apply for their degrees, track financial aid requirements, complete loan entrance counseling, and view current student account activity; advisors and administrators can view the academic records of students in their departments, approve degree applicants, and access online registration; instructors and administrators can access enrollment lists, student photographs, prerequisite reports, online subject evaluations, and online grading for their classes.
The Writing and Communication Center (WCC) offers free individual consultations on all types of written and spoken communication. The WCC's lecturers help MIT undergraduates, graduate students, postdocs, faculty, alums, staff, spouses and partners from every department and discipline at MIT. The WCC is staffed entirely by communication experts: all are published writers and scholars; all have advanced degrees; all have college classroom teaching experience; all have taught in the WCC for a minimum of six years (the average is 18+ years). They can help at any stage of the writing process, from getting an idea to polishing a piece for publication. They give advice about oral presentations, including conference presentations and job talks. They run practice sessions for those talks. The WCC's professional communication experts strategize with individuals to: deepen their content; expand the implications of their data, research, and ideas; analyze the conventions of their academic, technical, or professional disciplines and genres; tailor their messages and organization to different audiences; and craft their style to maximize rhetorical effect. The WCC helps with theses, dissertations, articles for publication, books, proposals of all kinds, conference papers and talks, slide design, papers for all courses, CVs, Research and Teaching Statements, and any job materials. The WCC has experts in teaching students whose first or strongest language is not English. They help with writing, pronunciation, speaking, and understanding American culture. In addition, the WCC runs support groups for thesis writers and postdocs as well as periodic workshops for various departments. Appointments are made online (https://mit.mywconline.com).
UNDERGRADUATE EDUCATION

MIT’s strength—as represented by its official seal and motto, mens et manus, mind and hand—is the fusion of academic knowledge with practical purpose. MIT believes the best education occurs when students are self-motivated and engaged participants in a dynamic community of learners. Consequently, an MIT undergraduate education combines rigorous academics with a “learning-by-doing” approach.

To earn a bachelor’s degree, undergraduates must complete the General Institute Requirements as well as the course of study prescribed for the degree to be awarded. This section outlines the general requirements together with other important aspects of undergraduate education, including admissions and financial aid.

ACADEMIC PROGRAMS

The undergraduate programs at MIT are designed to help students develop the knowledge and capabilities needed to meet the challenges of modern society. An MIT education joins the power of a specific discipline to a concern for social values and goals. In addition to developing expertise in a given field, undergraduates are encouraged to take advantage of the opportunities for broad learning at MIT and to become creative, intellectual leaders and problem solvers whose passion for learning is lifelong.

Central to the MIT undergraduate experience is the concept that a four-year residential college requires a full-time academic program. An MIT degree represents not only a specified number of credit units and a collection of subjects, but an intensity and continuity of involvement in an academic enterprise and an immersion in the culture of MIT. In general, MIT is not an appropriate place to pursue a part-time education.

MIT students base their studies on a core of subjects in science, mathematics, and the humanities, arts, and social sciences (the General Institute Requirements (p. 36)). They major in the physical or biological sciences, in management science, in architecture or urban studies and planning, in an area of the humanities, arts, and social sciences, or in one of the engineering fields. In the first year, many students take subjects from a variety of options in mathematics, physics, chemistry, biology, and humanities, arts, and social sciences. During the second year, students generally continue their studies with subjects meeting various Institute requirements and beginning subjects in departmental programs. In the third and fourth years, students focus on the departmental programs.

There is also time for students to take elective subjects each year. These elective opportunities allow students to follow social interests or to enrich their educational backgrounds. Students may also use elective time to prepare for study in a professional field such as medicine or law or to begin work toward graduate study. Students may also pursue minors in many fields.

One of the most exciting features of undergraduate education at MIT is the opportunity for students to join with faculty in ongoing research projects. For example, experiences in the Undergraduate Research Opportunities Program (UROP) (p. 44) encourage intellectual commitment and self-direction, and often provide a focus for students’ undergraduate studies. During the Independent Activities Period (p. 43) in January, students can spend time in workshops, independent research projects, intensive subjects and seminars, field trips, lecture series, and other activities that do not easily fit into the traditional academic calendar.

To complete work for a bachelor’s degree in any Course (major), each student must fulfill the General Institute Requirements and must complete the departmental program specified by that Course. Details on General Institute Requirements and on selecting a major course of study are discussed elsewhere in this section.

The program for the SB takes four years of full-time study for most students. Of the first-year undergraduates who entered between 2007 and 2011, the percentage of students who received their degrees within six years of entrance was about 93 percent.

FIRST YEAR

During the first year at MIT, students lay the foundation for their college education. First-year students may accommodate their individual preparation and learning styles by choosing among a variety of ways to complete the core subjects and prepare for further undergraduate study. Incoming first-year students are referred to the First Year at MIT website (http://web.mit.edu/firstyear) for detailed information on academics, the advisory system, and support services.

To begin fulfilling the General Institute Requirements (p. 36), first-year students choose subjects in mathematics, chemistry, biology, and physics to fulfill the science core, and select from a wide range of subjects in the humanities, arts, and social sciences (HASS subjects). Students have various options for satisfying the first year of the Communication Requirement.

A normal program for the first year includes completion of four or five of the six science core subjects in mathematics, physics, biology, and chemistry, and two of the eight HASS subjects, including a Communication-Intensive subject. Students may round out their programs with electives, often including first-year advising seminars (led by the students’ advisors). Some first-year students also elect to become involved in the Undergraduate Research Opportunities Program, described later in this section.

Entering students with degree credit for one or more of the science core requirements may substitute more advanced subjects or may take electives or Restricted Electives in Science and Technology.
Students may also enroll in one of the special learning communities: the Concourse Program, the Experimental Study Group, the Media Arts and Sciences First-Year Program, and Terrascope. These learning communities have their own faculty, meeting places, and methods of operation. In these programs, students make progress comparable to that of other first-year students, but the manner in which individual Institute requirements are met varies from program to program and among students within each program. In all four programs there is an especially high level of student-faculty interaction.

Concourse Program
Concourse (http://concourse.mit.edu) is a small community of students and faculty dedicated to exploring the fundamental questions at the heart of all serious human inquiry. The program offers small classes with rigorous instruction in the science and math General Institute Requirements, as well as in the humanities. In the humanities curriculum and first-year advising seminar, we raise questions and encourage debate about human nature, ethics, the proper role of science in society, and the possibilities for human well-being. Concourse students have close interactions with instructors and fellow students, and benefit from presentations by prominent guest speakers in diverse fields from MIT and elsewhere.

The program’s facilities lie at the heart of the MIT campus and consist of a dedicated classroom and lounge, complete with kitchen and seminar room. Students and faculty meet frequently in the 24/7 lounge, not only for study but also for discussions, class tutorials, weekly Friday lunches, and student-led events. All Concourse students are required to sign up for the first-year advising seminar and in the fall to take at least two additional subjects within Concourse, including one humanities subject. Please see the Concourse website for more details and instructions for applying.

For more information, contact Paula Cogliano (pcog@mit.edu), Room 16-129, 617-253-3200.

Experimental Study Group
The Experimental Study Group (ESG) (http://esg.mit.edu) is a close-knit academic program geared primarily toward motivated first-year undergraduate students who wish to take an active role in their MIT education. Each year 55 students, nine staff members, and approximately 40 upper-level teaching assistants (most of whom were in ESG as first years) participate in the program. Staff members are selected for their teaching ability and strong interest in community-based education and are drawn from the departments of Biology, Chemistry, Mathematics, Physics, and the School of Humanities, Arts, and Social Sciences.

In place of lectures and large classes, ESG students participate in small interactive classes (typically fewer than 12 students), discussion-based seminars, study groups, and tutorials. Almost all the core subjects in biology, chemistry, mathematics, and physics are offered through ESG, as well as an experimental CI-H writing class which combines writing and product design, a CI-H class that teaches production of educational video, and two HASS-H philosophy subjects. Although ESG can be a full-time activity for first years, students may take one or two subjects and seminars outside of ESG.

ESG’s small classes are structured to be active learning environments with plenty of opportunity for lively discussion, question-and-answer sessions, student presentations, and peer-led problem-solving sessions. ESG also promotes educational innovation by encouraging staff and students to design and teach experimental 6-unit seminars that combine theory and practice. Seminars this past year include such diverse offerings as The Chemistry of Sports; Programming Physics: E&M with Python; Why Can’t We Get Along; Poetry Beyond the Page; and Many Interesting Things.

ESG’s centrally located facility is comprised of 14 rooms (including a central lounge and a newly renovated kitchen) where classes are held and weekly activities are offered, such as luncheons and dinners, guest faculty speakers, and evening study sessions. Students and staff also plan regular outings for the first years, such as hiking trips, concerts, and visits to local museums and attractions.

For more information about ESG, contact Graham Gordon Ramsay (ramsay@mit.edu), associate director, Room 24-610, 617-258-0481, or visit the ESG website (http://esg.mit.edu).

Media Arts and Sciences First-Year Program
The Program in Media Arts and Sciences (MAS) (p. 130) offers a special first-year program (https://www.media.mit.edu/posts/academics-first-year-program) emphasizing research at MIT’s internationally known Media Lab. In the first-year program, instructors connect research topics in the Media Lab (p. 108) to core physics and chemistry subjects, and students learn firsthand how research is carried out.

The Program in Media Arts and Sciences is part of the School of Architecture and Planning. It is housed in the Media Lab, which carries on advanced research in the invention and creative use of technology to enhance communication and expression.

Up to 24 first-year students in the MAS First-Year Program are introduced to the learning-by-apprenticeship mode that characterizes MAS. During the fall term, students may choose to take part in one of several MAS first-year advising seminars, and take MAS.110 Fundamentals of Computational Media Design, with hands-on design exercises looking at the intersection between expression and technology. In the spring term they take MAS.111 Introduction to Doing Research in Media Arts and Sciences, which includes documenting and presenting research results.
conjunction with MAS.111, all students participate through the Undergraduate Research Opportunities Program (UROP) (p. 44) in one of the research projects at the Media Lab.

Researchers from the Media Lab teach recitation or tutorial sections in the fall for subjects 8.01 Physics I and 3.09J Introduction to Solid-State Chemistry and in the spring for 8.02 Physics II, in which they emphasize connections between the fundamentals of physics and chemistry and ongoing research at the Media Lab. Students take the lectures for these subjects, as well as lectures and recitations in other core and elective subjects, with other first-year students.

For information, please contact program director Dr. V. Michael Bove, Jr. (vmb@media.mit.edu), 617-253-0334, or visit the Media Lab website (https://www.media.mit.edu/posts/academics-first-year-program).

**Terrascope**

Terrascope (http://web.mit.edu/terrascope) is a learning community in which first-year students take ownership of their education as they address complex, real-world environmental problems. Every year Terrascope explores a different global sustainability issue, with students driving the process. Students work in teams to develop solutions, drawing on diverse perspectives, interdisciplinary research, and the resources of the Terrascope community. In the process, they learn about how to organize teams around complex problems of any kind, and how to take on and manage large projects.

In the fall class, 12.000 Solving Complex Problems, students develop solutions to the year’s theme problem and defend them in front of a panel of global experts in a presentation that is webcast live worldwide. In the spring, two optional subjects are available to Terrascope students. In 1.016[J] Design for Complex Environmental Issues: Building Solutions and Communicating Ideas, students design and prototype specific technologies that address aspects of the year’s problem. SP.360 Terrascope Radio fulfills a Communication Requirement (CI-H and HASS-A credit) as students produce a professional-quality radio program on an aspect of the year’s Terrascope issue.

Students fulfill General Institute Requirements (p. 36) by attending mainstream core subjects with other first-year students.

Terrascope students are advised by faculty and staff affiliated with the program, and close interactions among first-year students, upper-level students, faculty, staff, and alumni are an important part of the Terrascope experience. Students attend weekly lunches and participate in other program activities. They can also choose to participate in a weeklong field trip over spring break to a site related to the year’s work. Past locations have included the Netherlands, New Mexico, India, Alaska, and Iceland.

Terrascope students have 24-hour access to a variety of facilities in the center of campus, including a kitchen, lounge, and study space.

**Seminar XL**

Seminar XL (http://ome.mit.edu/programs-services/seminar-xlle) is a collaborative undergraduate learning experience in which groups of three to seven students meet for 90 minutes twice per week to share their understanding of course concepts and problem-solving methods. Each group is guided by a facilitator who is a postdoctoral fellow, a graduate student, or an upper-level undergraduate student who previously earned an A in the course. Although the Office of Minority Education (OME) historically has sponsored the program for first-year students, OME encourages upper-level students to enroll as well. First-year students can receive up to three units of credit per Seminar XL class provided they attend at least 80 percent of the group sessions, while upper-level students must register as listeners.

After the fifth week, interested students may enroll in Seminar XL Limited Edition (LE), which operates two 90-minute working group sessions per week, as does the regular Seminar XL. Past students have also stated that they benefited greatly from this academic program.

For more information about Seminar XL, Seminar XL LE, and other OME services, visit the Office of Minority Education, Room 4-107, 617-253-5010, or visit the OME website (http://ome.mit.edu/programs-services/seminar-xl).

**First-Year Grading**

In the first term and IAP, first-year students are graded on a pass or no-record basis. They receive grades of P, D, or F in all subjects they take, where P indicates C or better performance (C- with modifier used within MIT). First-year students receive no credit for subjects with D or F grades and these subjects do not appear on their transcripts.

In the second term, first-year students are graded on an A, B, C, or no-record basis. They continue to receive no credit for subjects with D or F grades, which do not appear on their transcripts. The A, B, or C grades are used in calculating students’ term and cumulative ratings.

First-year grading is designed to ease the transition from high school by giving students time to adjust to factors like increased workloads and variations in academic preparation. Students are encouraged to improve time-management skills and develop more mature attitudes about learning. A, B, and C grades are used during the second term so that first-year students can begin the progression to regular A–F grading in the sophomore year.

**Use of Hidden Grades**

MIT’s educational policy is to provide “hidden” grades to students for educational and advising purposes only. MIT will not release
hidden grades to any outside organization or individual, and these grades are never included on an external transcript. For more information, see the First Year website (http://web.mit.edu/firstyear).

Credit Limit for First-Year Students
A first-year student may not register or receive credit for subjects totaling more than 54 units in the fall term and 57 units in the spring term. The Committee on Academic Performance (CAP) rarely grants requests to exceed the credit limit. (Only in the fall term may first-year students exceed the 54-unit credit limit by 3 units to take 12,000 Solving Complex Problems or by 6 units to take Seminar XL.) Credit earned for passing an Advanced Standing Examination will be counted toward the term credit limit unless the exam is taken either in the September or February examination period. ROTC subjects are excluded from this credit limit. Note that all MIT students are limited to 12 units during the Independent Activities Period in January.

MAJOR COURSE OF STUDY
Whether or not they enter with plans for a specific field of study, all students are encouraged to examine with an open mind the wide range of Courses (majors) available at the Institute. Students may attend departmental orientation programs to talk with faculty and others with experience in fields of potential interest. They should select electives that will help them think about possible majors. The Independent Activities Period (p. 43) in January, described later in this section, provides students with opportunities to investigate different fields. For many students, this consideration of fields will reinforce existing convictions, while for others it will open up new avenues of interest. MIT may, however, limit enrollment in particular fields of study to balance resources with student interest.

Each student entering MIT is assigned an advisor who assists the student in designing an effective program of study. The selection of elective subjects is an important consideration, one that students should discuss in depth with their advisors.

All undergraduate degree programs combine the study of basic principles with practical applications. This combination helps to motivate the lifelong learning necessary for professional competence.

Students usually choose a Course (major) at the end of the first year, though they need not do so until the end of the second year. There is sufficient overlap and flexibility so that selection or change of Course can be made with relative ease in the second year.

All undergraduate and graduate academic programs, as well as faculty listings for each of the Institute’s departments, are described fully in Schools (p. 116) and Interdisciplinary Programs (p. 337).

Information on undergraduate registration may be found in Academic Procedures (p. 74) and Institute Regulations (p. 83).

Electives
Electives may be used for several different purposes. For example, students who are undecided about their eventual majors may decide to use some portion of their electives to explore the various departments or fields they are considering. Students more certain of their academic and professional goals may choose to use electives to explore areas of secondary interest. Still other students focus first on departmental or General Institute Requirements, deferring subjects of a more supplemental nature until a later year. The study of a language may also be started or continued.

First-year students should select electives that best suit their individual needs. There are several hundred subjects without prerequisites that are especially appropriate for first-year students. However, in general, any subject offered by the Institute is open to all students, provided they satisfy the prerequisites.

Double Majors
Students may earn a bachelor’s degree with two majors by successfully completing the GIRs and the departmental requirements for each major. To add a second major, a student must apply to the Committee on Curricula (COC) by Add Date of his or her penultimate term. Applications submitted after this deadline will be considered by the COC at its discretion on a case-by-case basis.

A double major program should be completed in eight to 10 academic terms and should be planned in advance. A student’s plan for completing both majors must be outlined in the application to the COC. The application must also include the expected completion date for the degree, and it must be approved by both programs.

Students should consult Student Financial Services regarding any impact that pursuing a double major might have on their eligibility for MIT or federal financial aid, particularly if they anticipate needing more than eight semesters to complete their studies.

Students must select a second major in a different area from the primary major. Students pursuing a double major may also complete up to two minors, but a minor may not be taken in the same area as either of the major programs.

Only registered undergraduates who have completed at least three terms at MIT, including at least one term with a declared major, may apply. Transfer students must complete at least two terms at MIT, including at least one term with a declared major. Students with cumulative averages below 4.0 will be considered by the COC on a case-by-case basis. A student who has previously earned a bachelor’s degree with a single major may not return to complete a second major.

For details on eligibility, deadlines, and procedures, see the COC website (http://web.mit.edu/doublemajor).
Minors may be pursued within the following framework. Science degrees, thus giving public recognition of this focused work. Students who successfully complete minors will have their fields of study specified on their transcripts as part of their Bachelor of Science degrees, thus giving public recognition of this focused work. Several interdisciplinary minors (p. 337) are also available.

Students who successfully complete minors will have their fields of study specified on their transcripts as part of their Bachelor of Science degrees, thus giving public recognition of this focused work. Minors may be pursued within the following framework.

- A student may not minor in the area of his or her major. For example, a student majoring in civil and environmental engineering may not pursue a minor in civil and environmental systems. In addition, if a student is pursuing a composite (joint) degree (such as the SB in Computer Science and Molecular Biology, the SB in Mathematical Economics, or the SB in Mathematics with Computer Science), he or she may not pursue a minor in either field of that program. The Committee on Curricula (COC) has the authority to determine whether a specific combination is permissible.
- At the discretion of a student’s major department, subjects taken for a minor may count toward departmental program requirements, provided the student’s combination of programs is permitted by the COC.

The general guidelines for a minor program are as follows:

- Minors consist of five to seven subjects, with a typical program comprising six. A minor may include subjects that count toward General Institute Requirements (GiRs) (p. 36).
- Subjects taken under the junior-senior P/D/F grading option cannot be used for a minor program.
- At the discretion of the minor advisor, approved transfer credit may be used to fulfill a portion of the minor program. MIT subjects, including those taken through cross-registration, must comprise at least half of the minor program.
- A student may earn no more than two minors, which are awarded only when the student receives the SB degree, and which must be associated with a specific degree. This two-minor maximum applies even if the student receives a double major.
- The student should apply for a minor by the end of the sophomore year, but no later than Add Date one full term preceding the one in which the SB degree is awarded. The student must complete an application form for a minor in consultation with the appropriate minor advisor. Note that application and completion forms vary among programs.

Minors are currently available in the fields listed below.

More information on departmental minors appears under the departments’ undergraduate program descriptions.

African and African Diaspora Studies (p. 349)  
Ancient and Medieval Studies (p. 350)  
Anthropology (p. 241)  
Applied International Studies (p. 351)  
Archaeology and Materials (p. 205)  
Architecture (p. 121)  
Art, Culture, and Technology (p. 121)  
Asian and Asian Diaspora Studies (p. 352)  
Astronomy (p. 353)  
Atmospheric Chemistry (p. 354)  
Biology (p. 301)  
Biomedical Engineering (p. 354)  
Brain and Cognitive Sciences (p. 307)  
Business Analytics (p. 284)  
Chemistry (p. 312)  
Chinese (p. 254)  
Civil and Environmental Systems (p. 174)  
Civil Engineering (p. 174)  
Comparative Media Studies (p. 243)  
Computer Science (p. 188)  
Design (p. 121)  
Earth, Atmospheric, and Planetary Sciences (p. 317)  
Economics (p. 249)  
Energy Studies (p. 355)  
Entrepreneurship and Innovation (p. 356)  
Environment and Sustainability (p. 358)  
Environmental Engineering Science (p. 174)  
Finance (p. 284)  
French (p. 254)  
German (p. 254)  
History (p. 259)  
History of Architecture, Art, and Design (p. 121)  
International Development (p. 132)  
Japanese (p. 254)  
Latin American and Latino/a Studies (p. 360)  
Linguistics (p. 262)  
Literature (p. 266)  
Management (p. 284)  
Materials Science and Engineering (p. 205)  
Mathematics (p. 324)  
Mechanical Engineering (p. 215)  
Middle Eastern Studies (p. 361)  
Music (p. 269)  
Nuclear Science and Engineering (p. 231)  
Philosophy (p. 262)  
Physics (p. 330)  
Political Science (p. 274)
Polymers and Soft Matter (p. 362) 2
Public Policy (p. 363) 1,2
Russian and Eurasian Studies (p. 363) 1,2
Science, Technology, and Society (p. 278) 1
Spanish (p. 254) 1
Statistics and Data Science (p. 364) 2
Theater Arts (p. 269) 1
Toxicology and Environmental Health (p. 158)
Urban Studies and Planning (p. 132) 1
Women’s and Gender Studies (p. 365) 1, 2
Writing (p. 243) 1

These programs are HASS minors, which may be built on the concentration component of the HASS General Institute Requirement (p. 36). Of the six subjects required for a HASS minor, at most five may count toward the eight-subject HASS Requirement. Of these five, at most one may count toward satisfying the distribution component of the HASS Requirement.

These programs are described under Interdisciplinary Programs (p. 337).

For additional information, instructions, and applications, students should contact the undergraduate office in their field of interest, or the Office of Undergraduate Advising and Academic Programming in Room 7-104. Information about HASS minors is available in the Office of the Dean, School of Humanities, Arts, and Social Sciences (Room 4-240) or on the SHASS website (http://shass.mit.edu/undergraduate/minors).

GENERAL INSTITUTE REQUIREMENTS

To be recommended for the degree of Bachelor of Science, students must have attended MIT not less than three regular academic terms, which ordinarily must include the term of graduation. In addition, students must have satisfactorily completed a program of study approved in accordance with the faculty regulations, which includes the General Institute Requirements (GIRs) and the departmental program of the Course in which the degree is to be awarded. Departures from the departmental programs are allowed with departmental permission. See the Schools section (p. 116), as well as individual degree charts (p. 380), for information about specific programs.

Substitutions for GIR subjects are allowed only by petition. Petitions pertaining to the Communication Requirement must be directed to the Subcommittee on the Communication Requirement (SOCR) (http://web.mit.edu/commreq/students.html#petitions), and petitions for any substitutions in the Humanities, Arts, and Social Sciences (HASS) Requirement must be directed to the Subcommittee on the HASS Requirement (SHR) (http://web.mit.edu/hassreq/petitions.html). The Committee on Curricula (COC) (https://registrar.mit.edu/faculty-curriculum-support/faculty-curriculum-committees/committee-curricula/petitions) considers petitions for substitutions in the Institute Laboratory Requirement and the Restricted Electives in Science and Technology (REST) Requirement.

Bachelor of Science Degree Requirements

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Chemistry (3.091, 5.111, or 5.112)</td>
<td></td>
</tr>
<tr>
<td>Physics (8.01, 8.011, 8.012, or 8.01L; and 8.02, 8.021, or 8.022)</td>
<td></td>
</tr>
<tr>
<td>Mathematics (18.01 or 18.01A; and 18.02, 18.02A, or 18.022)</td>
<td></td>
</tr>
<tr>
<td>Biology (7.012, 7.013, 7.014, 7.015, or 7.016)</td>
<td></td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

A departmental program includes the following elements:

Between one and six subjects that also satisfy the GIRs. 2
180–198 additional units beyond the GIRs, which must include a minimum of 48 units of unrestricted electives. The "units beyond" total does not include ROTC subjects. However, the units associated with CI-M subjects are normally included in this calculation. 3

Each program is designed so it can be completed with a normal academic load—the equivalent of 8 to 8.5 subjects each year—for a total of 32–34 subjects. 4

Units in Major                                                               | 114-186 |
Units in Unrestricted Electives                                              | 48-138  |
Units in Major That Also Satisfy the GIRs (12-72)

Total Units Beyond the GIRs Required for SB Degree 180-198

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

Transfer students generally will graduate under the requirements that apply to the class they join when they enter MIT.

These subjects are taken from among REST subjects, Institute Laboratory subjects, and/or HASS subjects. Each degree chart specifies how GIR subjects are integrated into the program. Most programs include an overlap of 36 units, or three subjects.

Exception: If a CI-M subject is also one of the 17 GIR subjects in a student’s program (such as a required Institute Laboratory subject), then the units associated with the subject will not be included in the “units beyond” calculation.

For the purpose of counting subjects, 6-unit subjects count as half-subjects: subjects of 9–15 units count as one subject; 18-unit subjects count as 1.5 subjects; and subjects of 21–24 units count as two subjects.

Science Requirement

MIT expects its graduates to have an understanding and appreciation of the basic concepts and methods of the physical and biological sciences. These concepts and methods are needed in most degree programs at the Institute. More important, they are an essential part of the background that MIT graduates bring to their roles as professionals and as broadly educated citizens in a world strongly influenced by science and technology.

Students begin with six science core subjects in mathematics, physics, biology, and chemistry, and then add the Laboratory and Restricted Electives in Science and Technology (REST) Requirements. These requirements introduce basic elements of the scientific method: experimental foundations and techniques, mathematical analysis, and conceptual models for experimental facts. Important experimental as well as conceptual aspects are introduced by the chemistry and biology requirements and by the Laboratory Requirement. Mathematical methods common to much of science and technology are explored in the mathematics requirement. Basic concepts that underlie many physical phenomena are defined and elucidated in the physics and REST requirements.

In addition to a rigorous introduction to the sciences, these requirements are intended to stimulate and challenge each student to review critically his or her knowledge, and to explore alternative conceptual and mathematical formulations that may provide better explanations of natural phenomena or may lead to better applications of technology. The development of critical and constructive approaches to both theory and practice in science, engineering, and other professions is a central objective of the Institute’s educational programs.

Biology

The Institute requirement in biology may be satisfied by one of five introductory subjects:

<table>
<thead>
<tr>
<th>Biology (GIR)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7.012</td>
<td>Introductory Biology ¹ 12</td>
</tr>
<tr>
<td>7.013</td>
<td>Introductory Biology ² 12</td>
</tr>
<tr>
<td>7.014</td>
<td>Introductory Biology ² 12</td>
</tr>
<tr>
<td>7.015</td>
<td>Introductory Biology ¹ 12</td>
</tr>
<tr>
<td>7.016</td>
<td>Introductory Biology ¹ 12</td>
</tr>
</tbody>
</table>

¹ Offered in the fall term
² Offered in the spring term

These five subjects cover the same core material, which includes the fundamental principles of biochemistry, genetics, molecular biology, and cell biology. In addition, each subject has its own distinctive material.

Chemistry

The Institute requirement in chemistry may be satisfied by taking one of the following:

<table>
<thead>
<tr>
<th>Chemistry (GIR)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.091</td>
<td>Introduction to Solid-State Chemistry 12</td>
</tr>
<tr>
<td>5.111</td>
<td>Principles of Chemical Science 12</td>
</tr>
<tr>
<td>5.112</td>
<td>Principles of Chemical Science 12</td>
</tr>
</tbody>
</table>

Subject 3.091 is designed for students who are particularly interested in the chemistry of the solid state. Subjects 5.111 and 5.112 emphasize basic chemical principles and their applications. However, 5.112 is intended for students with a strong background in high school chemistry. The content of 5.111 and 5.112 is formally coordinated with more advanced subjects taught by the Department of Chemistry (e.g., 5.60 Thermodynamics and Kinetics and 5.12 Organic Chemistry I), although any one of the three GIR subjects (5.111, 5.112, or 3.091) may be used as the prerequisite for those more advanced subjects.

Mathematics

The Institute requires all students to complete single-variable calculus, denoted as Calculus I (GIR), and multivariable calculus, denoted as Calculus II (GIR).

<table>
<thead>
<tr>
<th>Calculus I (GIR)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>18.01</td>
<td>Calculus 12</td>
</tr>
<tr>
<td>18.01A</td>
<td>Calculus 12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculus II (GIR)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>18.02</td>
<td>Calculus 12</td>
</tr>
<tr>
<td>18.02A</td>
<td>Calculus 12</td>
</tr>
<tr>
<td>18.022</td>
<td>Calculus 12</td>
</tr>
</tbody>
</table>
Students with advanced standing, advanced placement, or transfer credit for 18.01 may go directly into multivariable calculus. Two versions are offered in the fall term: 18.02, the basic version, and 18.02A, a more theoretical version. Both 18.02 and 18.022 present calculus as it is taught in science and engineering.

Students with a year of high school calculus may qualify for the accelerated sequence of 18.02A/18.02A, which covers the material in one and a half terms. See the subject descriptions for details about how each subject is taught within that timeframe.

Students with advanced placement, advanced standing, or transfer credit for 18.01 lose it if they take 18.01, and receive 3 units of elective credit if they take 18.01A.

**Physics**
The Institute requirement in physics may be satisfied through several combinations of introductory physics subjects.

<table>
<thead>
<tr>
<th>Physics I (GIR)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8.01</td>
<td>Physics I</td>
</tr>
<tr>
<td>8.01L</td>
<td>Physics I</td>
</tr>
<tr>
<td>8.011</td>
<td>Physics I</td>
</tr>
<tr>
<td>8.012</td>
<td>Physics I</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physics II (GIR)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8.02</td>
<td>Physics II</td>
</tr>
<tr>
<td>8.021</td>
<td>Physics II</td>
</tr>
<tr>
<td>8.022</td>
<td>Physics II</td>
</tr>
</tbody>
</table>

Most students find the sequence of 8.01 and 8.02 suited to their needs. The sequence of 8.012 and 8.022 covers essentially the same subject matter as 8.01 and 8.02, but is more advanced mathematically; calculus is used freely from the beginning of the term. Subject 8.01L is offered for students who have had little exposure to physics with calculus in high school; it covers the same material as 8.01, but is taught over a longer interval that begins in the fall and continues through the end of January (IAP (p. 43)).

A student may combine a Physics I (GIR) subject in one sequence with a Physics II (GIR) subject in another to satisfy the requirement. However, under no circumstances may a student enroll in a Physics II (GIR) subject without having first received credit for a Physics I (GIR) subject.

Students who score a 5 on Parts I and II of the Physics C Advanced Placement test receive credit for 8.01. Students with advanced-placement or advanced-standing credit for 8.01 who elect to take 8.012 receive 6 units of elective credit in place of 8.01.

**Communication Requirement**
The Communication Requirement makes the development of effective writing and speaking an integral part of undergraduate education at the Institute. The Communication Requirement ensures that all undergraduates receive substantial instruction and practice in general expository writing and speaking and the forms of discourse common to their professional fields.

The Communication Requirement consists of four communication-intensive (CI) subjects sequenced throughout a student’s undergraduate career. Students take two CI subjects in the humanities, arts, and social sciences (CI-H) and two CI subjects in their major program (CI-M). Students must maintain a minimum pace in completing their CI subjects in order to remain in good standing with the Communication Requirement. They must complete one of their CI subjects by the end of the first year, two by the end of the second, three by the end of the third year, and four by graduation.

Students must earn a passing grade to receive CI credit, and CI subjects must be taken for a letter grade. Therefore, students may not use their junior-senior P/D/F option for these subjects. Only one CI-H subject per term may be counted toward completion of the Communication Requirement. However, students may receive credit for more than one CI-M subject in the same term or a CI-H and a CI-M completed concurrently.

More information on CI-H subjects is included in the section of the Bulletin on the HASS Requirement. Specifics on the CI-M subjects for each major appear in the descriptions of the individual undergraduate degree programs. Additional information can be found on the Communication Requirement website.

The general structure of the Requirement is described below.

**First year.** Students must pass one CI-H or CI-HW subject (http://web.mit.edu/commreq/cih.html) by the end of their second term at the Institute.

Before entering MIT, all students are asked to take the Freshman Essay Evaluation (FEE). The FEE is a placement tool used to determine the best program for each undergraduate within the Communication Requirement. Students who receive a score of “CI-H/CI-HW Required” on the FEE or receive a score of 3 on either the Advanced Placement Language and Composition Test or the Advanced Placement Literature and Composition Test or receive a score of 7 on the English A or B Higher-Level International Baccalaureate (IB) exam have the option of taking any CI-H subject, including a writing-focused CI-H subject (CI-HW).

All other students must take one of the designated Communication Intensive in the Humanities, Arts, and Social Sciences—Writing Focused (CI-HW) subjects as their first CI subject.

Students who do not complete a CI-H/CI-HW subject in their first term at MIT may not advance to sophomore standing in their second term.

**Second year.** Students must pass at least two CI subjects by the end of their fourth term at the Institute. In most cases, these first two CI
subjects will satisfy the CI-H portion of the requirement, providing a foundation in written and oral exposition.

**Third year.** Students must pass at least three of the four required CI subjects by the end of their sixth term. Most students will take their first CI-M subject as juniors and begin to develop the communication skills specific to the professional and academic culture of their discipline.

**Before receiving an SB degree.** Students must complete two CI-H subjects and the two CI-M subjects specified for their SB degree program prior to receiving their degree.

**Noncompliance.** Students who fall behind the minimum pace of completion for the Communication Requirement are in noncompliance. At the end of each term, the names of noncompliant students are forwarded to the Committee on Academic Performance, which may take further action to bring such students into good academic standing.

**Double majors.** Students who wish to complete two majors must pass two CI-H subjects and complete the CI-M subjects that fulfill the communication component of each major. Normally, these students will take four CI-M subjects, that is, two in each major program. In certain cases a CI-M subject may be common to both departments and may be used to fulfill the communication component of two majors simultaneously.

**Information about the Communication Requirement.** For more detailed information about CI subjects or for assistance with any aspect of the Communication Requirement, including petitions, visit the Communication Requirement website (http://web.mit.edu/commreq). Students may also contact the Office of the Communication Requirement (commreq@mit.edu) to discuss their individual circumstances.

**HASS Requirement**

MIT provides a substantial and varied program in the humanities, arts, and social sciences (HASS) that forms an essential part of the education of every undergraduate. This program is intended to ensure that students develop a broad understanding of human society, its traditions, and its institutions. The requirement enables students to deepen their knowledge in a variety of cultural and disciplinary areas and encourages the development of sensibilities and skills vital to an effective and satisfying life as an individual, a professional, and a member of society.

More specifically, the objectives of the program are to develop skills in communication, both oral and written; knowledge of human cultures, past and present, and of the ways in which they have influenced one another; awareness of concepts, ideas, and systems of thought that underlie human activities; understanding of the social, political, and economic framework of different societies; and, finally, sensitivity to modes of communication and self-expression in the arts. Work in these areas will, where appropriate, display a special concern with the relation of science and technology to society.

The student’s program in the Humanities, Arts, and Social Sciences (HASS) is based on the following Institute requirements:

**Minimum.** Every candidate for a bachelor’s degree must have completed a minimum of eight subjects in the humanities, arts, and social sciences, including distribution and concentration components. Subjects must be taken for a letter grade and students may not use their junior-senior P/D/F option. Two HASS subjects that are designated Communication Intensive may also be used toward the Communication Requirement.

**Distribution.** Three of the eight subjects must be selected from designated categories: humanities, arts, and social sciences.

- **Humanities:** Humanities subjects describe and interpret human achievements, problems, and historical changes at individual as well as societal levels. Although humanist inquiry employs a variety of methods, such disciplines as history, literature, and philosophy typically produce their accounts of cultural accomplishments through close analysis of texts and ideas: contemporary and historical, personal and communal, imaginative and reflective.
- **Arts:** Arts subjects emphasize the skilled craft, practices, and standards of excellence involved in creating representations through images, words, sounds, and movement (e.g., sculptures, stories, plays, music, dance, films, or video games). Although arts subjects also engage in critical interpretation and historical analysis, they focus more centrally on expressive and aesthetic techniques and tools, such as the uses of rhythm, texture, and line.
- **Social Sciences:** Social Science subjects engage in theory-driven as well as empirical exploration and analysis of human transactions. They address the mental and behavioral activities of individuals, groups, organizations, institutions, and nations. Social science disciplines such as anthropology, economics, linguistics, political science, and psychology seek generalizable interpretations and explanations of human interaction.

The three subjects may be taken at any stage of the student’s undergraduate career, although students are encouraged to complete their distribution by the end of their junior year. Over 600 subjects may be used to fulfill this requirement. For a complete list of the subjects in each category, consult the Subjects (http://catalog.mit.edu/subjects).

**Concentration.** Each student should designate a field of concentration, in consultation with a designated advisor in the field, by submitting a Concentration Proposal Form no later than the end of the first week of classes in the second term of junior year. Concentration requirements are set by each field and consist of either three or four subjects. One of the subjects that counts toward
the distribution may also be designated as a concentration subject with the permission of the concentration advisor. Upon completion of all of the subjects noted on the Proposal Form, each student should submit a Concentration Completion Form no later than the end of the first week of classes of the final term prior to graduation. For more information, visit the HASS Requirement website (http://web.mit.edu/hassreq).

Currently, the following fields of concentration are offered:

- African and African Diaspora Studies
- American Studies
- Ancient and Medieval Studies
- Anthropology
- Archaeology and Archaeological Science
- Art, Culture and Technology
- Asian and Asian Diaspora Studies
- Comparative Media Studies
- Development Economics
- Economics
- Ethics
- Global Studies and Languages
  - Chinese
  - ELS
  - French
  - German
  - Japanese
  - Portuguese
  - Russian
  - Spanish
  - Other Languages
- Studies in International Literature and Cultures
- Theory of Languages
- History
- History of Architecture, Art, and Design
- Latin American and Latino/a Studies
- Legal Studies
- Linguistics
- Literature
- Middle Eastern Studies
- Music
- Philosophy
- Political Science
- Religious Studies
- Russian and Eurasian Studies
- Science, Technology, and Society
- Theater Arts
- Urban Studies
- Women's and Gender Studies
- Writing

In individual cases, a special concentration may be arranged with advance approval. For more information, visit the HASS Requirement website (http://web.mit.edu/hassreq).

Electives. The remainder of the eight-subject requirement, above and beyond the Distribution and Concentration, may be fulfilled by subjects from any distribution category or by subjects that are designated as HASS electives.

HASS Information. For detailed information on distribution subjects and on the concentration requirements in any field, and for assistance with any aspect of the Humanities, Arts, and Social Sciences Requirement, including petitioning for a substitution, visit the HASS Requirement website (http://web.mit.edu/hassreq). Students may also contact the Office of the HASS Requirement (hassreq@mit.edu) to discuss their individual circumstances.

REST Requirement

Through Restricted Electives in Science and Technology (REST) Requirement subjects, students can broaden and deepen the educational foundation in basic science begun in the first-year program and further the understanding of scientific inquiry. These subjects are designed to give students the opportunity to proceed further in areas already studied, or to explore other areas of potential interest.

REST subjects vary in approach and emphasis. Some give a systematic introduction to the fundamental concepts and principles of a field; others illustrate through examples some of the attitudes, concerns, and methods that characterize professional work in the field. In general, REST subjects are not too specialized, too advanced, or devoted chiefly to instruction in a particular skill. Students typically take REST subjects in the second year, although with the proper prerequisites they may begin taking them in the first year.

Students meet the REST Requirement by taking two subjects from the list below. Of the subjects used to fulfill the requirement, the student can take no more than one in his or her department. However, subjects designated with a J that are offered jointly with another department do not fall under the departmental limitation.

In many cases, subjects required by a Departmental Program for the SB degree are also on the lists of REST and Laboratory Requirement subjects. Thus, students who follow a particular Departmental Program may simultaneously satisfy some part of these requirements.

REST Requirement Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Code</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Computation and Data Science</td>
<td>1.00</td>
<td>Engineering Computation and Data Science</td>
<td>12</td>
</tr>
</tbody>
</table>
### GENERAL INSTITUTE REQUIREMENTS

#### 1.000 Computer Programming for Engineering Applications 12
#### 1.050 Solid Mechanics 12
#### 2.001 Mechanics and Materials I 12
#### 2.003[J] Dynamics and Control I 12
#### 2.086 Numerical Computation for Mechanical Engineers 12
#### 3.012 Fundamentals of Materials Science and Engineering 15
#### 3.021 Introduction to Modeling and Simulation 12
#### 3.046 Thermodynamics of Materials 12
#### 4.440[J] Introduction to Structural Design 12
#### 5.07[J] Biological Chemistry I 12
#### 5.12 Organic Chemistry I 12
#### 5.60 Thermodynamics and Kinetics 12
#### 5.61 Physical Chemistry 12
#### 6.00 Introduction to Computer Science and Programming 12
#### 6.002 Circuits and Electronics 12
#### 6.003 Signals and Systems 12
#### 6.004 Computation Structures 12
#### 7.03 Genetics 12
#### 7.05 General Biochemistry 12
#### 8.03 Physics III 12
#### 8.033 Relativity 12
#### 8.04 Quantum Physics I 12
#### 8.20 Introduction to Special Relativity 9
#### 8.21 Physics of Energy 12
#### 8.282[J] Introduction to Astronomy 9
#### 8.286 The Early Universe 12
#### 9.01 Introduction to Neuroscience 12
#### 10.301 Fluid Mechanics 12
#### 12.001 Introduction to Geology 12
#### 12.002 Introduction to Geophysics and Planetary Science 12
#### 12.003 Introduction to Atmosphere, Ocean, and Climate Dynamics 12
#### 12.102 Environmental Earth Science 12
#### 12.400 The Solar System 12
#### 14.30 Introduction to Statistical Methods in Economics 12
#### 15.053 Optimization Methods in Business Analytics 12
#### 15.0791 Introduction to Applied Probability 12
#### 16.001 Unified Engineering: Materials and Structures 12
#### 18.03 Differential Equations 12
#### 18.032 Differential Equations 12
#### 18.05 Introduction to Probability and Statistics 12
#### 18.06 Linear Algebra 12
#### 18.600 Probability and Random Variables 12
#### 18.700 Linear Algebra 12
#### 20.110[J] Thermodynamics of Biomolecular Systems 12
#### 22.01 Introduction to Nuclear Engineering and Ionizing Radiation 12
#### 22.02 Introduction to Applied Nuclear Physics 12
#### 22.071 Electronics, Signals, and Measurement 12
#### IDS.045[J] System Safety 12

The following combinations of six-unit subjects also count toward the REST Requirement:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0001 &amp; 6.0002</td>
<td>12</td>
</tr>
<tr>
<td>6.041A &amp; 6.041B</td>
<td>12</td>
</tr>
<tr>
<td>6.0001 &amp; 6.0002</td>
<td>12</td>
</tr>
</tbody>
</table>

#### Laboratory Requirement

The Institute Laboratory Requirement consists of subjects that require a major commitment of the student’s attention in comprehensive projects rather than stand-alone experiments or exercises. The primary emphasis of an Institute Laboratory subject is to stimulate a student’s resourcefulness, planning skills, and analysis of observations. Institute Laboratory subjects combine ideas, methods and techniques that would be familiar to a professional in the subject’s discipline. While a Laboratory subject may teach specific techniques, the techniques themselves are not the primary emphasis. Under faculty supervision, the student is responsible for planning and designing the experiments or projects, including selecting measurement techniques, executing the plan, analyzing results, and presenting their conclusions. Details of the elements that comprise an Institute Laboratory subject differ between disciplines.

The Laboratory Requirement is met by successfully completing subjects designed and approved for this purpose. Each Institute Laboratory subject provides a designated number of units toward...
the Laboratory Requirement. Such subjects may be taken in any combination to fulfill the Requirement so long as the student completes 12 units in sum designated as counting towards the Laboratory Requirement. Any units taken as part of these subjects beyond the 12 needed for completion of the Laboratory Requirement will be counted as units beyond the GIRs. At least a portion of the Laboratory Requirement is suggested to be fulfilled in the first two years.

### Laboratory Requirement Subjects

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject 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>
<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>
<tr>
<td>2.008</td>
<td>Design and Manufacturing II (6 units of laboratory credit)</td>
<td>12</td>
</tr>
<tr>
<td>2.017[J]</td>
<td>Design of Electromechanical Robotic Systems (6 units of laboratory credit)</td>
<td>12</td>
</tr>
<tr>
<td>2.671</td>
<td>Measurement and Instrumentation</td>
<td>12</td>
</tr>
<tr>
<td>3.014</td>
<td>Materials Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>4.411[J]</td>
<td>D-Lab Schools: Building Technology Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>5.310</td>
<td>Laboratory Chemistry</td>
<td>12</td>
</tr>
<tr>
<td>5.351</td>
<td>Fundamentals of Spectroscopy</td>
<td>4</td>
</tr>
<tr>
<td>5.352</td>
<td>Synthesis of Coordination</td>
<td>5</td>
</tr>
<tr>
<td>5.353</td>
<td>Macromolecular Prodrugs</td>
<td>4</td>
</tr>
<tr>
<td>5.363</td>
<td>Organic Structure Determination</td>
<td>4</td>
</tr>
<tr>
<td>6.008</td>
<td>Introduction to Inference</td>
<td>12</td>
</tr>
<tr>
<td>6.009</td>
<td>Fundamentals of Programming</td>
<td>12</td>
</tr>
<tr>
<td>6.01</td>
<td>Introduction to EECS via Robotics</td>
<td>12</td>
</tr>
<tr>
<td>6.02</td>
<td>Introduction to EECS via Communication Networks</td>
<td>12</td>
</tr>
<tr>
<td>6.03</td>
<td>Introduction to EECS via Medical Technology</td>
<td>12</td>
</tr>
<tr>
<td>6.101</td>
<td>Introductory Analog Electronics Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>6.111</td>
<td>Introductory Digital Systems Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>6.115</td>
<td>Microcomputer Project Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>6.129[J]</td>
<td>Biological Circuit Engineering Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>6.131</td>
<td>Power Electronics Laboratory</td>
<td>12</td>
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<tr>
<td>6.161</td>
<td>Modern Optics Project Laboratory</td>
<td>12</td>
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<td>6.163</td>
<td>Strobe Project Laboratory</td>
<td>12</td>
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<tr>
<td>6.182</td>
<td>Psychoacoustics Project Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>7.02[J]</td>
<td>Introduction to Experimental Biology and Communication (12 units of laboratory credit)</td>
<td>18</td>
</tr>
<tr>
<td>7.102</td>
<td>Laboratory in Molecular Biology</td>
<td>6</td>
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<tr>
<td>8.13</td>
<td>Experimental Physics I (12 units of laboratory credit)</td>
<td>18</td>
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<tr>
<td>9.12</td>
<td>Experimental Molecular Neurobiology</td>
<td>12</td>
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<tr>
<td>9.17</td>
<td>Systems Neuroscience Laboratory</td>
<td>12</td>
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<tr>
<td>9.59[J]</td>
<td>Laboratory in Psycholinguistics</td>
<td>12</td>
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<tr>
<td>9.63</td>
<td>Laboratory in Visual Cognition</td>
<td>12</td>
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<td>11.188</td>
<td>Urban Planning and Social Science Laboratory</td>
<td>12</td>
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<tr>
<td>12.110A</td>
<td>Sedimentary Environments</td>
<td>6</td>
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<tr>
<td>12.110B</td>
<td>Sedimentology in the Field</td>
<td>9</td>
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<tr>
<td>12.115</td>
<td>Field Geology</td>
<td>9</td>
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<tr>
<td>12.116</td>
<td>Analysis of Geologic Data (3 units of laboratory credit)</td>
<td>6</td>
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<tr>
<td>12.119</td>
<td>Analytical Techniques for Studying Environmental and Geologic Samples</td>
<td>12</td>
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<td>12.307</td>
<td>Weather and Climate Laboratory</td>
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<td>12.335</td>
<td>Experimental Atmospheric Chemistry</td>
<td>12</td>
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<tr>
<td>12.410[J]</td>
<td>Observational Techniques of Optical Astronomy (12 units of laboratory credit)</td>
<td>15</td>
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<tr>
<td>14.32</td>
<td>Econometric Data Science</td>
<td>12</td>
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<tr>
<td>14.33</td>
<td>Research and Communication in Economics: Topics, Methods, and Implementation</td>
<td>12</td>
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<tr>
<td>15.075[J]</td>
<td>Statistical Thinking and Data Analysis</td>
<td>12</td>
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<tr>
<td>15.301</td>
<td>People, Teams, and Organizations Laboratory (12 units of laboratory credit)</td>
<td>15</td>
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<tr>
<td>15.417</td>
<td>Laboratory in Investments (12 units of laboratory credit)</td>
<td>15</td>
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<tr>
<td>15.418</td>
<td>Laboratory in Corporate Finance (12 units of laboratory credit)</td>
<td>15</td>
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<tr>
<td>16.622</td>
<td>Experimental Projects II</td>
<td>12</td>
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<tr>
<td>16.821</td>
<td>Flight Vehicle Development (12 units of laboratory credit)</td>
<td>18</td>
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<tr>
<td>16.831[J]</td>
<td>Space Systems Development (12 units of laboratory credit)</td>
<td>18</td>
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<tr>
<td>17.803</td>
<td>Political Science Laboratory</td>
<td>15</td>
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<tr>
<td>18.821</td>
<td>Project Laboratory in Mathematics</td>
<td>12</td>
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Physical Education Requirement

The mission of the Physical Education General Institute Requirement is to provide learners with the instruction and skills necessary to lead healthy, active lifestyles and to foster both personal growth and a sense of community through physical activity. The program enables students to engage in physical activity while they are involved in rigorous academic study. Major emphasis is placed on the development of skills that can be used for lifetime fitness and wellness. Students receive a strong background in the fundamentals of the activity selected. Instruction is offered in fitness, wellness, individual and team sports, martial arts, dance, aquatics, and outdoor adventure activities. Information on classes, including descriptions of current offerings, is available at the Physical Education website (http://mitpe.com).

To satisfy the Physical Education Requirement, undergraduates entering MIT as first-year students must take four physical education courses (for eight points) and complete the swimming requirement. Transfer students need to complete four points (two courses) as well as the swimming requirement. A student may repeat a course at any level and receive points. The swimming requirement can be satisfied by taking a beginning swim class or by passing the swim test during orientation week in the fall. First-year students are expected to complete the swim test on fall registration day or, if they cannot participate in this event, the swim test during orientation week. They are responsible for completing their four courses during their first year, and they are responsible for completing the Physical Education Requirement by the end of their second year. In general, students must attend 11 sessions/classes to receive the two points that are awarded for a physical education course. Students who do not complete the entire Physical Education Requirement by the end of their second year must submit a plan for a time extension with the Physical Education Office.

Physical education courses are offered in two six-week quarters during the fall term and during the spring term. A fifth “quarter” is offered during the January Independent Activities Period. There is also a summer session. Two points are awarded for each course per quarter.

Physical education registration is open to undergraduates and graduate students. Registration is first come, first serve and is conducted online through the Physical Education Office. Information on registration, including registration dates, can be obtained through on the Physical Education website (http://mitpe.com).

Physical education courses offered last year included Group Exercise (Cycling, Kickboxing, Pilates, PiYo, Step, Yoga, Zumba), Aikido, Archery, Backpacking/Hiking, Badminton, Boot Camp for Athletes, Broomball, Dance (Ballroom, Hip Hop, Middle Eastern, Tango, Salsa, Swing, Square), Fencing, Figure Skating, Fitness/First Aid/CPR, Fitness/Nutrition, Fitness/Stress Management, Fitness/Meditation, Fitness/Relationship Health, Fitness/Sport Nutrition, Golf, Ice Hockey, Karate, Kayaking, Pickleball, Pistol, Rifle, Tchoukball, Top Ropes, Tsegball, Running/Logging, Sailing, SCUBA, Self Defense, Sport Taekwondo, Skating, Skiing/Snowboarding, Soccer (indoor), Swimming, Tennis, Top Rope Climbing, Volleyball, and Weight Training.

Students must wear appropriate attire for activity classes. Goggles are recommended for swim courses, and non-marking court shoes are required for squash and tennis. Most courses provide all necessary equipment. Lab fees are required for some courses. Undergraduate and graduate students must activate their MIT ID card annually to gain access to all MIT sport facilities.

For further information contact the Physical Education Office (mitpe@mit.edu), Room W35-297X, 617-253-4291, or visit the department’s website (http://mitpe.com).

ACADEMIC AND RESEARCH OPTIONS

Students at MIT may take advantage of a variety of academic and research opportunities to enrich or complement their academic pursuits. These include programs designed specifically to support first-year students adjusting to college life, opportunities to engage in collaborative research, global study projects and internships abroad, cross-registration options at other Boston-area schools, and the flexible learning structure and innovative offerings of the Independent Activities Period.

INDEPENDENT ACTIVITIES PERIOD

Independent Activities Period (IAP) (http://web.mit.edu/iap) is a four-week period in January during which faculty and students are...
freed from the rigors of regularly scheduled classes for flexible teaching and learning and for independent study and research. IAP is part of the academic program of the Institute—the “s” month in MIT’s “4-1-4” academic calendar. Students are encouraged to explore the educational resources of the Institute by taking specially designed subjects, arranging individual projects with faculty members, or organizing and participating in IAP activities. They may also pursue interests independently either on or off campus.

Departmental programs may require students to complete a subject (of no more than 12 units) during one IAP.

Activities
More than 600 activities are offered each year on a wide range of topics, both academic and nonacademic. In addition, “special subjects” exist in most departments, for which students can arrange credit for individual work.

Many IAP activities, both credit and noncredit, are organized each fall. Noncredit activities are advertised, beginning in early November, on the IAP website (http://web.mit.edu/iap). Information on credit activities is available, beginning in early December, on the Subject Listing and Schedule website (http://student.mit.edu/catalog).

Organizing Activities
Nonacademic activities may be organized or attended by members of the MIT Community: faculty, students, and employees. Tips on organizing an IAP activity are available on the IAP website (http://web.mit.edu/iap). Organizers may approach MIT departments and organizations to help defray expenses.

Students find organizing IAP activities a rewarding challenge. For many, it is their first opportunity to develop and teach a program from their own ideas. In doing so, they acquire organizational and leadership skills that prove invaluable to their careers.

Tuition, Room, and Board
Regular students paying full tuition in either the fall or spring term do not have to pay additional tuition or room fees to the Institute during IAP. Students who have not been charged full tuition in either the fall or spring term are subject to additional tuition charges and should consult the Registrar’s Office, Room 5-117, 617-258-6409. MIT Dining provides food service options through retail, house dining, and catering services throughout the entire academic year, including IAP. Please visit the dining website (http://dining.mit.edu) in early December to learn more about dining options during IAP.

Academic Credit and Grades
Students should follow directions published on MIT’s IAP website (http://web.mit.edu/iap) regarding registration for subjects. In addition to regular subjects, students may make arrangements to earn credit for independent work under faculty supervision. No student may earn more than 12 units of credit during IAP. Credits received by first-year undergraduate students during IAP are not counted toward their credit limits for fall or spring term.

All credit-bearing subjects are graded according to the grading rules approved for that subject number. A subject can be graded P/D/F only if it has been approved with P/D/F grading. Similarly, the number of units awarded must be as specified for that subject. However, faculty sometimes teach new classes under special subject numbers for which credit units are arranged.

For students to receive credit for work done in IAP, instructors must submit grades to the Registrar’s Office by the deadline given in the academic calendar. If a grade is received after the Add Date of the succeeding term and the student did not register in the subject during IAP, the student must petition to receive credit. IAP credit will not be given if the grade is received after the end of the succeeding spring term.

Students may view their IAP grades on WebSIS (http://student.mit.edu/) shortly after the start of the spring term. Students who do not receive grades when expected should check promptly with their instructors or the Registrar’s Office to ensure the grades are submitted and recorded.

Special Students
Applications for special student status solely for IAP will not be accepted. Special students admitted to the fall or spring term must consult the Admissions Office concerning their status during IAP; they do not automatically have IAP privileges. If the special student has paid full tuition during the fall term or is admitted to do so in the spring, there will not be an additional tuition charge for IAP. If the student has not been paying full tuition, a charge for the IAP units will be added to either the fall or spring term up to a maximum of full tuition for the term.

UNDERGRADUATE RESEARCH OPPORTUNITIES PROGRAM
The Undergraduate Research Opportunities Program (UROP) (http://uaap.mit.edu/research-exploration/urop) invites undergraduates to participate in a wide range of research activities that are available in every academic department and most interdisciplinary laboratories and centers in collaboration with MIT faculty.

There are many advantages to becoming involved in such pursuits as early as possible in an undergraduate career: establishing ties to faculty, investigating a potential major, acquiring data-gathering and laboratory techniques, exploring the frontiers of a field, undertaking topics not amenable to the classroom, facing a real-world problem, and establishing a focus for educational experiences. Through UROP, students may gain a better understanding of the intellectual process of inquiry, while having the opportunity to experience personal and professional growth. Students may earn pay or academic credit, or may work
on a volunteer basis. Whatever the chosen mode, all UROP work is expected to be worth academic credit.

Guidelines for participating are available online (http://uaap.mit.edu/research-exploration/urop). This website lists UROP contacts for Institute departments, laboratories, and centers. While these people are prepared to assist students, a certain amount of footwork and negotiation is required to achieve a satisfying collaboration. The UROP experience is unlike any other; its benefits and rewards are great, but expectations and standards are commensurate. For advice and assistance, contact UROP staff (urop@mit.edu) in Room 7-104, 617-253-7306.

**FIRST-YEAR ADVISING SEMINARS**

The First-Year Advising Seminars (FAS) (http://uaap.mit.edu/office-first-year/first-year-advising/advising-options) program, offered by the Office of the First Year (http://uaap.mit.edu/office-first-year), is one advising option available to first year students. It is available only during the first term to first year students, who must apply online. A First-Year Advising Seminar is typically led by a faculty member who also serves as the first year advisor to the small group of seminar advises. While FASEs vary in style and topic, most are oriented to group discussion and offer an opportunity to interact closely with faculty. All Advising Seminars receive six units of credit and are graded P/D/F.

**INTERPHASE EDGE**

Interphase EDGE (Empowering Discovery | Gateway to Excellence) (http://ome.mit.edu/programs-services/interphase-edge-empowering-discovery-gateway-excellence) is a two-year scholar-enrichment program sponsored by the Office of Minority Education (http://ome.mit.edu) that includes a seven-week summer session as well as programming during the academic year. The focus of the summer program is to give scholars an introduction to the MIT experience by exposing them to the rigors of a full subject load and to life on campus.

In addition, the Interphase EDGE curriculum is uniquely designed to impart pivotal concepts that will increase long-term academic success. The program is designed not only to give students an "edge" on their MIT experience, but also to catalyze their successes beyond MIT. During the summer and academic year, scholars will participate in a range of personal and educational development seminars and activities designed to ensure their smooth transition to college life. Throughout the academic year, scholars will continue to build upon the relationships created during the summer by attending biweekly meetings with EDGE advisors and monthly professional and academic enhancement events, including programs that expose them to various career pathways.

**EDGERTON CENTER**

The Edgerton Center (http://edgerton.mit.edu) offers a wide variety of subjects for both undergraduate and graduate students, and provides resources and opportunities for students to pursue hands-on projects, UROPs, and other activities.

Named for Professor Harold Edgerton, whose high-speed photography legacy (http://edgerton-digital-collections.org) lives on with the Strobe Alley exhibition of Edgerton photographs, the center can provide students with a workplace, a place to test equipment, access to the Student Machine Shop, or simply advice and encouragement. The classroom and studio are located in Strobe Alley on the fourth floor of Building 4, as is the Student Project Lab (http://edgerton.mit.edu/student_project_lab) (4-409). The lab is equipped with hand tools, a sewing machine, soldering tools, electronics prototyping tools, and basic test equipment. For more information on using these facilities, contact Jim Bales (bales@mit.edu) or Amy Fitzgerald (amyfitz@mit.edu).

Subjects offered (http://edgerton.mit.edu/academics) include introductory electronics, digital photography, and classes in international development (D-Lab classes). In addition, Doc Edgerton's Strobe Project Laboratory 6.163 is taught each term by associate director Jim Bales.

The Student Shop in 44-022 (http://edgerton.mit.edu/student-shops/edgerton-student-shop) offers regular training sessions for use of CNC mills, lathes, a 3D printer, and more. The Area 51 CNC Machine Shop (http://edgerton.mit.edu/student-shops/area-51-cnc-shop) is located on the first floor of N51. The first floor fabrication facility—with CNC milling and lathe machines, an injection molding machine, a thermal forming machine, and a waterjet cutting machine—is available to students on clubs and teams, D-Lab (http://d-lab.mit.edu), and to the students, faculty, and staff of the International Design Center. The third floor space, the Milk Drop Shop, is used by clubs and teams for small-scale project work. Both Area 51 and 4-409 are Maker Lodges (https://makerlodge.mit.edu), part of Project Manus (http://project-manus.mit.edu).

The center supports about a dozen student clubs and teams including the Solar Electric Vehicle Team, the MIT Robotics Team, MIT Motorsports, and others. We provide teams with a space to work, machinery equipment, some funding, administrative support, and advising. Students interested in proposing a new team can fill out an application form (https://edgerton.mit.edu/club-team-application) or email Sandi Lipnoski (slipnosk@mit.edu).

The Edgerton Center K-12 Outreach Program (http://edgerton.mit.edu/k-12) gives MIT students an on-campus opportunity to teach engineering and science to 4th through 8th graders from area schools. Topics include mechanical engineering,
Global Education offers comprehensive support to undergraduates to integrate global opportunities into their MIT experience. In addition, Global Education is a one-stop office for information on all MIT programs students may take subjects not offered at MIT. These students typically receive transfer credit. Through the cross-registration experiences, and upon successful completion of these courses, students are enriched by day-to-day exposure to different cultural and/or social experiences, and upon successful completion of these courses, they may receive transfer credit. Through the cross-registration programs students may take subjects not offered at MIT.

**STUDY AT OTHER UNIVERSITIES**

There are a number of opportunities for MIT undergraduates to study at other universities, including study abroad, domestic study away, and cross-registration programs with local universities. Students who spend a term or a year studying abroad or at another US university find that in addition to the intellectual benefit, they are enriched by day-to-day exposure to different cultural and/or social experiences, and upon successful completion of these courses, they may receive transfer credit. Through the cross-registration programs students may take subjects not offered at MIT.

**Global Education**

Global Education is a one-stop office for information on all MIT global education opportunities, helping students identify and integrate global opportunities into their MIT experience. In addition, Global Education offers comprehensive support to undergraduates interested in and preparing for study abroad, and works with partner programs such as the UROP Office, the Priscilla King Gray Public Service Center, D-Lab, and MISTI to support global opportunities.

**Study Abroad Opportunities**

**MIT-Madrid Program**

The MIT-Madrid Program (http://gecd.mit.edu/go_abroad/study/explore/madrid) gives students the opportunity to study in Madrid at the Universidad Carlos III de Madrid (UC3M) for the spring term during their sophomore or junior year. Depending upon major and interests, students can choose engineering, science, humanities, arts, and social sciences courses at UC3M (courses are taught in Spanish and English). In addition to academic courses, students can participate in an internship during this program. Students who plan to participate in MIT-Madrid must be in good academic standing and have taken at least one year of Spanish language to participate in the programs. Students who wish to take courses in Spanish should have Spanish language proficiency at the Spanish IV level. MIT-Madrid Program participants are placed individually with Spanish families in homestays.

**IAP Programs**

Four study abroad programs administered by the Global Education Office are offered during IAP. Three of these programs are offered in Madrid. The intensive Spanish III language program is taught by MIT faculty in Madrid and is open to MIT undergraduate and graduate students. Students planning to participate in this program need to have Spanish language fluency at the Spanish II level. An advanced Spanish course is also offered, Spanish Conversation and Composition, for students who have a Spanish language proficiency at the Spanish IV level. The Spanish incubator literature course is taught in English. Students participating in these programs are placed with Spanish families in homestays. The fourth program is the Literary London course and is offered in London. The course gives students the opportunity to delve first-hand into the worlds of Shakespeare and other famous English writers.

**Exchange Programs**

The new multi-departmental academic exchange with Imperial College London gives MIT students an opportunity to study at Imperial for a semester or a year. The following departments send students on this exchange:

- Aeronautics and Astronautics
- Chemistry
- Chemical Engineering
- Earth, Atmospheric and Planetary Sciences
- Electrical Engineering and Computer Science
- Materials Science and Engineering
- Mathematics
- Mechanical Engineering
• Nuclear Science and Engineering

Several MIT departments also offer smaller exchange programs (http://gecd.mit.edu/go_abroad/study/explore/exchange) that allow their MIT students to swap places with peers from foreign partner universities. The following departments send students for a semester or year for study:

• The Department of Aeronautics and Astronautics offers an exchange program with the University of Pretoria in South Africa. Courses are offered in English.
• The Department of Materials Science and Engineering has two exchange programs: with the University of Oxford and the University of Tokyo (courses are offered in English).
• The Department of Political Science has an exchange program with Sciences Po in France. This program is open to students in all majors who are interested in taking courses in social sciences and/or humanities at Sciences Po. Participating students can choose courses in English and/or French.
• The Department of Mechanical Engineering has two exchange programs: with ETH-Zurich in Switzerland and the University of Tokyo. Students participating in the ETH-Zurich Exchange can take courses in English and/or German, while students participating in the University of Tokyo Exchange take courses in English.
• The Department of Nuclear Science and Engineering has one such exchange program with the University of Tokyo (courses in English).

In addition, the following departments participate in the Imperial-MIT Summer Research Exchange: Aeronautics and Astronautics, Biological Engineering, Chemical Engineering, Chemistry, Civil and Environmental Engineering, Electrical Engineering and Computer Science, Materials Science and Engineering, Mathematics, Physics, and Nuclear Science and Engineering. This program allows students to conduct faculty-mentored research over the summer and is offered in collaboration with the MIT UROP office.

Other Study Abroad Options

MIT students may also apply for admission directly to foreign institutions that offer study abroad programs or to a study abroad program administered by another US institution or study abroad provider. Examples of such opportunities include the University of Edinburgh, the London School of Economics, University of Oxford and other UK institutions, and a number of programs in Australia and China.

Students interested in study abroad should meet with a staff member in Global Education who can help students identify a program that is a best fit for them academically and professionally. Students should also work out their academic plans with a faculty advisor and appropriate transfer credit examiner(s) in the department. They also must complete a Worksheet for Planning Study Abroad/Domestic Study Away (http://gecd.mit.edu/go_abroad/study/prepare) in order to gain approval for study abroad. Global Education staff can help students navigate all of these steps. While on an approved study abroad program during the fall and/or spring term(s), a student maintains full-time student status at MIT. Although it is most common to study abroad during the junior year, it is possible to participate in a study abroad program in the sophomore year or, in some cases, in the senior year. Study during IAP and/or summer are popular options for any undergraduate year.

Financial aid is portable for semester or year study abroad programs. Students who receive financial aid at MIT are advised to discuss their study abroad plans with the Student Financial Aid Office (http://sfs.mit.edu) at least one term prior to the term in which they wish to commence study abroad. This will help students develop the best possible financial plans for their time abroad. Global Education has funding available for IAP and summer programs, and can also help students apply for external study abroad scholarships.

Numerous institutions offer programs abroad taught in English. It is possible to study in a foreign country without prior knowledge of the host country's language. However, a working command of the language can add greatly to the overseas experience. Even a student without prior language skills can usually achieve a good level of proficiency in a foreign language by the beginning of the junior year if he or she begins language study by spring term of the first year of undergraduate study.

With proper planning and preparation, students who successfully complete an approved program of study abroad receive transfer credit toward their MIT degree. While at the host institution, students must arrange to have an official transcript sent directly to the MIT Registrar's Office showing coursework and final grade(s) completed at the outside institution. Upon return, they must submit a completed Request for Additional Credit Form, signed by the appropriate transfer credit examiner(s), and the SHASS Dean's Office, if applicable.

For further information, contact Global Education (studyabroad@mit.edu), 617-324-7239, or visit the website (http://gecd.mit.edu/go_abroad).

Domestic Study Away

Students may choose to spend from one term to one year studying at another academic institution within the US. Students studying at another US university through this option pay tuition to the outside institution rather than to MIT for these terms. While on an approved domestic study away program during the fall and/or spring term(s), students maintain full-time student status at MIT. Students interested in domestic study away should make an appointment with a staff member in Global Education (http://gecd.mit.edu/go_abroad).
To qualify for Domestic Year Away status, students must show that their proposed program of study draws upon resources available at the outside institution that are not generally available at MIT, or at the institutions with which MIT has cross-registration privileges. In addition, a planned program of study should be consistent with an overall degree program at MIT. Students must be accepted by a school of established academic merit and undertake a workload comparable to that at MIT. Students planning to spend time studying at another academic institution in the US need to work out their plans with a faculty advisor and appropriate transfer credit examiner(s), and complete and get signatures on a Worksheet for Planning Study Abroad/Domestic Study Away (http://gecd.mit.edu/go_abroad/study/prepare).

With proper planning and preparation, students who successfully complete an approved program of study at another US university receive transfer credit. While at the host institution, students must arrange to have an official transcript sent directly to the MIT Registrar’s Office showing coursework and final grade(s) completed at the outside institution. Upon return, they must submit a completed Request for Additional Credit Form, signed by the appropriate transfer credit examiner(s), and the SHASS Dean’s Office, if applicable.

For further information, contact Global Education (studyabroad@mit.edu), 617-324-7239.

Cross-registration Programs
Subjects taken through cross-registration programs with Harvard and Wellesley may be used to fulfill departmental major and minor requirements with the permission of a faculty advisor.

When appropriate, cross-registration subjects taken for a letter grade at Harvard and Wellesley may count toward fulfillment of the HASS Requirement; in most cases, students must submit a petition to the Subcommittee on the HASS Requirement. Subjects may be designated as part of the Concentration for the Humanities, Arts, and Social Sciences at the discretion of the designated advisor in that field of concentration.

Harvard University
MIT undergraduates are permitted to take subjects at Harvard University (except Harvard Business School, Harvard Extension School, and Harvard Summer School) for degree credit at no extra charge. This cooperative arrangement is not applicable to the summer session or IAP. In general, MIT students take subjects at Harvard which are not offered regularly at MIT. Cross-registration is limited to upper-level students who must be regularly enrolled at MIT and paying full tuition for the term in question. No more than half of a student’s registration (up to a maximum of 24 units) may be taken at Harvard in any one term.

Where appropriate, Harvard subjects can count toward fulfillment of the HASS Requirement; in most cases, students must submit a petition to the Subcommittee on the HASS Requirement. Letter grades earned in Harvard subjects appear on the transcripts of MIT undergraduates. Detailed information about the Harvard cross-registration option for undergraduates is available online (https://registrar.mit.edu/registration-academics/registration-information/cross-registration/harvard).

Wellesly College
MIT students may cross-register for any courses at Wellesley College if they present the necessary prerequisites. This exchange program is not applicable to IAP or the summer session. Wellesley is a small, liberal arts college for women located on a 500-acre campus 17 miles west of Cambridge.

Through the Wellesley Education Department, MIT students may earn Massachusetts certification to teach at the elementary or high school level. This certification is recognized by many other states.

Students generally cannot substitute Wellesley subjects for MIT Science Requirement (p. 37) subjects (Chemistry, Biology, Physics, and Calculus) or Institute Laboratory Requirement (p. 41) subjects. They may take Wellesley subjects to satisfy Restricted Electives in Science and Technology (REST) (p. 40) Requirements, but need the approval of the Committee on Curricula.

When appropriate, Wellesley subjects can count toward fulfillment of the HASS Requirement; in most cases, students must submit a petition to the Subcommittee on the HASS Requirement.

Wellesley subjects may be used to fulfill departmental major and minor requirements with the permission of a faculty advisor.

For upper-level students, letter grades will be recorded for Wellesley subjects, unless the student designates a Wellesley subject as one of his or her two electives to be graded P, D, or F. Grades for first-year students will be converted to the MIT first-year grading system.

Students may take physical education classes at Wellesley on a space-available basis and may apply these classes toward their MIT physical education requirements. MIT students receive full library privileges at the Wellesley College Library.

Wellesley operates free weekday bus service between the two campuses. The service is open to everyone with an MIT or Wellesley identification card, but priority will be given to cross-registered students. The ride is about 50 minutes each way.

Detailed information on registration procedures is available online (https://registrar.mit.edu/registration-academics/registration-information/cross-registration/wellesley). The Exchange Office at Wellesley is located in Room 339C, Green Hall, 781-283-2325.
Massachusetts College of Art and Design
MIT undergraduates may cross-register at the Massachusetts College of Art and Design (MassArt), a highly respected art school in Boston with studio classes such as drawing, painting, and printmaking that are not offered for credit at MIT.

Classes taken at MassArt through the cross-regISTRATION program are graded P, D, or F and may not be used to satisfy Institute, departmental, or minor requirements. They may be used toward unrestricted elective credit. Only one subject from the school may be taken in a semester. This program is not applicable to IAP or the summer session.

Students must complete a cross-registration form, available in the Student Services Center, Room 11-120, by the deadline set by the MIT Registrar. Detailed information is available online (http://act.mit.edu/academic-program/cross-registration).

INTERNSHIPS ABROAD
MIT International Science and Technology Initiatives (MISTI) (http://misti.mit.edu) is MIT’s pioneering international education program. Each year nearly 1,000 MIT undergraduate and graduate students intern, teach, research, and collaborate in more than 25 countries around the world.

MISTI’s internship program (http://misti.mit.edu/student-programs/internships) matches MIT students with hands-on projects in leading international companies, schools and labs. Through MISTI’s teaching programs (http://misti.mit.edu/global-teaching-labs), students learn how to communicate with international peers by teaching STEM and entrepreneurship in foreign high schools and universities. To prepare for their experiences abroad, MISTI students complete coursework in the language, culture, history, and politics of their host country. Students also participate in a series of location-specific Preparation & Training (http://misti.mit.edu/preparation-training) modules covering topics such as cross-cultural communication, current events, technology, and innovation in the host country, navigating the workplace, logistics, and safety.

CAREER AND PROFESSIONAL OPTIONS
An MIT education is a valuable investment in the future. Several options are available to students who need or desire career advice or job-search assistance, as well as to those seeking guidance about further study. Students can take advantage of programs to gain international experience or to earn teaching credentials. Leadership and military training opportunities are available through US Reserve Office Training Corps programs. This section describes some of the available options.

CAREER ADVISING AND PROFESSIONAL DEVELOPMENT
Career Advising and Professional Development (http://gecd.mit.edu) helps MIT students, recent alumni, and postdocs find jobs and internships, explore career options, and apply to graduate and professional schools. The office is located in E17-294 and can be reached by phone at 617-715-5329 or by email (gecd@mit.edu).

All students are encouraged to make use of Career Advising and Professional Development services early and often. These include:

- Resume, cover letter, and CV review
- Guided self-assessments
- Mock interviews
- Career fair preparation
- Counseling on other career issues, including researching careers, finding jobs and internships, networking, and negotiating job offers
- Workshops and events
- Job postings
- On-campus recruiting and interviews

Many of these services can be accessed via CareerBridge (http://myinterface.com/mit/student), Career Advising and Professional Development’s online career tool for signing up for appointments, registering for events, and searching job postings.

First-year students can register for the First-Year/Alumni Summer Internship Program (http://gecd.mit.edu/fasip) (SP.800 First-Year/Alumni Summer Internship Program/SP.801 First-Year/Alumni Summer Internship Program II), a 6-unit graded seminar that offers career development training.

Prehealth Advising
Prehealth Advising, part of Career Advising and Professional Development and located in Room E17-294, supports students interested in exploring and applying to health professional schools. There is no required major for admission to health professional schools; however, schools do require applicants to complete a number of science and writing subjects prior to admission. Students should visit the website (http://gecd.mit.edu/grad-and-med-school) for information on admissions criteria, the application process, and services provided.

TEACHER LICENSURE AND EDUCATION
Options for MIT students interested in teaching elementary or secondary school range from exploratory activities such as tutoring and participation in the Undergraduate Research Opportunities Program (UROP) (p. 44) to an official teacher certification program.
For students who wish to explore teaching as a career (in the short or long term), the MIT/Wellesley Scheller Teacher Education Program (STEP) (http://education.mit.edu), housed in the Department of Urban Studies and Planning, offers instruction to meet the requirements for Massachusetts State Teacher Certification in math and science at the middle and high school levels (and can be transferred to many other states). Courses offered through STEP are also useful for students preparing to teach at the college level, as well as those who wish to apply their work to related research fields such as curriculum design or educational technology. Those going into industry find that STEP training can apply to workforce development, training, leadership, and mentoring within a company.

Education subjects that focus on math/science teaching at the secondary level (grades 5-12) are offered through Course 11 Urban Studies and Planning. To receive Massachusetts State Teacher Certification, students must complete 300 hours of supervised teaching practicum starting in IAP and ending in Spring semester and additional coursework at MIT, or through Wellesley College. A HASS concentration in Urban Studies with emphasis in education is offered as part of the undergraduate curriculum.

To explore K-12 teaching opportunities less formally, students may volunteer as tutors or teacher assistants in local schools, design and teach classes through the Educational Studies Program (https://esp.mit.edu/learn), or work with faculty members who conduct research in schools. (Refer to the UROP Directory for a list of faculty members interested in such research.) Other groups that can help identify similar opportunities on campus are the Student Services Center, Room 11-120; the Priscilla King Gray Public Service Center, Room 3-123; the Edgerton Center, Room 4-408; the MIT Museum, 265 Massachusetts Ave; and Career Advising and Professional Development, Room E17-294.

**ROTC PROGRAMS**

Military training has existed at MIT ever since the Institute opened its doors in 1865. More than 12,000 officers have been commissioned from MIT, of whom more than 150 have reached the rank of general or admiral. Students who are United States citizens or who have applied for citizenship, are of good moral character, and are medically qualified for military service, may enroll in the programs for leadership training. Non-citizens who fulfill naturalization requirements for citizenship prior to graduation may enroll and participate in the two-year non-scholarship programs. Any full-time MIT student may participate in the programs for leadership training.

All three programs—Air Force, Army, and Naval ROTC—have the following characteristics in common:

- Enrollment as a non-scholarship first-year student or sophomore does not involve a military service obligation.
- Most students enter the program at the beginning of their first year. However, entry up to the middle of the sophomore year is available. (For Army ROTC, students may enter at any time as long as they have four full semesters remaining until undergraduate or graduate degree completion).
- To be eligible for a commission as an officer in the Armed Forces, students must complete the Reserve Officers’ Training Corps (ROTC) program, including summer training, and earn their bachelor’s degree. (Army ROTC students who are pursuing a graduate degree must complete the ROTC program, including summer training, and earn their graduate degree).
- Upon request by the student, any required summer employment financial aid contribution can be waived if summer training makes such employment impossible.
- Non-scholarship students may compete for ROTC scholarships, many of which cover full tuition and fees, and range from one to four years for the Army, Air Force, and Navy.
- Enrollment as a scholarship recipient beyond the first year generally creates an obligation of four years of active duty service in the Navy or Air Force, or four years of active duty or eight years of reserve duty in the National Guard or Reserve for the Army.

Aerospace Studies (AS), Military Science (MS), and Naval Science (NS) subjects are not included in a student’s grade point average, and the credits do not count toward a degree. These subjects can be applied toward the Physical Education Requirement. In some cases, the ROTC programs may include departmentally approved subjects that provide academic credit.

Students who accept a contract to become an officer must maintain acceptable levels of academic performance and physical fitness. ROTC academic performance requirements may exceed Institute standards. Breach or willful evasion of the contract could lead to a period of enlisted service or to repayment of scholarship funds.

Specific information concerning benefits, ROTC training programs, career opportunities, and contractual obligations can be obtained from the program offices listed in this section.

**Air Force ROTC**

The Air Force ROTC program provides students the opportunity to become commissioned officers in the Air Force after completing their undergraduate or, with exception, graduate degree. It is designed to develop the leadership and management skills essential for an Air Force officer while preparing the student for assignment in a career field related to his or her academic specialty.

**Training Program**

The program consists of classroom and leadership laboratory work during the four years of academic study and one summer training
period of three weeks between the second and third years at an Air Force base. Students with three academic years remaining may enroll in the four-year program by combining the first two years.

The first two years of the four-year program are known as the General Military Course (GMC). Upon completion of the GMC and summer field training, students may compete for entry into the Professional Officer Course (POC). Selection into the POC is based on academic aptitude and performance, successful completion of the GMC and field training, and recommendation of the professor of Aerospace Studies.

Scholarships
Air Force ROTC scholarships are available on a competitive basis to qualified applicants. Scholarships pay up to full tuition, include $600 per year for textbooks, and a $300–500 nontaxable allowance each month. Two- to three-and-a-half-year scholarships are offered on a competitive basis in addition to the four-year scholarships offered to high school seniors. The detachment commander also has three-and-a-half year full-tuition scholarships to award to outstanding first-year undergraduates (technical majors) and $18,000 per year scholarships to award to non-technical students.

Classroom Instruction
The Aerospace Studies curriculum emphasizes the history, organization, and mission of the Air Force, including its role in national defense strategy and American society. Academic classes and leadership laboratory activities provide training and practical experience in developing leadership and managerial skills.

Students enrolled in the first two years of the program attend one hour of class and two hours of Leadership Laboratory (LLAB). In the final two years of the program, the class time is three hours per week with the same LLAB requirement. LLAB has always been a highlight of the program, introducing cadets to a variety of motivational and interactive activities. Aside from standard drill practice, students participate in guest-speaker events, athletic competitions, self-defense class, marksmanship training, rock climbing, career day, and much more. Cadets must also complete three hours of physical fitness training each week.

Eligibility Requirements
To be eligible for the Air Force ROTC scholarship program and the POC, students must be citizens of the United States; physically qualified in accordance with existing Air Force regulations; and enrolled at MIT, Harvard University, Salem State University, Suffolk University, Tufts University, or Wellesley College as full-time students.

Application Procedure
Interested students can sign up for the Air Force ROTC program by visiting the Aerospace Studies Department, Room W59-114, calling 617-253-4475, or emailing afrotc@mit.edu.

Army ROTC
The Army ROTC program at MIT (http://web.mit.edu/armyrotc) is designed to enhance a student’s college education by integrating into the curriculum leadership and management theory with leadership practicum modules. Through coursework and in-class practical experience, students will develop decision-making, team-building, and time-management skills—leadership qualities that are essential to success in any field, including corporate or research careers. Students completing the ROTC program earn a commission as a Second Lieutenant in the US Army, Army Reserve, or Army National Guard. Non-scholarship students may participate in the first two years of Army ROTC with no commitment to military service.

The Military Science and Leadership Program is a four-year program composed of the Basic Course (first and sophomore years) and the Advanced Course (junior and senior years).

Four-Year Program
The four-year curriculum combines classroom and leadership laboratory work. Any MIT student is eligible to participate in the leadership development courses regardless of academic grade.

During the summer between their junior and senior years, students participate in a four-week Advanced Camp (AC) at Fort Knox, KY (near Louisville). Upon graduation from college and successful completion of Advanced Camp, students are commissioned as officers in the US Army, US Army Reserve, or Army National Guard.

Two-Year Program
The two-year program is designed for students who did not complete the first two years of the Army ROTC program. If students have at least four semesters remaining in their academic program at MIT or are interested in pursuing a graduate degree, they may be eligible to participate in the Advanced Course. Students who do not complete all requirements of the Basic Course (first and sophomore years) of instruction must participate in a four-week training camp Basic Camp (BC) at Fort Knox, KY unless they have successfully completed any service enlisted Basic Training Course or are a graduate of a certified Junior Reserve Officers Training Corps program. Once students complete Basic Camp, they are eligible to receive the same benefits as members in the four-year program.

Scholarships
Army ROTC scholarships are available on a competitive basis to qualified applicants. Two-, three-, and four-year scholarships are available each year, and are awarded on campus through the professor of military science or through a national selection board. High school seniors may apply for four-year scholarships in conjunction with their application to MIT. Scholarships pay full tuition and all mandatory fees, plus $1,200 for books and supplies each year, and a tax-free stipend ranging from $300 to $500 per month. The scholarship is flexible in that it can be used for either of the following: tuition and all mandatory fees, or room and board.
Program of Instruction
The Army ROTC curriculum is designed to enhance a student’s college education by providing distinctive leadership and management training in conjunction with realistic experience. The program emphasizes leadership theory and practice, organizational management, public speaking, tactics, purpose and history of the military, and physical fitness.

Students enrolled in the first two years of the program attend one hour of class and three hours of physical fitness each week. Collegiate athletes who meet Army fitness standards are excused from physical fitness training while their sport is in season. In the final two years of the program, class and physical fitness total four to five hours per week. Students also participate in a weekly Leadership Lab that highlights a particular military activity. Finally, students participate in a field training exercise each semester that includes small unit leadership training, military tactics, land navigation, rappelling, obstacle negotiation, and possibly a helicopter orientation ride.

Extracurricular Events
The ROTC program offers MIT students a wide spectrum of opportunities to participate in numerous challenging and rewarding extracurricular activities, such as high adventure training and field training exercises. Army Airborne, Air Assault, Mountain Warfare, and other military schooling and training programs are available on a voluntary basis to qualified cadets. Also, there are global summer internships available at national research laboratories, numerous Army bases, or the Pentagon. Finally, following graduation there are opportunities—primarily for students going on to law, medical, seminary, dental, or veterinary school—to defer the service obligation until completion of their graduate studies. Many graduate study opportunities are funded by the Army.

Opportunities in the US Army Reserve/Army National Guard
Army ROTC offers opportunities to seek a commission as a Second Lieutenant in the Army National Guard or Army Reserve. This unique option provides the flexibility for newly commissioned officers to participate in the Army part time while pursuing an advanced degree or a full-time career.

Eligibility Criteria
Enrollment in the first-year and sophomore ROTC courses is open to all MIT students. To be eligible for Army ROTC scholarships and/or enrollment in the junior- and senior year ROTC courses, students must be citizens of the United States or on the path to citizenship and will become a citizen before they graduate; physically and medically qualified in accordance with existing Army regulations; and enrolled at MIT, Harvard University, Tufts University, Wellesley College, Lesley University, Endicott College, Gordon College, Gordon-Conwell Theological Seminary, or Salem State University as full-time students.

Application Procedure
Students normally apply for the four-year program during their first year, but students may enroll in the course or apply for a campus-based scholarship each semester. Interested students can inquire about the Army ROTC program by visiting the Army ROTC office at W59-192 (201 Vassar St, Cambridge, MA 02139), by calling 617-253-4471, by emailing goarmy@mit.edu, or by visiting the website (http://army-rotc.mit.edu) or the program’s Facebook page (https://www.facebook.com/PaulRevereBattalion).

Naval ROTC
The Navy Reserve Officers Training Program (NROTC) (http://www.nrotc.navy.mil) is a multi-year program that runs concurrently with a student’s normal college or university educational course of study. The mission of the nationwide NROTC program is to develop midshipmen mentally, morally, and physically. The program aims to imbue them with the highest ideals of duty and loyalty, and with the core values of honor, courage, and commitment. The program commissions college graduates as naval officers who possess a basic professional background, are motivated toward careers in the naval service, and have a potential for future development in mind and character so as to assume the highest responsibilities of command, citizenship, and government.

In addition to a normal academic workload leading to a baccalaureate degree, NROTC students attend classes in Naval Science, participate in the NROTC unit for drill, physical training, and other activities. The purpose of the NROTC program is to provide instruction and training in naval science subjects which, when coupled with a bachelor’s degree, qualify students for commissions in the US Navy and US Marine Corps.

The NROTC unit at MIT (http://nrotc.mit.edu) offers two officer development programs for which students attending Tufts and Harvard are also eligible. The Scholarship Program provides full tuition, fees, uniforms, a semester book stipend, and a monthly stipend for two, three, or four years. The length of scholarship benefits is predicated upon the student’s degree plan. Students will receive scholarship benefits only for the time required to receive their Baccalaureate Degree or four years, whichever comes first. If additional benefits are necessary, students may request and, in some cases, be granted fifth-year benefits.

Students in the College Program for two or four years receive naval science books and uniforms. College Program midshipmen accepted for advanced standing receive a monthly stipend for up to 20 months during the last two academic years. Each year, College Program students compete for full-tuition scholarships for their remaining years in school.

Program of Instruction
The NROTC program of instruction includes one Naval Science course each semester which encompasses the science of nautical
matters and principles of leadership, ethics, and management. Leadership principles and high ideals of a military officer are taught and practiced during weekly drill instruction periods. Concurrently, midshipmen complete all requirements for a bachelor’s degree under their respective university’s rules and regulations. Navy Option Scholarship Program midshipmen must complete one year of calculus, one year of calculus-based physics, and one year of English grammar and composition. Both Navy and Marine Option midshipmen complete one semester of American history or national security policy and one semester of cultural or regional studies. NROTC academic instruction is complemented by tours conducted to local naval facilities, cruises aboard active duty naval vessels, and practical navigation and piloting practice conducted aboard training craft.

Between academic years, Scholarship Program midshipmen attend approximately one month of summer training aboard active duty naval vessels and at shore bases throughout the world to become familiar with Navy and Marine Corps procedures. College Program midshipmen must complete one summer cruise after their junior year.

Graduating Midshipmen
Upon graduation, midshipmen who complete all academic requirements in the NROTC program are offered commissions as Ensigns in the Navy or Second Lieutenants in the Marine Corps. Unrestricted Navy line officers serve in the aviation, submarine, surface warfare, or special operations communities, among others. Additionally, qualified officers may be invited to become Naval Reactors Engineers in Washington, DC. Navy Option Scholarship Program midshipmen are required to serve a minimum of five years of active military service and College Program midshipmen serve a minimum of three years. There may be additional requirements for specific assignments. Marine Corps Option midshipmen serve at least four years on active duty.

Eligibility Requirements
To be eligible for the four-year NROTC program at MIT, Harvard University, or Tufts University, a prospective midshipman must be accepted at one of these institutions. Additionally he or she must be a United States citizen, not less than 17 years old by September 1 of the year starting college, and no more than 23 on December 31 of that year. Applicants must also be found physically qualified by the Department of Defense Medical Review Board.

Application Procedure
Further detailed information is available at MIT’s NROTC website (http://nrotc.mit.edu) and at the Naval Reserve Officers Training Program website (http://www.nrotc.navy.mil). Visitors are also invited to learn more at the NROTC unit at MIT, Room W59-110, or at any US Navy Recruiting Station.

ADMISSIONS

First-Year Admissions
The information provided here contains a broad overview of Admissions policies and procedures. For specific information, please visit the Undergraduate Admissions website (http://mitadmissions.org).

Secondary School Preparation
Although MIT does not have any required high school classes, applicants are expected to have enrolled in a broad, rigorous program in high school. A strong academic foundation in high school will help students make the most of the Institute when they are here. Advice and suggestions on how to prepare for MIT (http://mitadmissions.org/apply/prepare/highschool) are available on the Admissions website.

Campus Tours and Information Sessions
Prospective applicants and their families are welcome to visit the Admissions Reception Center in Room 10-100, Monday through Friday between 9 am and 5 pm. Undergraduate admissions information sessions are offered most weekdays in the morning and in the afternoon with student-guided tours of the campus immediately following. Visit the Admissions website (http://mitadmissions.org/visit) for detailed information.

Application Procedures
MIT has its own online application. Students may register for a MyMIT (http://mitadmissions.org/apply/freshman/mymit) account at any time to be added to the mailing list and when they’re ready to apply, use their MyMIT account to access the application. The application will be available online in August of the year prior to proposed entry. Early Action has a November 1 deadline. Regular Action candidates must complete the application process by January 1 of the year of intended entrance. Early Action decisions will be announced in mid-December. At that time, the committee may offer admission, deny admission, or defer the decision to Regular Action. Deferred applications are reconsidered without prejudice in March. The application fee is $75. MIT accepts fee waiver requests.

Additionally, MIT participates in the QuestBridge National College Match program, which aims to increase the percentage of talented low-income students attending the nation’s best universities and the ranks of national leadership itself. Interested applicants should consult the QuestBridge website (http://www.questbridge.org).

Applicant Interviews
MIT recommends that applicants interview with a member of the MIT Educational Council if available. Council members are MIT graduates who have volunteered to interview on behalf of the Office of Admissions. Applicants will be referred via their MyMIT account to a member of the council near the applicant’s home. Students
contact their Education Counselor by October 20 for Early Action and
December 10 for Regular Action.

**Standardized Testing Requirements**

Standardized tests are required for all applicants. Specific SAT, ACT, and
TOEFL testing requirements are outlined in detail on the Tests & Scores (http://mitadmissions.org/apply/freshman/tests) page of
the Admissions website.

**Transfer Admissions**

Although spaces are very limited, transfer students are welcome on
campus for their fresh perspective, maturity, and focus. Students
who have completed a minimum of one year with high academic
standing at an accredited college, university, technical institute,
or community college may be considered for transfer admission.
Students with more than two and one-half years of study are not
eligible.

**Transfer Application Procedures**

The MIT transfer application (http://mitadmissions.org/apply/transfer/application) is available online. Students applying
for spring admission must complete all testing requirements
by November 30 and the transfer application by November 15.
Students applying for fall admission must complete all testing
requirements by December 31 and the transfer application by March
15. International students are eligible for fall admission only. The
application fee is $75. Applicants may request a fee waiver.

**Credit Transfer**

Students admitted by transfer may receive credit for subjects of
study completed elsewhere which are substantially equivalent to
corresponding Institute subjects. Academic credit is not assessed
until after a student is admitted. You may compare the courses
offered at your institution to those offered at MIT this year (http://
catalog.mit.edu/subjects).

**Undergraduate Special Student Admissions**

An undergraduate special student is one whose intended program
of study is at the undergraduate level but who is not a degree
candidate. Undergraduates enrolled at other universities who wish
to take classes not offered at their home university may apply as
non-degree undergraduate special students. Undergraduate special
student status is available to individuals who have successfully
completed at least one year of full-time study, or the equivalent,
at the university level. Secondary school students are not eligible.
Undergraduate special student status is granted for one term
only, and a new application is required for a successive term.
Enrollment as a special student is limited to two full academic terms.
Admission as a special student does not carry any implication for
other applications.

The Special Student application and more information about
the admission process may be found on the Undergraduate
Special Student (http://specialstudent.mit.edu) website.

**COSTS**

**Tuition and Fees**

The basic tuition and fees at MIT for the academic year 2018–2019
(which are reviewed and likely to increase each year) are as follows:

<table>
<thead>
<tr>
<th>Fee</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuition</td>
<td>$51,520</td>
</tr>
<tr>
<td>Student Activity Fee</td>
<td>$312</td>
</tr>
<tr>
<td>MIT Student Extended Insurance Plan</td>
<td>$2,568</td>
</tr>
</tbody>
</table>

Enrollment in the MIT Student Extended Insurance Plan is
automatic. Students may submit an online waiver request (http://
medweb.mit.edu/healthplans/student/waiver.html) if they have
comparable insurance coverage.

Payment of the tuition fee entitles all regular and special students to
many health care services at MIT Medical (http://medweb.mit.edu)
(Building E23) at no charge. The MIT Student Extended Insurance
Plan covers hospitalization due to accidents or illness and meets the
state’s requirement for comprehensive health insurance. Insurance
is required for all students unless they can demonstrate that they
have comparable coverage through another insurance program.

Refer to the Medical Requirements (p. 57) section for additional
details or read more about the student health plans (https://
medical.mit.edu/mit-health-plans/student-health-plans).

The tuition for all regular undergraduates in the fall and spring terms
is $25,760 per term. Full tuition in either term of the current year
covers the January Independent Activities Period. Tuition rates for
the summer session are published each year in the Summer Session
Catalog (http://web.mit.edu/catalog/summer), available in April.

Regular undergraduate students who have permission to take
only a few subjects are initially charged full tuition. They may then
apply to have their tuition charged at the rate of $800 per unit
with the approval of the faculty advisor. In such cases, there is a
minimum fee of $4,800 for subjects and a minimum of $1,600 for
the SB thesis. Registration for 32 or more units will be assessed
the full tuition charge. Upon recommendation of a department, the
Office of Undergraduate Education may set a special tuition rate
in unusual circumstances. Financial aid will be adjusted based on
enrollment costs. Some classes (including ROTC and classes taken
on listener status) are not included in the determination of financial
aid eligibility.

Special students are charged at the rate of $800 per unit taken
either for credit or not for credit. This unit fee applies up to a
maximum of $25,760 per term and is subject to the following minimum fees:

<table>
<thead>
<tr>
<th>Fee</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members of the MIT community (includes special students who are full-time employees of the Institute or who are dependents of full-time employees or regular students)</td>
<td>$4,800</td>
</tr>
<tr>
<td>Other special students</td>
<td>$7,200</td>
</tr>
</tbody>
</table>

Internship and cooperative programs offered by MIT provide industrial and research experience through a series of work assignments interwoven with regular study at the Institute. The tuition fee for these programs is the same as that for other regular undergraduate students.

Light-load tuition adjustments are not normally available to students who are (or were) in cooperative and internship programs.

Withdrawal
A student withdrawing before the start of a term is not charged any tuition for that term, and any tuition payments previously made for that term will be refunded. Students withdrawing during the fall or spring term are charged one-twelfth of the stated tuition for the term for each week from the starting date of the term, with a minimum two-week charge. A student is financially obligated to the Institute for the tuition appropriate to the program approved by his or her faculty advisor at the beginning of the term. Any subsequent reduction in fees is based on the date that cancellation of subject or withdrawal from the Institute is effected. At that time, any excess payments which the student has made will be refunded.

If the student receives financial aid through one of the federal student financial aid programs, and aid is reduced as a consequence of the reduced tuition, the reduction in aid will be made in accordance with current federal regulations. Visit the Student Financial Services website ([http://web.mit.edu/sfs](http://web.mit.edu/sfs)) for more information.

Miscellaneous Fees
Miscellaneous fees include the following:

<table>
<thead>
<tr>
<th>Fee</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application fee for undergraduate admission</td>
<td>$75</td>
</tr>
<tr>
<td>Fee for late submission of preregistration ($85 if very late)</td>
<td>$50</td>
</tr>
<tr>
<td>Fee for late filing of the degree application ($85 if very late)</td>
<td>$50</td>
</tr>
<tr>
<td>Fee for late initiation of the registration process or very late registration</td>
<td>$100</td>
</tr>
</tbody>
</table>

See Academic Calendar (p. 8) for dates.

The miscellaneous fees and processing charges listed above are nonrefundable unless levied in error.

**Processing Charges for Late Changes in Registration**
A late change in registration, which requires a petition ([http://web.mit.edu/acadinfo/cop/petitions](http://web.mit.edu/acadinfo/cop/petitions)) to the Committee on Academic Performance, is defined as adding a subject after the fifth week or dropping a subject during the last three weeks of a term. The processing charge for late changes is $25. There is an additional charge of $25 for a change judged by the Committee to result from the student’s neglect.

**Undergraduate Living Costs**
Living expenses for undergraduate students vary depending on factors such as availability of resources, interests, and tastes. More than 70% of undergraduate students live on campus and first-year students are required to live on campus for the duration of their first year. Dining options and meal plans ([http://studentlife.mit.edu/dining/residential-dining/meal-plans/new-2018-19-meal-plans](http://studentlife.mit.edu/dining/residential-dining/meal-plans/new-2018-19-meal-plans)) are available to all students, including those who live in on-campus housing; however, students living in Baker House, Maseeh Hall, McCormick Hall, Next House, and Simmons Hall are required to enroll in a meal plan. On average, undergraduates can expect to pay $15,510 for housing and dining. This does not include additional expenses for books, supplies, personal items, and travel.

**Payment of Tuition and Other Institute Charges**
An individual who registers as a student at MIT agrees to pay all charges on his or her account when due, and acknowledges that the Institute may charge a hold fee, suspend registration, revoke Institute services, and withhold the degree if these charges are not paid.

Student Financial Services (SFS) ([http://sfs.mit.edu](http://sfs.mit.edu)) gathers, bills, and collects student charges and provides a student account statement of that activity. These charges originate in the offices from which the student receives Institute services. SFS bills by posting a monthly student account electronic billing statement on MITPAY—a secure, paperless online billing and payment system. The statement is posted by the 10th of the month in which there is a new charge on the account. SFS sends students a courtesy monthly email reminder to check the statement and pay any balance due. The statement includes charges (e.g., tuition, fees, housing, and library fees), payments (financial aid, tuition awards), additional amounts due, and payment deadlines.

Payment in full or a satisfactory arrangement for payment is due on or before August 1 for the fall term and on or before January 1 for spring term. New charges that occur after the initial statement will appear on a subsequent statement. If a student anticipates that he or she may not be able to pay the entire amount due by the term bill due date, the MIT Payment Plan is available and should be considered.
The MIT Monthly Payment Plan (http://sfs.mit.edu/billing-repayment/your-billing-statement/how-to-pay-your-bill) is an installment arrangement that allows students to pay the balance due in monthly installments interest-free. The terms and conditions of the monthly payment plan are available on the SFS website.

SFS also offers information on federal student loan programs as additional options for eligible US citizens and permanent residents.

A student who fails to make satisfactory arrangements for payment will have a registration or degree hold imposed and a Hold Fee of $100 will be charged to the student account. The balance due, including the Hold Fee, must be paid in full before a hold will be released.

Students who have unanticipated financial situations during a term should resolve them using the resources of SFS and Student Support and Wellbeing, as well as outside sources such as parents and relatives. The policy is designed to allow students sufficient time to resolve their financial difficulties. Students owing fall term balances have from July to November to clear their account before a hold is imposed; students owing spring term balances have from December through April. This should be sufficient time for students to deal with their financial issues.

Notifications to Undergraduates with Unpaid Balances
The fifth week of the term, SFS will identify undergraduates who have an unpaid balance on their student account for that term and who have not made satisfactory arrangements for payment of the balance. SFS will notify these students—both through the regular billing process and by email—informing them of the MIT policy regarding financial holds and registration holds for subsequent terms.

After the 11th week of the term, SFS will identify undergraduate students who have unpaid balances on their student accounts for that term and who have not made satisfactory arrangements for payment of those balances. SFS will notify these students—both through the regular monthly billing process and by email—informing them of the Institute’s policy regarding financial holds.

Policy on Undergraduate Financial Holds
Undergraduate students are subject to the Financial Hold policy adopted by the Committee on the Undergraduate Program (CUP) and the Committee on Academic Performance (CAP) in 1998. Students who have not paid their outstanding student account balance, made satisfactory arrangements with SFS to pay the balance, or completed a financial aid application by the end of the term will lose access to student services for subsequent terms. Removal of services includes the right to register for the term, Athena access, MIT housing, dining, the MIT Card, and library access. Students who have not made efforts to resolve their financial situation will not be allowed to register, will not receive credit retroactively and will be assessed a $100 Hold Fee. The student account must be paid in full in order for a degree to be conferred.

Removal of Services and Other Actions
Undergraduate students who have not paid or negotiated satisfactory arrangements for payment of unpaid balances from the previous term may not register for subsequent terms and may be restricted from Institute student services. When students have not made satisfactory payment arrangements by Registration Day of the subsequent term, SFS and other Institute offices may take the following actions:

- The right to live in MIT housing is suspended.
- The MIT Card is deactivated, and undergraduates are not authorized to use the services for which the card provides access. These services include but are not limited to the libraries, the dining system, computing resources, and Institute housing.
- Students are permitted to retain an mit.edu email address which will be forwarded to a specified outside email provider until the normal graduation date. All other computer services, including Athena access and use of MIT licensed software, will be suspended.
- Undergraduates will be excluded from the student payroll and UROP systems.
- Undergraduates will not be placed on class rosters. They will not be allowed to participate in class projects. Work that is turned in for the class will not be graded or returned.
- Undergraduates will not have their financial aid applications reviewed for the upcoming academic year until their past due balance is cleared.

Student accounts unpaid after the student has left MIT for any reason may be reported to credit bureau agencies and/or sent to an outside collection agency and assessed additional fees on the outstanding balance. Please visit the website (http://sfs.mit.edu/billing-repayment/your-billing-statement/what-happens-when-graduate-leave) for more information and to review the Student Financial Responsibility Statement. (http://sfs.mit.edu/sites/default/files/Student_Financial_Responsibility.pdf)

FINANCIAL AID
MIT meets the full financial need of every undergraduate for all four years of his or her undergraduate career. Student Financial Services (SFS) (http://sfs.mit.edu) awards financial aid based on the financial need of the individual student, as determined by analysis of information provided by the family on the Free Application for Federal Student Aid (FAFSA) and the CSS PROFILE applications. Copies of parental federal tax return(s) are required in support of aid applications.
SFS reviews applications and makes need-based awards to students from Institute sources. MIT is fortunate in having received gifts from many benefactors, alumni, and friends to help support the educational needs of MIT students.

Students choose term-time work and/or loan eligibility to meet their self-help requirement, which is an amount that students are expected to contribute themselves. Student loan funds allow the student to pay part of the costs of his or her education on long-term credit under favorable financial terms.

Specific jobs are not assigned; students are expected to arrange work most suitable to their own talents and schedules. The SFS website maintains listings of positions for students seeking part-time jobs during the term or full-time summer jobs. On-campus work is usually available in residence halls, offices, libraries, and laboratories. Listings for off-campus positions are also available.

SFS participates in the Federal Community Service Program (part of the Federal Work-Study Program). Eligible students work in jobs that have a direct impact on the Cambridge and Boston communities or their hometowns over the summer. Wages are subsidized up to the student’s work-study eligibility.

All students who are thinking of attending MIT are strongly urged to explore all areas of financial assistance, including government and private financial aid programs. A number of states sponsor scholarship programs for residents, and information on eligibility may usually be obtained from secondary school guidance counselors. ROTC programs at MIT may also provide substantial scholarship support.

For more information on financing an MIT education, see the SFS website (http://sfs.mit.edu).

**Applications**

Details on applying for financial aid (http://sfs.mit.edu/undergraduate-financial-aid/aid-info) are available on the website.

**Entering First-Year and Transfer Students**

Students who wish to be considered for financial aid should complete the Free Application for Federal Student Aid (FAFSA) and the CSS PROFILE form. MIT also requires the parents’ tax returns, W-2 forms, and all schedules. An application for admission is not prejudiced by an application for aid; the two decisions are entirely separate. Need criteria have no bearing on admissions, and admissions criteria have no part in determining qualifications for aid.

**International Students**

As with other undergraduates, MIT meets the full need of international undergraduate students who demonstrate financial need. International students who wish to be considered for financial aid should complete the International Student CSS PROFILE online and provide verification of parent income.

Students should also seek aid from sources other than MIT. International students should make all arrangements for their financial obligations to MIT for their entire stay in the United States before leaving their home country.

For complete instructions on applying for financial aid, including the documents required, visit the Prospective First-Year and Transfer Students page (http://sfs.mit.edu/undergraduate-financial-aid/aid-info) on the SFS website.

**Upper-Level Students**

Enrolled students receiving financial aid are required to reapply each year for continued assistance in the following year. Award applications must be submitted no later than April 15 of the year preceding the term in which aid is anticipated. Upper-level students must complete the Free Application for Federal Student Aid (FAFSA) and the CSS PROFILE. The application process also requires a copy of parental federal tax return(s), and all applicants are expected to apply for a state grant where applicable, as well as any renewable grants received in prior years.

A student’s eligibility for MIT undergraduate grant funds will end when the student receives an initial degree, or after the equivalent of eight attempted or completed terms, whichever occurs first. Students may appeal for eligibility for additional terms by contacting SFS. Eligibility for federal financial aid is not not limited to eight terms, but ends once a student’s degree requirements have been met. Student Financial Services will replace federal aid with equivalent MIT funds if federal eligibility ends before a student has completed eight terms.

Eligibility for undergraduate loans continues through all undergraduate programs. A student becomes eligible for the higher loan maximums that pertain to graduate students upon enrollment in a graduate program. Additional information is available at the About Loans page (http://sfs.mit.edu/undergraduate-financial-aid/types-of-aid/loans) on the SFS website.

**Veterans’ Benefits**

Students who are receiving veterans’ benefits need to verify their enrollment each term in order to be certified. For more information, visit Veterans’ Benefits at MIT (http://sfs.mit.edu/undergraduate-financial-aid/types-of-aid/veterans-benefits).

**MEDICAL REQUIREMENTS**

**Medical Report Requirements**

MIT requires that all incoming students submit a medical history, have a complete physical examination, and document immunity against certain infectious diseases. Medical Report forms (https://
medical.mit.edu/sites/default/files/medreport.pdf) need to be submitted before registering for classes. Specific deadlines for each term are listed on the form itself.

Registration will not be permitted for any student who has not complied with the Medical Report and/or immunization requirements stated above.

MIT Medical

To meet the health care needs of MIT community members, MIT Medical offers a single, centralized source of comprehensive health insurance, care, and treatment at our own medical centers, and an extensive roster of health promotion programs. Members of the MIT community and their families have convenient, on-campus access to a broad range of clinical services and medical and dental specialties, delivered by highly qualified health care professionals. Through our affiliations with Boston’s leading hospitals, our clinicians are able to refer patients with more serious conditions to the most appropriate specialists. MIT Medical is located in Building E23.

Visits to MIT Medical are by appointment, except for urgent care. Urgent medical care is available at MIT Medical seven days a week. (See the MIT Medical website (https://medical.mit.edu/services/urgent-care) for hours of operation.) MIT Medical’s Mental Health and Counseling Service offers assistance to students dealing with personal concerns, including anxiety, depression, relationship problems, and stress. They provide evaluations and consultations, brief treatment, referrals, and group counseling. All services at the Mental Health and Counseling Service are available free of charge to MIT students. The Mental Health and Counseling Service also has walk-in hours for urgent matters from 2 to 4 pm daily, Monday through Friday. MIT community members should call 617-253-4481 day or night for medical advice.

Visit the MIT Medical website (https://medical.mit.edu/services) for more information about our services, including appointment hours, phone numbers, and clinician profiles.

Health Insurance Requirements

All MIT students must have health insurance that meets the requirements for the Massachusetts Student Health Insurance Plan (SHIP). Students with J-1 visas under MIT sponsorship must have insurance that also meets US Department of State regulations for themselves and their spouses and children who accompany them. Visit the MIT Medical website (https://medical.mit.edu/mit-health-plans/student-health-plans) for more information about Massachusetts health insurance requirements.

MIT Student Health Plan

The MIT Student Health Plan (https://medical.mit.edu/mit-health-plans/student-health-plans) consists of two complementary parts, the MIT Student Medical Plan and the MIT Student Extended Insurance Plan.

The MIT Student Medical Plan covers a wide range of services provided at MIT Medical, including primary care, many medical specialties, urgent care 7 days a week, mental health care, and other services. Registered MIT students paying tuition to MIT are automatically enrolled in the MIT Student Medical Plan as part of their tuition. Student partners and children of students can pay a Partner/Child MIT Student Medical Plan premium for comprehensive access. To enroll their families, students must complete the MIT Student Health Plan enrollment form during the enrollment period. Partners and children of students who purchase the MIT Student Medical Plan premium must also provide evidence that they are enrolled in a health insurance plan or may purchase the MIT Student Extended Insurance Plan.

The MIT Student Extended Insurance Plan is designed to coordinate with the MIT Student Medical Plan and provides coverage for more extensive care, such as hospitalization, diagnostic tests, physical therapy, surgery, prescription medication, and obstetrical care. Since health insurance is mandatory under Massachusetts law, all regular students and special students registered with 75% of the full-time academic requirement or full-time, including students on a J-1 or F-1 visa, are automatically enrolled in the MIT Student Extended Insurance Plan. Prior to the beginning of each academic year, students have the option to submit an online request to waive the MIT Student Extended Insurance Plan for either the full year if they already have coverage which meets the Massachusetts requirements for student health insurance. If students choose to keep the MIT Student Extended Insurance Plan for the fall term, they will still have the option to waive the MIT Student Extended Insurance Plan for the spring academic term. All waivers must be submitted before the designated deadline to avoid a late fee. J-1 students under MIT visa sponsorship may waive the MIT Student Extended Insurance Plan only if their policies meet both the Massachusetts requirements and specified United States Information Agency (USIA) requirements. Massachusetts state law requires coverage through an insurance carrier based in the United States. New waiver forms must be filled out each academic year.

Special students taking two or more subjects but registered at MIT less than 75% of the full-time academic requirement are eligible to purchase the MIT Student Extended Insurance Plan but are not enrolled automatically.

If students have enrolled their partners and/or children and wish to continue their enrollment in the MIT Student Medical or Extended Insurance Plan, no further action needs to be taken as they will be automatically re-enrolled as long as the student remains covered by the MIT Student Extended Insurance Plan. If students wish to end coverage for their family, they must notify stuplan@med.mit.edu the Health Plan office, in writing, by the enrollment deadlines.
The deadline for submitting enrollment forms and waiver forms is August 31 for the fall term, January 31 for the spring term, and June 15 for the summer term.

Visit the MIT Medical website (https://medical.mit.edu/mit-health-plans/student-health-plans) for more information about the MIT Student Health Plans, including benefits, rates, and enrollment or waiver processes.

Please contact MIT Health Plans (stuplan@med.mit.edu) with enrollment or waiver questions, or contact Claims and Member Service (mservices@med.mit.edu) with any questions about benefits or claims.
MIT graduate programs provide collaborative environments for advanced study by students and faculty working together to extend the boundaries of knowledge. Traditionally a leader in engineering and science graduate education, MIT has also attained national prominence for its doctoral programs in mathematics and the physical and life sciences. Top-ranked graduate programs in economics; political science; linguistics; science, technology, and society; architecture; media studies; urban studies; and management have broadened the spectrum of graduate education at the Institute.

GRADUATE STUDY AT MIT

For more than a century, MIT graduate programs have provided ideal environments for advanced study by faculty and students working together to extend the boundaries of knowledge. Traditionally a leader in engineering and science graduate education, MIT has also attained national prominence for its doctoral programs in mathematics and the physical and life sciences. Top-ranked graduate programs in economics; political science; linguistics; science, technology, and society; architecture; media studies; urban studies; and management broaden the spectrum of graduate education.

The most important factor in the effectiveness of graduate programs at MIT is the quality of the faculty. MIT is proud of its nationally and internationally recognized faculty of scholars and academic leaders, who are also effective teachers and research collaborators.

The broad scope and high quality of its graduate education have made MIT an international leader. More than a third of its graduate students come from foreign nations. Significant efforts have been made, with some success, to increase the numbers of minority and women students attending MIT's graduate programs. This representation of students from diverse backgrounds contributes greatly to the richness of the MIT community and to the excellence of its graduate academic programs.

Graduate education at MIT places special emphasis on the relevance of science and technology to the complex problems of society. Such problems frequently require an interdisciplinary approach involving expertise in several different departments.

Extensive resources for graduate study have developed naturally at MIT from a long tradition of emphasis on contributions to new knowledge. The wealth and diversity of teaching and research resources are described in the school and departmental sections.

Although most graduate students find their interests served by programs available within a single department, many elect to work in interdisciplinary fields (described in the sections on Interdisciplinary Graduate Programs (p. 367) and Research and Study (p. 88)), which may reach into two or more departments and involve work in any of MIT’s laboratories and centers.

An additional resource for graduate study is cross-registration in programs with Harvard University and Wellesley College, and joint degree programs with the Woods Hole Oceanographic Institution. Limited study opportunities are also available at Boston University, Brandeis University, Tufts University, and at local institutions through the Consortium for Graduate Studies in Gender, Culture, Women, and Sexuality.

Graduate students are encouraged to use MIT’s extensive athletic facilities. Teams comprised of both undergraduate and graduate students participate in intercollegiate competitions and the intramural athletic program.

Graduate students also share in the cultural and social activities and recreational facilities at MIT. Concerts and dramatic performances are frequently given by Institute groups and professional performers. Leaders in many fields give on-campus lectures and seminars, which are open to all members of the institute community. MIT students also take advantage of the numerous cultural and intellectual opportunities in the Boston area, including free admission to the Boston Museum of Fine Arts and the Museum of Science. A more detailed description of campus activities can be found in the section on Campus Life (p. 17).

Independent Activities Period

Independent Activities Period (IAP) (http://web.mit.edu/iap) is a four-week period in January during which faculty and students are freed from the rigors of regularly scheduled classes for flexible teaching and learning and for independent study and research. IAP is part of the academic program of the Institute—the "4" month in MIT’s "4-1-4" academic calendar. Students are encouraged to explore the educational resources of the Institute by taking specially designed subjects, arranging individual projects with faculty members, or organizing and participating in IAP activities. They may also pursue interests independently either on or off campus.

Departmental programs may require students to complete a subject (of no more than 12 units) during one IAP.

Activities

More than 600 activities are offered each year on a wide range of topics, both academic and nonacademic. In addition, “special subjects” exist in most departments, for which students can arrange credit for individual work.

Many IAP activities, both credit and noncredit, are organized each fall. Noncredit activities are advertised, beginning in early November, on the IAP website (http://web.mit.edu/iap). Information on credit activities is available, beginning in early December, on
the Subject Listing and Schedule website (http://student.mit.edu/catalog).

Organizing Activities
Nonacademic activities may be organized or attended by members of the MIT Community: faculty, students, and employees. Tips on organizing an IAP activity are available on the IAP website (http://web.mit.edu/iap). Organizers may approach MIT departments and organizations to help defray expenses.

Students find organizing IAP activities a rewarding challenge. For many, it is their first opportunity to develop and teach a program from their own ideas. In doing so, they acquire organizational and leadership skills that prove invaluable to their careers.

Tuition, Room, and Board
Regular students paying full tuition in either the fall or spring term do not have to pay additional tuition or room fees to the Institute during IAP. Students who have not been charged full tuition in either the fall or spring term are subject to additional tuition charges and should consult the Registrar’s Office, Room 5-117, 617-258-6409. MIT Dining provides food service options through retail, house dining, and catering services throughout the entire academic year, including IAP. Please visit the dining website (http://dining.mit.edu) in early December to learn more about dining options during IAP.

Academic Credit and Grades
Students should follow directions published on MIT’s IAP website (http://web.mit.edu/iap) regarding registration for subjects. In addition to regular subjects, students may make arrangements to earn credit for independent work under faculty supervision. No student may earn more than 12 units of credit during IAP. Credits received by first-year undergraduate students during IAP are not counted toward their credit limits for fall or spring term.

All credit-bearing subjects are graded according to the grading rules approved for that subject number. A subject can be graded P/D/F only if it has been approved with P/D/F grading. Similarly, the number of units awarded must be as specified for that subject. However, faculty sometimes teach new classes under special subject numbers for which credit units are arranged.

For students to receive credit for work done in IAP, instructors must submit grades to the Registrar’s Office by the deadline given in the academic calendar. If a grade is received after the Add Date of the succeeding term and the student did not register in the subject during IAP, the student must petition to receive credit. IAP credit will not be given if the grade is received after the end of the succeeding spring term.

Students may view their IAP grades on WebSIS (http://student.mit.edu) shortly after the start of the spring term. Students who do not receive grades when expected should check promptly with their instructors or the Registrar’s Office to ensure the grades are submitted and recorded.

Special Students
Applications for special student status solely for IAP will not be accepted. Special students admitted to the fall or spring term must consult the Admissions Office concerning their status during IAP; they do not automatically have IAP privileges. If the special student has paid full tuition during the fall term or is admitted to do so in the spring, there will not be an additional tuition charge for IAP. If the student has not been paying full tuition, a charge for the IAP units will be added to either the fall or spring term up to a maximum of full tuition for the term.

Office of Graduate Education
The Institute has a single faculty that is responsible for both undergraduate and graduate instruction. The administration of graduate education rests with the president, provost, chancellor, vice chancellor, senior associate dean for graduate education, and the Committee on Graduate Programs (a standing committee of the Faculty).

Each department exercises a large measure of autonomy for its graduate programs, under general guidelines established for the Institute as a whole. Each department has a departmental committee on graduate students, including one or more graduate registration officers, to administer department and Institute graduate procedures.

More detailed information about the organization, rules, regulations, and procedures of graduate education is given in the publication, Graduate Policies and Procedures (http://odge.mit.edu/gpp).

Career Advising and Professional Development
Career Advising and Professional Development helps students make informed decisions about career goals and find opportunities related to their professional objectives. Graduate students are encouraged to visit the office, located in E17-294, during their first year to learn what career resources are available. The office can also be reached by phone at 617-715-5329 or by email (gecd@mit.edu).

See also the Career Advising and Professional Development description (p. 49) under Undergraduate Education.

GENERAL DEGREE REQUIREMENTS
Graduate students may pursue work leading to any of the following types of degrees: Doctor of Philosophy (PhD), Doctor of Science (ScD), Engineer’s degrees, Master of Science (SM), Master of Architecture (MArch), Master of Applied Science (MASc), Master
of Business Administration (MBA), Master of Business Analytics (MBAn), Master in City Planning (MCP), Master of Engineering (MEng), and Master of Finance (MFin). Graduate programs are described in individual department statements, and in the Interdisciplinary Graduate Programs section (p. 367).

Each graduate student is officially enrolled in a degree program. The programs are not limited, however, to subjects offered in a single department. Subjects and research programs may be chosen from several departments, given the approval of the departmental faculty advisor to ensure that the overall program is integrated and well balanced with respect to a major field of study.

A student who expects to come to MIT for an advanced degree after earning an undergraduate degree elsewhere should give careful attention to undergraduate prerequisites as outlined by each department or program elsewhere in this catalog. For more specific information, a student should consult the department or program in which he or she wishes to enroll.

MIT degrees are "residence" degrees in the sense that a major portion of the work must be done on campus in association with the faculty, other graduate students, and the Institute community. The amount of time required to attain any one degree varies.

**Master's Degree**

**Master of Science With and Without Specification**

For the degree of Master of Science, the student must have satisfactorily completed a program of study of at least 66 units of graduate subject credit and a thesis approved by the department in which he or she is enrolled. If 34 units and the thesis are in a single approved program, as determined by a departmental committee on graduate students, the degree will be recommended without specification. The same high standard of academic performance in a program approved by a departmental committee on graduate students is required for either degree.

The choice of area of specialization must be approved by the committee on graduate students of the department in which the student is enrolled. Approval of the entire program must be obtained from this committee and from the student's faculty advisor. A special interdepartmental committee, approved by the Office of Graduate Education, may be appointed to supervise a program in an interdepartmental field.

The satisfactory completion of the master's degree requires the student to be in residence as a full-time regular graduate student for a minimum of one regular academic term (not the summer session). Every degree candidate working on a thesis must register for thesis in all terms during which his or her thesis research or writing is actually in progress and during the term his or her name appears on the degree list.

**Master of Architecture**

For the degree of Master of Architecture, the student must have satisfactorily completed a program of study of at least 312 units of graduate subject credit and a thesis, both acceptable to the Department of Architecture. The program requires three and one-half academic years of residence. Advanced entry may be considered for students with a pre-professional bachelor's degree in architecture. The degree requirements for students pursuing advanced entry will depend on the student academic experience and waived requirements, but will be no less than two and one-half years of residence, as well as satisfactory completion of 164 units of graduate subject credit and a thesis, both acceptable to the Department of Architecture.

**Master of Applied Science**

To be awarded the Master of Applied Science (MASc) degree with specification of the field in which the student has specialized, the student must satisfactorily complete at least 90 units of credit (including at least 66 units of graduate subject credit) from within a program of study that includes a slate of required and elective subjects, and a capstone experience, both acceptable to the department in which the student is enrolled. The candidate must also have been in residence for a minimum of one regular term.

**Master of Business Administration**

To be awarded the degree of Master of Business Administration through the two-year MBA program, the student must satisfactorily complete a program of study of at least 189 units that includes a set of required core subjects, at least 144 units of elective graduate subject credit, and four regular academic terms in residence, as acceptable to the Sloan School of Management.

To be awarded the degree of Master of Business Administration through the one-year Sloan Fellows Program in Innovation and Global Leadership, the student must satisfactorily complete a program of study of at least 171 units that includes a set of required core subjects, and at least 48 units of graduate subject credit acceptable to the Sloan School of Management.

To be awarded the degree of Master of Business Administration through the two-year Executive MBA (EMBA) Program, the student must satisfactorily complete a program of study of at least 174 units that includes a set of required core subjects, plus three graduate-level restricted electives taken at designated times throughout the program.

**Master of Business Analytics**

To be awarded the degree of Master of Business Analytics, the student must satisfactorily complete a minimum of 66 units of graduate subject credit from within a program of study that includes a slate of required and elective subjects, a project class, a seminar, and a summer capstone experience. The candidate must
also have been in residence as a graduate student for at least two academic terms. A summer term is also required.

**Master in City Planning**
To be awarded the degree of Master in City Planning, the student must satisfactorily complete a minimum of 126 units of graduate subject credit. The student must also complete a thesis acceptable to the Department of Urban Studies and Planning, and have been in residence for a minimum of two regular academic terms.

**Master of Engineering**
To be awarded the Master of Engineering degree with specification of the field in which the student has specialized, the student must satisfactorily complete at least 66 units of subject credit (including at least 42 units of graduate subject credit) and a thesis which collectively constitute a structured program of at least 90 units acceptable to the department of the School of Engineering in which the student is enrolled. The candidate must also have been in residence for a minimum of one regular term.

**Master of Finance**
To be awarded the Master of Finance (MFin) degree, the student must satisfactorily complete a minimum of 66 units of graduate subject credit from within a program of study that includes a slate of required subjects, restricted and general electives, and a pro-seminar. The candidate must also have been in residence as a graduate student for at least two consecutive academic terms (fall and spring). In most cases, a summer term is also required.

**Simultaneous Registration for Two Master’s Degrees**

**Single thesis.** This degree plan is intended for qualified graduate students who seek academic recognition in two professional fields that, although distinct, have a substantial intellectual connection. The degree plan requires a balanced choice of academic subjects, made with the advice of each of two departments, and by selection of the thesis topic.

To satisfy the minimum requirements for the program, the student must complete (in addition to thesis units) at least 132 units of subject credit, of which 66 units are unique to each department. In those instances where a department or program has established unit requirements in excess of the foregoing minimums, the department or program requirements prevail. Such excess of units in one department may not be applied to the program in the other department.

A student pursuing a Master in City Planning in addition to a second master’s degree must have both programs approved in the usual way, but the subject units for the Master in City Planning can be lowered at the discretion of the Department of Urban Studies and Planning.

The dual-degree Leaders for Global Operations (http://lgo.mit.edu) program confers both an MBA from the Sloan School of Management and an SM from one of seven engineering programs.

Individuals who wish to qualify for a Master of Science degree in Real Estate Development, in addition to a Master of Architecture or Master in City Planning degree, will be required to satisfy all the subject requirements of each program. Specifically, candidates for the Master of Architecture degree must take 164 subject units and Master in City Planning degree candidates must take 126 subject units. Individuals who wish to qualify for the master’s degree in Real Estate Development also must take at least 66 subject units unique to this program. Students may submit a single thesis provided it is acceptable to the graduate committees of each program. It is expected that such dual degree candidates will be in residence at least one term longer than expected if enrolled in a single degree program.

In order to be eligible to participate in a dual degree program, students must meet the admissions criteria of both departments. At least two regular terms prior to completion of the program, the student must submit to each department a statement of educational objectives along with a detailed program plan that includes a description of the proposed thesis topic. The total program must meet with the approval of each department, and a petition approved by the Office of Graduate Education describing the program must be filed with the Registrar’s Office.

The thesis research must be conducted under the supervision of an approved member of one of the two participating departments, with the other department providing a thesis reader. The thesis must be of superior quality. The single thesis cannot be used to satisfy the thesis requirements of any additional graduate degree programs.

In special cases, the standing committee of an approved interdisciplinary program may act in lieu of one of the two participating departments.

**Two theses.** Occasionally an individual, already admitted for graduate study, may wish to pursue simultaneously two distinct master’s programs, fulfilling the thesis requirement with a separate thesis for each degree program. In such cases, the usual unit requirements for each program apply separately. Registration for two degrees is contingent upon approval by the second department of a request for admission. Such a request can be initiated by a petition approved by both departments and approved by the Office of Graduate Education.

**Simultaneous Award of Bachelor’s and Master’s Degrees**
An undergraduate student of the Institute who is enrolled as a candidate for the bachelor’s degree may be admitted by a department as a candidate for the master’s degree. Students must register as graduate students for at least one regular academic term (not the summer session) to be recommended for the simultaneous award of the bachelor’s and master’s degrees. The thesis submitted
GENERAL DEGREE REQUIREMENTS

for the master’s degree may also be accepted by the department in fulfillment of the undergraduate thesis requirement, if any. A student wishing to pursue this type of academic program must apply for graduate admission in the usual way.

Once a student is classified as a graduate student by the Institute, their eligibility for certain financial aid programs will change. US citizens who are graduate students, and who are enrolled at least half time, are eligible to apply for several types of Title IV federal loans. The interest rates, subsidy rules and origination fees may be different than those for undergraduate students. Graduate students are not eligible for MIT scholarship funds from Student Financial Services. International students who are graduate students may apply for MIT Loans. More information about graduate financial aid as well as instructions and application forms can be found on the Student Financial Services (http://sfs.mit.edu/graduate-financial-aid) website.

Undergraduate students eligible for a simultaneous degree are entitled to remain in undergraduate housing on the condition that they are within their “eight-term maximum” housing guarantee. Otherwise, ninth-term undergraduate students must apply to the graduate housing waiting list.

Engineer’s Degree

The program for an engineer’s degree requires more advanced and broader competence in engineering and science subjects than for the master’s degree, but with less emphasis on original research than a doctoral program. In general, the engineer’s degree requires two academic years beyond an undergraduate degree.

The following engineer’s degrees are awarded:

• Civil Engineer (CE)
• Electrical Engineer (EE)
• Engineer in Aeronautics and Astronautics (EAA)
• Engineer in Computer Science (ECS)
• Environmental Engineer (EnvE)
• Materials Engineer (MatE)
• Mechanical Engineer (MechE)
• Naval Engineer (NavE)
• Nuclear Engineer (NuclE)

The requirement for such a degree is the satisfactory completion of a program of advanced study and research approved by the appropriate department or interdepartmental committee of the School of Engineering. The minimum program consists of at least 162 subject units (exclusive of thesis units) and the completion of an acceptable thesis. The candidate must also have been in residence for a minimum of two regular academic terms. Every degree candidate working on a thesis is expected to register for thesis in all periods during which the thesis research or writing is actually in progress and during the term his or her name appears

on the degree list. A department may accept a master’s thesis of superior quality for the engineer’s degree only if the student intends to use that document to fulfill the requirements of a single master’s degree.

Doctoral Degree

Doctoral degrees are offered by various departments and programs within each of MIT’s five schools; see each school’s description for the lists of degrees. A list of the interdisciplinary graduate degrees offered at MIT, including those offered by the MIT-Harvard Health Sciences and Technology Program and the Joint Program with Woods Hole Oceanographic Institution, is available in the section on Interdisciplinary Graduate Programs (p. 367). MIT offers the degrees of Doctor of Science and Doctor of Philosophy interchangeably in the engineering and science departments (except biology and brain and cognitive sciences) and from the Harvard-MIT Health Sciences and Technology Program. These degrees certify creditable completion of an approved program of advanced study in addition to a research dissertation of high quality based on original research.

The two Institute requirements for a doctorate are completion of a program of advanced study, including a general examination, and completion and oral defense of a thesis on original research.

The course of advanced study and research leading to the doctorate must be pursued under the direction of the departmental committee on graduate students for at least four academic terms. In some cases, the required period of residence may be reduced, but in no instance can it be reduced to less than two regular academic terms and one summer session.

A student is enrolled in a program of advanced study and research approved by the department. The thesis research is in this same area, but the program often includes subjects reaching into several departments. If the field requires substantial participation by two or more departments, an interdepartmental faculty committee, approved by the Office of Graduate Education, should be appointed to supervise the student’s program.

Each doctoral candidate must take a general examination in his or her program of study at such time and in such manner as the departmental or interdepartmental committee approves. This examination consists of both oral and written parts.

Nonresident Doctoral Thesis Research Status

Thesis research is ordinarily done in residence at the Institute. However, on some occasions, it may be essential or desirable that the student be absent from the campus during a portion of thesis research or writing. Nonresident doctoral thesis research status allows thesis research to be carried out while not in formal residence at the Institute. Nonresident status is intended for doctoral students who have completed all requirements other than the thesis. Permission to become a nonresident doctoral candidate
must be obtained from the Office of Graduate Education at least one month prior to Registration Day of the term during which the student wishes to register in this category (a fee will be assessed for late requests). A student who is permitted to undertake nonresidential thesis research must register as a nonresident doctoral candidate and pay a substantially reduced tuition. For the first three regular academic terms, tuition is approximately 5 percent of regular full tuition. Thereafter, it is charged at approximately 15 percent.

Nonresident students have limited access to the facilities and academic life of the Institute. However, they are permitted access to the libraries and athletic facilities and have the same student health privileges and options as resident students upon payment of the appropriate fees. For the first three semesters of nonresident status, a student may receive fellowship support from MIT for an amount up to 5 percent of tuition per semester. After the third semester, nonresident students can no longer receive tuition or stipend fellowship support from MIT. However, departments and programs may provide funding to cover student health insurance for the duration of the nonresident period. Eligibility for federal loans and sponsored billing (http://sfs.mit.edu/billing-repayment/your-billing-statement/how-to-pay-your-bill/#sponsorbilling) remain unaffected for the length of nonresident tenure. Consult the Office of Graduate Education (http://odge.mit.edu) or see Graduate Policies and Procedures (http://odge.mit.edu/gpp/degrees/thesis/nonresident-doctoral-thesis-research-status) for additional information on nonresident status.

Minor Program
Although there is no Institute requirement of a minor for the doctoral degree, certain departments require that candidates take a number of subjects outside their major field.

Language Proficiency
There is no Institute language requirement; however, several departments require that a candidate be able to read or speak a second or third language with intermediate competence. A student may satisfy the requirement in one of three ways: by fulfilling the requirement before entrance by passing one or more intermediate or advanced subjects with a grade of C or better; through examination by MIT Global Studies and Languages (GSL); or by taking language subjects offered by MIT GSL or its affiliated cross-registration partners according to the requirements of the candidate’s home department.

Normally, introductory subjects in a language cannot be used to satisfy a requirement for language proficiency.

MIT GSL offers a variety of intermediate and advanced language subjects, stressing the ability to read and speak in Chinese, French, German, Japanese, Portuguese, Russian, or Spanish. For the purpose of meeting the requirement through examination, MIT GSL gives written examinations each semester prior to pre-registration (November and April) in any language offered at MIT. If a candidate wishes to be examined in a language not offered at MIT, the candidate’s home department will have to arrange for this examination.

For more information, visit the the GSL Graduate Language Exam website (http://mitgsl.mit.edu/graduate-language-exam-gle).

OTHER INSTITUTIONS

Harvard University
A regular or special full-time graduate student at MIT may enroll to take subjects (exclusive of thesis) at Harvard (except Harvard Extension School and Harvard Summer School) without paying additional tuition, provided that this enrollment does not exceed one-half of the student’s total registration for the term. This cooperative arrangement is not applicable to the summer session or, except in limited circumstances, during IAP.

Requests for cross-registration must be approved by the student’s MIT department of registration and should generally be confined to subjects that are not offered at MIT. Students will not be allowed to attend classes in which additional registrants put an undue load on the instructors. The procedures to be followed are available on the Registrar’s Office website (https://registrar.mit.edu/registration-academics/registration-information/cross-registration/harvard). Grades earned in Harvard subjects appear on MIT transcripts as the closest equivalent MIT grade.

Wellesley-MIT Exchange
Graduate students are eligible to participate in the Wellesley-MIT Exchange Program. Wellesley courses are not considered graduate-level subjects, but may be accepted for graduate credit toward a student’s degree with the approval of the department. For details about the exchange, see the program description in the section on Undergraduate Education.

Boston University
An arrangement for cross-registration has been made between the MIT departments of Economics and Political Science and the African Studies Program of Boston University. Details of the procedures to be followed are similar to those for Harvard-MIT cross-registration.

Brandeis University
A cooperative arrangement exists between the MIT Department of Urban Studies and Planning and the Florence Heller Graduate School for Advanced Studies in Social Welfare at Brandeis University. Cross-registration is restricted to one or two subjects per term in the areas of social welfare at Brandeis and urban studies at MIT.
Tufts University

A cross-registration agreement exists between MIT and the School of Dental Medicine at Tufts University. The program is restricted to specific graduate subjects at each institution.

Consortium for Graduate Studies in Gender, Culture, Women, and Sexuality at MIT

Founded in 1992, the Consortium for Graduate Studies in Gender, Culture, Women, and Sexuality (GCWS) is a pioneering effort by faculty at six degree-granting institutions in the Boston area and MIT to advance women’s and gender studies scholarship through a series of ongoing team-taught interdisciplinary graduate seminars, curriculum development events, and conferences that feature graduate student work. Currently there are nine participating institutions: Boston College, Boston University, Brandeis University, Harvard University, MIT, Northeastern University, Simmons College, Tufts University, and the University of Massachusetts Boston.

In keeping with the collaborative tradition of Women’s and Gender Studies, GCWS offers seminars to students matriculated in graduate programs at our member institutions. Students enrolled in any department or program at MIT may register for GCWS seminars and receive graduate credit. Graduate students receive priority, but MIT undergraduates may also apply.

Several graduate seminars are offered each year including a writing workshop for students currently working on dissertations that incorporate women’s, gender, and sexuality studies’ topics. Examples of past seminars (http://web.mit.edu/gcws/courses/course-archive.html) include Feminist Inquiry; Gender, Health, and Marginalization; and Gender, Race, and the Complexities of Science and Technology, among others. Enrollment in each is limited, so students who are interested in enrolling in GCWS seminars must complete a short GCWS course application online (http://web.mit.edu/gcws/courses/how-to-apply.html). Undergraduate students must first consult with the director of Women’s and Gender Studies at MIT. Admissions decisions are based on the student’s background and brief statement of interest. The list of seminars offered and the online application are available on the GCWS website (http://web.mit.edu/gcws).

In GCWS courses, faculty explicitly integrate gender analyses with issues of class, race, culture, ethnicity, and sexualities, and the practical and public-policy implications of feminist theory and scholarship are considered. Courses are designed not only to examine existing feminist scholarship, but to open paths to the creation of new knowledge. GCWS graduate courses also provide crucial intellectual support for students pursuing feminist work within the framework of traditional disciplines. For additional information, contact the GCWS Office (gcws@mit.edu), Room 14N.211.

ADMISSIONS

Regular Graduate Admissions

A regular graduate student is an individual who has been admitted to the Institute and who is registered for a program of advanced study and research leading to any of the post-baccalaureate degrees offered by MIT.

To be admitted as a regular graduate student, an applicant must normally have received a bachelor’s degree or its equivalent from a college, university, or technical school of acceptable standing. Applicants are evaluated by the department in which they propose to register on the basis of their prior performance and professional promise. These are evidenced by academic records, letters of evaluation from individuals familiar with the applicant’s capabilities, and any other pertinent data furnished by the applicant. While high academic achievement does not guarantee admission, such achievement, or other persuasive evidence of professional promise, is expected.

A student registered in a program of study leading to the simultaneous award of the bachelor’s degree and master’s degree must apply for graduate study and be registered as a graduate student for at least one academic term (not the summer session) of his or her program of study.

Some engineering departments require students seeking a doctoral degree to qualify first for a master’s degree.

Undergraduate Requirements for Advanced Degrees

In addition to preparation in the specific field of interest, most departments require significant work in mathematics and the physical sciences, but some require as little as a year of college-level work in these disciplines. Requirements of individual departments are described in their chapters of this catalog. Students with minor deficiencies in preparation may be admitted for graduate study; however, deficiencies in prerequisite or general or professional subjects must be made up before the student can proceed with graduate work dependent on them.

Application Procedures

Students normally begin graduate study in September. However, in select departments, suitable programs can be arranged for students entering in June or February. Prospective applicants should check with individual departments about their dates for admission and matriculation. Application deadlines vary by department. Deadlines are noted on the graduate admission application.

All applicants are required to apply online. Each department or program has its own online application with specific instructions. Department websites and application instructions may be found
on the MIT Graduate Admissions (http://gradadmissions.mit.edu) website.

Inquiries about specific application and testing requirements, deadlines, and notification of decision for admission should be addressed to the appropriate graduate department or program.

**International Graduate Admissions**

Graduate student applicants who are citizens of countries other than the United States must have received a bachelor’s degree or its equivalent from a college, university, or technical institute of acceptable standing. The academic record and all credentials must indicate the ability of the candidate to complete the approved program of graduate study and research. Applicants are evaluated by the academic departments. Admission is granted on a competitive basis. Competence in written and spoken English is expected.

Students whose native language is not English and whose schooling has not been predominantly in English may be required to submit scores from the International English Language Testing System (IELTS) or the Test of English as a Foreign Language (TOEFL). Inquiries about specific testing requirements for admission should be addressed to the appropriate graduate department.

**Special Graduate Student Admissions**

A special graduate student is one whose intended program of study is essentially graduate in nature but who is not a candidate for an advanced degree. Students holding a bachelor’s degree or higher who are not currently enrolled in an MIT degree program and are interested in taking classes as a non-degree student at MIT must apply through MIT’s Advanced Study Program (http://advancedstudy.mit.edu). Deadlines for filing applications are May 1 for fall term and December 1 for spring term. The application and additional information may be found on the Advanced Study Program website (http://advancedstudy.mit.edu).

Admission is valid only for one term; a student must seek readmission each term to continue at the Institute. Those applying for special graduate student status for the first time must pay an application fee. To be allowed to continue as a special graduate student, satisfactory academic performance must be maintained. Admission as a special graduate student does not imply any commitment toward an individual’s admissibility to regular graduate student status.

A student who is neither a United States citizen nor a United States Permanent Resident is considered an International Student. The form I-20 or DS-2019 will not be issued for subject registration of less than 36 units. Most subjects at MIT are either 9 or 12 units each. Detailed information about policies and procedures can be found at the Office of Graduate Education website (http://odge.mit.edu/gpp/registration/status/special-student).

**Graduate Student Status for Research Staff Members**

In view of their full-time responsibilities on assigned research and their corresponding salary scales, Institute research staff or employees of the Lincoln Laboratory or the Charles Stark Draper Laboratory may not be full-time regular graduate students, but may, under certain conditions, be granted the status of special graduate student. However, a research staff appointee or an employee of the Lincoln Laboratory or the Draper Laboratory who desires to work for an advanced degree must be admitted as a regular graduate student and must complete the residency and other requirements of the degree program to which the individual has been accepted. This individual may not continue to hold a research staff appointment, nor include any work completed while employed as part of the thesis for an advanced degree.

Any research staff appointee and any employee of the Lincoln Laboratory or the Draper Laboratory may, by written permission from the director of the division (or his or her designate), apply for admission as a special graduate student for enrollment in one subject only per term (but not thesis), either as a listener or for academic credit.

Acceptance for such enrollment will be granted if, in the opinion of the instructor, the individual is qualified to undertake the subject and if section size permits. For this type of enrollment, the student will be assigned to an appropriate registration officer and will pay, whether as a student or listener, the fee established at the special student rate.
**COSTS**

**Tuition and Fees**

The basic tuition and fees at MIT for the academic year 2018–2019 (which are reviewed and likely to increase next year) are as follows:

<table>
<thead>
<tr>
<th>Fee</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuition</td>
<td>$51,520</td>
</tr>
<tr>
<td>Student Activity Fee</td>
<td>$312</td>
</tr>
<tr>
<td>MIT Student Extended Insurance Plan (optional)</td>
<td>$3,000</td>
</tr>
</tbody>
</table>

Enrollment in the MIT Student Extended Insurance Plan is automatic. Students may submit an online waiver request [here](https://medical.mit.edu/mit-health-plans/student/waiver.html) if they have comparable insurance coverage.

Payment of the tuition fee entitles all regular and special students to many health care services at MIT Medical ([here](https://medical.mit.edu)) at no charge. The MIT Student Extended Insurance Plan covers hospitalization due to accidents or illness and meets the state’s requirement for comprehensive health insurance. Insurance is required for all students unless they can demonstrate that they have comparable coverage through another insurance program. Refer to the Medical Requirements (p. 72) section for additional details or visit MIT Medical ([here](https://medical.mit.edu/mit-health-plans/student-health-plans)).

The tuition for all regular students, including graduate student staff, in the first and second terms is $25,760 per term, except for students entering the Sloan Master’s Program, the Leaders for Global Operations Program, the Real Estate Development Master’s program, and the master’s programs in Supply Chain Management. Students in these programs should check with the appropriate department office for relevant tuition amounts. Full tuition in either term of the current year covers the January Independent Activities Period. The minimum term tuition charge for registration for doctoral thesis upon readmission as a resident student is $38,640 if not registered during the preceding regular term.

The tuition for all regular graduate students, including fellows, trainees, and academic staff in the 2018 summer session was $17,155. Graduate students who are enrolled in a research program, and who are not taking courses, will have their summer tuition subsidized(https://registrar.mit.edu/registration-academics/tuition-fees/graduate/summer-tuition-subsidy) (that is, paid from other Institute resources). Special tuition rates apply to other students in the summer session. These are published each year in the Summer Session Catalog ([here](https://catalog.mit.edu/summer)), available in April.

Special students are charged at the rate of $800 per unit whether taken for credit or not. This unit fee applies up to a maximum of $25,760 per term and is subject to the following minimum fees:

<table>
<thead>
<tr>
<th>Fee</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members of the MIT community (Includes special students who are full-time employees of the Institute or who are dependents of full-time employees or regular students.)</td>
<td>$4,800</td>
</tr>
<tr>
<td>Other special students</td>
<td>$7,200</td>
</tr>
</tbody>
</table>

Any resident graduate student making progress toward a degree is expected to register and is considered a full-time student. If a graduate student requires only part of a term to complete the thesis, full tuition for the term is charged, and adjustments to tuition are made at a later date. If the student was registered for thesis as a resident student in the immediately preceding term, regular or summer, tuition for thesis will be adjusted after acceptance by the department of the completed document on the basis of a charge of $2,140 per week from the starting date of the term, with a minimum of $2,140 for the master’s or engineer’s degree and $4,291 for the doctoral degree. If the immediately preceding term was the summer term and if the graduate student was not registered for thesis in that summer term, but was registered for thesis in residence in the previous second term, the minimum tuition for thesis is $12,880.

A student who continues to hold a fellowship, traineeship, or graduate staff appointment for the remainder of the term after delivery of the thesis continues to be regarded as a full-time student and the tuition will not be adjusted. In unusual circumstances, the Office of Graduate Education may set special tuition rates for graduate students.

Students who are permitted to undertake nonresident thesis research must register as nonresident doctoral candidates and, in the first three semesters of registration as a nonresident, pay tuition equal to approximately five percent of the regular full tuition ($1,290 per term for 2018–2019). For the fourth and subsequent semesters of registration as a nonresident, tuition will equal approximately 15 percent of the regular full tuition ($3,865 per term for 2018–2019). Following completion of the nonresident period, the student must return to resident status for completion and presentation of the doctoral thesis. If the student requires only part of this first term back in residence to complete the thesis, the tuition will be adjusted subject to a minimum of $12,880. Please consult Graduate Policies and Procedures ([here](http://odge.mit.edu/gpp/degrees/thesis/nonres)) for additional information on nonresident status.

Cooperative and practice-school programs offered by MIT provide industrial and research experience through a series of work assignments interwoven with regular study at the Institute. The tuition fees for these programs are the same as those for regular graduate students:

- Chemical Engineering Practice School, Course 10-A
• Electrical Engineering and Computer Science, Course 6-A

Students interested in the Sloan Fellows Program for Innovation and Global Leadership should consult the Sloan School of Management with regard to fees.

**Withdrawal**

A student withdrawing before the start of a term is not charged any tuition for that term and any tuition payments previously made for that term will be refunded. Students withdrawing during the fall or spring term are charged one-twelfth of the stated tuition for the term for each week from the starting date of the term, with a minimum two-week charge. A student must pay full tuition and fees at the beginning of the term. Any subsequent reduction in fees is based on the date that cancellation of a subject or withdrawal from the Institute is effected. At that time, any excess payments which the student has made will be refunded.

**Miscellaneous Fees**

Miscellaneous fees include the following:

<table>
<thead>
<tr>
<th>Fee</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application for graduate admission</td>
<td>$75</td>
</tr>
<tr>
<td>Application for MBA Program in Sloan School of Management</td>
<td>$250</td>
</tr>
<tr>
<td>Late submission of preregistration material ($85 if very late)</td>
<td>$50</td>
</tr>
<tr>
<td>Late initiation of registration process or very late registration, or late submission of application for nonresident doctoral status</td>
<td>$100</td>
</tr>
<tr>
<td>Late filing of degree application ($85 if very late)</td>
<td>$50</td>
</tr>
<tr>
<td>Late thesis title</td>
<td>$85</td>
</tr>
<tr>
<td>Library processing fees:</td>
<td></td>
</tr>
<tr>
<td>Doctoral theses</td>
<td>$115</td>
</tr>
<tr>
<td>All other theses for advanced degrees</td>
<td>$50</td>
</tr>
</tbody>
</table>

See the Academic Calendar (p. 8) for dates.

The miscellaneous fees and processing charges listed above are nonrefundable unless levied in error.

**Processing Charges for Late Changes in Registration**

A late change in registration, which requires a petition (http://odge.mit.edu/gpp/oversight/petitions) to the Office of Graduate Education, is defined as adding a subject after the fifth week or dropping a subject during the last three weeks of a term. The processing charge for late changes is $50. There is an additional charge of $50 for a retroactive change after the end of the term.

**Graduate Living Costs**

Living expenses for graduate students vary widely depending on such factors as marital status, availability of resources, interests, and tastes. Monthly living costs (housing, food, and personal expenses) are roughly $2,850 for a single graduate student. These cost estimates do not include tuition, books, or the Hospital and Accident Insurance Policy. Campus housing for graduate students is limited, however, 97% of new graduate student applicants, and 65% of returning student applicants, receive graduate housing through the housing allocation process. On-campus dining opportunities are available to graduate students.

**Payment of Tuition and Other Charges**

An individual who registers as a student at MIT agrees to pay all charges on his or her account when due, and acknowledges that the Institute may charge a hold fee, suspend registration, revoke Institute services, and withhold the degree if these charges are not paid.

Student Financial Services (SFS) (http://sfs.mit.edu) gathers, bills, and collects student charges and provides a student account statement of that activity. These charges originate in the offices from which the student receives Institute services. SFS bills by posting a monthly student account electronic billing statement on MITPAY—a secure, paperless online billing and payment system. The statement is posted by the 10th of the month in which there is a new charge on the account. SFS sends students a courtesy monthly email reminder to check the statement and pay any balance due. The statement includes charges (e.g., tuition, fees, housing, and library fees), payments (financial aid, tuition awards), additional amounts due, and payment deadlines.

Payment in full or a satisfactory arrangement for payment is due on or before August 1 for fall term and on or before January 1 for spring term. New charges that occur after the initial statement will appear on a subsequent statement. If a student anticipates that he or she may not be able to pay the entire amount due by the term bill due date, the MIT Payment Plan is available and should be considered.

The MIT Monthly Payment Plan is an installment arrangement that allows students to pay the balance due in monthly installments interest free. The terms and conditions of the monthly payment plan are available on the SFS website.

SFS also offers information on federal student loan programs as additional options for eligible US citizens and permanent residents.

A student who fails to make satisfactory arrangements for payment will have a registration or degree hold imposed and a Hold Fee of $100 will be charged to the student account. The balance due, including the Hold Fee, must be paid in full before a hold will be released.

**Notifications to Graduate Students with Unpaid Balances**

The fifth week of the term, SFS will identify graduate students who have an unpaid balance on their student account for the term and who have not made satisfactory arrangements for payment of the balances. SFS will notify these students—both through the regular
Fellowships, Assistantships, and Taxes

At MIT, a fellowship award to a graduate student covers full or partial tuition, and may also provide a stipend to help defray living expenses. In the context of graduate study, a scholarship covers full or partial tuition only. Although most awards are made on the basis of academic merit, financial need is a factor in some instances.

Many individual, foundation, corporate, and government granting organizations provide external fellowship support for students. Students should apply directly to the granting organization for funding based on eligibility. Application deadlines typically fall between October 1 and May 1 of any given year.

Generous donors have provided MIT with permanent funds in support of fellowships, many of which have unique restrictions. MIT offices administer a number of these endowed internal fellowships through annual processes. Students who seek financial support from any of the fellowships administered by MIT should inform their academic department. The award process typically runs concurrently with the timeline for application for admission. For further information on guidelines, see Graduate Policies and Procedures (http://odge.mit.edu/gpp/assistance/awards/applying). In accordance with a resolution of the US Council of Graduate Schools (endorsed by most graduate schools), a student has until April 15 to accept or decline an offer. If a student does not reply to an offer by this date, it may be cancelled.

More information on both external and internal fellowships, including links and tips for applying, is provided by the Office of Graduate Education. (https://odge.mit.edu/finances/fellowships)

Every student holding a fellowship for graduate study at the Institute must register as a full-time graduate student for the period of the award. Fellowship limitations apply to nonresident doctoral students; see "Terms of Status" (http://odge.mit.edu/gpp/degrees/thesis/nonres) for this category in Graduate Policies and Procedures. If a student withdraws from the Institute before tenure expires, the award must be relinquished, and the student will be required to refund any payment made in excess of tenure.

Teaching Assistantships

MIT employs about 1,300 graduate students each year as part-time or full-time teaching assistants to assist the faculty in grading undergraduate quizzes, instructing in the classroom and laboratory, and conducting tutorials.

The departments regard seriously the benefits of a teaching assistantship as a preparation for a career in university teaching. Each year, the Institute offers a prize, the Goodwin Medal (https://odge.mit.edu/development/teaching/the-goodwin-medal), for conspicuously effective teaching by a graduate student.

The units for which an instructor or teaching assistant may register as a student are determined by the department in light of the student’s assistantship duties, program of study, and compensation. Teaching assistants receive stipends as well as tuition support for the services that they provide.
Appointments to teaching assistantships are made upon recommendation of the head of a department. A student who wishes to be considered for a teaching appointment should contact the departmental graduate administrator. Only full-time graduate students who are candidates for advanced degrees may be appointed. A Free Application for Federal Student Aid (FAFSA) is required for all teaching assistants who are US citizens or permanent residents.

Research Assistantships

Each year about 3,800 graduate students at MIT hold appointments as research assistants. The principal duty of a research assistant is to contribute to a program of departmental or interdepartmental research.

Most students welcome the opportunity to participate as a junior colleague of a faculty member in an ongoing research project that frequently influences their choice of thesis topic. Appointments to research assistantships are made by the department head to full-time students who are candidates for advanced MIT degrees.

The units for which a research assistant may register are determined by the department in light of duties and program of study. Research assistants receive stipends and tuition support for the services they provide, and are compensated on the basis of time devoted to their research.

Students who receive primary financial support from fellowships or other sources may receive supplementary stipends as teaching or research assistants in accordance with Institute and departmental guidelines.

Taxes

Tuition payments made through fellowships and research and teaching assistantships are nontaxable.

Stipends provided to teaching (TA) and research (RA) assistants are considered taxable income. For students who are US citizens and permanent residents, TA and RA stipend payments are subject to withholding tax. MIT will issue a W2 form to all students from whom this tax has been withheld.

Fellowship stipends are also legally taxable income. However, for students who are US citizens and permanent residents, tax withholding regulations do not allow for withholding federal and Massachusetts income taxes from the fellowship payments. Thus, students should anticipate the tax obligation, and no W2 will be issued. For international students, federal income tax is withheld from Fellowship stipends at a flat rate depending on the student’s visa type; Massachusetts income tax is not automatically withheld and it is the student’s responsibility to determine their state income tax liability and make estimated tax payments to the state, if necessary.


Loan Funds

US Citizens

Graduate students may want to consider federal student loans first as these loans ordinarily have better terms and conditions. To establish eligibility for federal student loans, applicants must complete the Free Application for Federal Student Aid (FAFSA) (http://www.fafsa.ed.gov) and the MIT Graduate Loan Application (http://sfs.mit.edu/graduate-financial-aid/aid-info). The maximum Federal Direct Unsubsidized Loan per year is $20,500. Application forms and details of the application procedure may be obtained from SFS (http://sfs.mit.edu) in Room 11-120.

Students who need additional student loan funding (beyond the Federal Direct Unsubsidized Loan) may want to consider securing a Federal PLUS Loan or private alternative loan, which are not based on financial need. The Federal PLUS Loan and private alternative loans may be used to borrow the remainder of a student’s expenses. MIT does not maintain a preferred lender list. MIT believes it is inappropriate to endorse or recommend one private loan over another as students and their families have different needs and priorities.

International Students

Students who are not US citizens or who do not hold a permanent resident visa are not eligible for federal loans. International students must be prepared to meet their expenses without help from loans from the Institute. International Students may consider applying for loans from private sources as explained in the previous sections. Most of these loans will require a US-based co-signer.

Student Employment

Student Financial Services (SFS) (https://sfs.mit.edu) maintains listings of on-campus and off-campus job opportunities (http://sfs.mit.edu/jobs/about-jobs-mit) that are open to graduate students. Some positions are available directly through administrative offices on campus. Graduate students who hold full-time research or teaching assistantships or fellowships and who are US citizens or permanent residents may typically work an additional 10 hours per week in such employment. For additional information, visit Student Financial Services (https://sfs.mit.edu).

For international students, regulations regarding on-campus and off-campus employment depend on the student’s visa type and other circumstances; full details are available on the International

US graduate students who complete the Free Application for Federal Student Aid (FAFSA) and are eligible for Federal Work-Study may do paid community service. Wages are subsidized for students performing direct community service at approved nonprofit agencies. For additional information, please see the website (http://sfs.mit.edu/jobs/about-jobs-mit).

**Graduate Residents**  
Any graduate student at MIT may apply for a position as a graduate resident tutor (GRT) through Residential Life Programs (http://studentlife.mit.edu/life-campus/residential-life-programs). The compensation for a GRT position includes free use of a room/apartment in the assigned residence during the appointment plus a stipend of $730 per semester (which is taxable).

**Veterans' Benefits**  
Students who are receiving veterans' benefits need to verify their enrollment each term in order to be certified. For more information, visit Veterans’ Benefits at MIT (http://sfs.mit.edu/undergraduate-financial-aid/types-of-aid/veterans-benefits).

**MEDICAL REQUIREMENTS**

**Medical Report Requirements**  
MIT requires that all incoming students submit a medical history, have a complete physical examination, and document immunity against certain infectious diseases. Medical Report forms (https://medical.mit.edu/sites/default/files/medreport.pdf) need to be submitted before registering for classes. Specific deadlines for each term are listed on the form itself.

*Registration will not be permitted for any student who has not complied with the Medical Report and/or immunization requirements stated above.*

**MIT Medical**  
To meet the health care needs of MIT community members, MIT Medical offers a single, centralized source of comprehensive health insurance, care, and treatment at our own medical centers, and an extensive roster of health promotion programs. Members of the MIT community and their families have convenient, on-campus access to a broad range of clinical services and medical and dental specialties, delivered by highly qualified health care professionals. Through our affiliations with Boston’s leading hospitals, our clinicians are able to refer patients with more serious conditions to the most appropriate specialists. MIT Medical is located in Building E23.

Visits to MIT Medical are by appointment, except for urgent care. Urgent medical care is available at MIT Medical seven days a week. (See the MIT Medical website (https://medical.mit.edu/services/urgent-care) for hours of operation.) MIT Medical’s Mental Health and Counseling Service offers assistance to students dealing with personal concerns, including anxiety, depression, relationship problems, and stress. They provide evaluations and consultations, brief treatment, referrals, and group counseling. All services at the Mental Health and Counseling Service are available free of charge to MIT students. The Mental Health and Counseling Service also has walk-in hours for urgent matters from 2 to 4 pm daily, Monday through Friday. MIT community members should call 617-253-4481 day or night for medical advice.

Visit the MIT Medical website (https://medical.mit.edu/services) for more information about our services, including appointment hours, phone numbers, and clinician profiles.

**Health Insurance Requirements**  
All MIT students must have health insurance that meets the requirements for the Massachusetts Student Health Insurance Plan (SHIP). Students with J-1 visas under MIT sponsorship must have insurance that also meets US Department of State regulations for themselves and their spouses and children who accompany them. Visit the MIT Medical website (https://medical.mit.edu/mit-health-plans/student-health-plans) for more information about Massachusetts health insurance requirements.

**MIT Student Health Plan**  
The MIT Student Health Plan (https://medical.mit.edu/mit-health-plans/student-health-plans) consists of two complementary parts, the MIT Student Medical Plan and the MIT Student Extended Insurance Plan.

The MIT Student Medical Plan covers a wide range of services provided at MIT Medical, including primary care, many medical specialties, urgent care 7 days a week, mental health care, and other services. Registered MIT students paying tuition to MIT are automatically enrolled in the MIT Student Medical Plan as part of their tuition. Student partners and children of students can pay a Partner/Child MIT Student Medical Plan premium for comprehensive access. To enroll their families, students must complete the MIT Student Health Plan enrollment form during the enrollment period. Partners and children of students who purchase the MIT Student Medical Plan premium must also provide evidence that they are enrolled in a health insurance plan or may purchase the MIT Student Extended Insurance Plan.

The MIT Student Extended Insurance Plan is designed to coordinate with the MIT Student Medical Plan and provides coverage for more extensive care, such as hospitalization, diagnostic tests, physical therapy, surgery, prescription medication, and obstetrical care. Since health insurance is mandatory under Massachusetts law,
all regular students and special students registered with 75% of the full-time academic requirement or full-time, including students on a J-1 or F-1 visa, are automatically enrolled in the MIT Student Extended Insurance Plan. Prior to the beginning of each academic year, students have the option to submit an online request to waive the MIT Student Extended Insurance Plan for either the full year if they already have coverage which meets the Massachusetts requirements for student health insurance. If students choose to keep the MIT Student Extended Insurance Plan for the fall term, they will still have the option to waive the MIT Student Extended Insurance Plan for the spring academic term. All waivers must be submitted before the designated deadline to avoid a late fee. J-1 students under MIT visa sponsorship may waive the MIT Student Extended Insurance Plan only if their policies meet both the Massachusetts requirements and specified United States Information Agency (USIA) requirements. Massachusetts state law requires coverage through an insurance carrier based in the United States. New waiver forms must be filled out each academic year.

Special students taking two or more subjects but registered at MIT less than 75% of the full-time academic requirement are eligible to purchase the MIT Student Extended Insurance Plan but are not enrolled automatically.

If students have enrolled their partners and/or children and wish to continue their enrollment in the MIT Student Medical or Extended Insurance Plan, no further action needs to be taken as they will be automatically re-enrolled as long as the student remains covered by the MIT Student Extended Insurance Plan. If students wish to end coverage for their family, they must notify (stuplan@med.mit.edu) the Health Plan office, in writing, by the enrollment deadlines.

*The deadline for submitting enrollment forms and waiver forms is August 31 for the fall term, January 31 for the spring term, and June 15 for the summer term.*

Visit the MIT Medical website ([https://medical.mit.edu/mit-health-plans/student-health-plans](https://medical.mit.edu/mit-health-plans/student-health-plans)) for more information about the MIT Student Health Plans, including benefits, rates, and enrollment or waiver processes.

Please contact MIT Health Plans (stuplan@med.mit.edu) with enrollment or waiver questions, or contact Claims and Member Service (mservices@med.mit.edu) with any questions about benefits or claims.
ACADEMIC PROCEDURES

What is MIT’s policy on grading? On plagiarism? On harassment? Does MIT disclose information about students to persons outside the Institute? This section contains the essential rules and regulations that govern day-to-day operations at MIT.

In addition to the information presented in this catalog, students are expected to be familiar with the Mind and Hand Book (http://handbook.mit.edu) and the Institute Policies and Procedures (http://web.mit.edu/policies).

REGISTRATION

Information on preregistration and registration procedures is available on the Registrar’s Office website (https://registrar.mit.edu/registration-academics/registration-information).

Retaining Student Status

A person becomes an MIT student at the start of the term for which he or she is admitted or readmitted. Regular student status is retained until graduation, unless the student takes a leave or is disqualified.

For the fall and spring terms, undergraduate and graduate students must complete the three steps listed below in order to continue student status during that term:

- Preregistration must be completed according to instructions issued by the Registrar’s Office.
- All Institute and Fraternity, Sorority, and Independent Living Group (FSILG) charges must be paid when due, or satisfactory alternative arrangements must be made with Student Financial Services or the FSILG.
- Registration must be approved by the student’s advisor or registration officer and submitted by the student to the Registrar’s Office by the published deadline.

Students who do not complete these steps by the published deadlines are subject to fines. Failure to pay charges and complete registration by the end of the second week of the term will result in the loss of student status.

International students are required by immigration regulations to be registered full-time when school is in session in order to maintain legal status in the US. Students should check with the International Students Office (http://web.mit.edu/iso) for details.

Undergraduate and graduate students registered in the spring term who do not graduate or take a leave from MIT retain their student status through the following summer, whether or not they register for the summer session; they cease being students if they do not register in the fall (although the rules for student status with regard to loan repayment are somewhat different). Graduate students making progress toward a degree during the summer must register for the summer session in accordance with Office of Graduate Education regulations.

Students do not have to register for the Independent Activities Period to retain student status between fall and spring terms.

If a student has begun the registration process but wishes to take a leave, he or she must notify Student Support and Wellbeing if an undergraduate; his or her registration officer if a graduate student; and, in addition, the International Students Office if an international student.

A person wishing to be reinstated as an undergraduate must apply to return through Student Support and Wellbeing. No application to return to the undergraduate program will be considered from any applicant who has received a bachelor’s degree or the equivalent from another institution. A person wishing to be reinstated as a graduate student must apply to return through the Admissions Office and the department. International students also need to be cleared by the International Students Office.

People on campus who are not registered during a term are not considered students and have no student privileges.

Prerequisites

Prerequisites are used to indicate the sequence in which subjects are to be taken and the base of knowledge on which a particular subject will build. Before taking a subject, a student should complete any prerequisite(s) listed for that subject; corequisites, which are listed in italics, are to be taken concurrently. (See subject listings by department/program (http://catalog.mit.edu/subjects)).

Once prerequisites and corequisites are included in a subject listing, it is the responsibility of the instructor to ensure that the subject is taught at the appropriate level. At the first class, instructors should reiterate the prerequisites and corequisites, and describe acceptable substitutions.

Students who do not have the stated prerequisites should obtain the permission of the instructor. Instructors may request that the Registrar’s Office identify students without prerequisites, and in some cases, screen them from the subjects.

If the instructor allows a student to waive or make a substitution for a prerequisite, it is then the student’s responsibility to master any missing background material in a timely fashion so that the content of the subject does not change for other students in the subject.

The instructor may determine that a student does not have the required preparation and knowledge to take a subject and may, with the help of the Registrar’s Office, exclude the student from the subject.
Some departments require students with a D-level performance in certain prerequisite subjects within the departmental program to do additional work or to retake the prerequisite before proceeding with the follow-on subject.

Credit Hours and Designations for Subjects

The credit hours (units) for each subject indicate the total amount of time spent in class and laboratory, plus the estimated time that the average student spends on outside preparation, for one regular term. Each subject is listed in the online MIT Subject Listing & Schedule (http://student.mit.edu/catalog), with three credit numbers, showing in sequence the units allotted to class time (lecture and/or recitation); laboratory, design, or fieldwork; and preparation. Each unit represents about 14 hours of work per term, or about one hour of work per week for a subject that spans an entire term. The total unit credit for a subject is obtained by adding together all the units shown. Additional information regarding subject designations may be found in the Subjects Key (http://catalog.mit.edu/subjects/#keytext).

Advanced Standing Examinations/Credit

Undergraduate Students

Advanced standing examinations for undergraduate students are given in August/September, December, January/February, and May. These examinations may be taken only by students who have never been registered for or attended class at MIT in the subject concerned. Special students are not eligible to take advanced standing examinations.

Except for entering first-year and transfer students, who may take advanced standing examinations offered during orientation, students must petition to take an advanced standing examination. The petition must be approved by the instructor in charge of the subject and the student’s advisor, and then submitted to the Registrar’s Office, Room 5-117, at least three weeks before the first day of the examination period.

Students interested in taking higher-level examinations should check in advance what preparation is required. The instructor may require evidence of competence in addition to the examination if the subject normally involves measures of student performance that are qualitatively different from the examination.

If a student fails an advanced standing examination, he or she may not retake the examination, but may register for the same subject in any subsequent term.

For more information, see the advanced standing examination procedures on the Registrar’s website (https://registrar.mit.edu/classes-grades-evaluations/examinations/advanced-standing-examinations).

Graduate Students

Academic departments may decide to arrange advanced standing credit for their graduate students. The department may do so, in agreement with the faculty member in charge of the subject concerned, who may require evidence of competence in addition to an examination. A passing grade entitles a student to full credit for the subject. A failing grade will appear on the permanent record.

TERM REGULATIONS AND EXAMINATION POLICIES

These term regulations and examination policies (https://facultygovernance.mit.edu/rules-and-regulations/#term-regulations-and-examination-policies) derive from Rules and Regulations of the Faculty (https://facultygovernance.mit.edu/rules-and-regulations/#rules-and-regulations-of-the-faculty). They apply to academic exercises during the fall and spring terms. Questions of interpretation and requests for exceptions to regulations should be referred to the Chair of the Faculty.

All Subjects

Class Times. Academic exercises are, in general, held between 9 am and 5 pm, Monday through Friday. Classes begin five minutes after and end five minutes before the scheduled hour or half-hour.

Beginning of Term. Early in the term, the faculty member should inform students of expectations regarding permissible academic conduct. Particular attention should be given to such questions as the extent of collaboration permitted or encouraged, and the use of prior years’ materials in completing problem sets, lab reports, and other assignments.

Scheduling Final Examinations. Final examinations for full-term subjects and H2 and H4 half-term subjects are held during the five-day final examination period at the end of each term, and are scheduled through the Schedules Office. Final examinations are scheduled in either the morning (9 am to noon) or afternoon (1:30 pm to 4:30 pm) on examination days. A final examination in any of these subjects must be scheduled to last at least one hour and not more than three hours. Final examinations may not be cancelled once they are announced, and, after the final examination schedule is published, the time of the final examination may not be changed. Instructors may not administer a take-home examination as a final examination, except as permitted with respect to ex camera examinations.

Final examinations for H1 and H3 half-term subjects shall be held during a regularly scheduled class period in the final week of the subject (the Half-Term Final Examination Period). The final examination scheduled in any H1 and H3 half-term subject shall last no longer than one class period.
Students are responsible for attending the final examinations in subjects for which they are registered. The schedule of final examinations for full-term subjects and H2 and H4 half-term subjects is published on the web by the end of the third week of the term. The Schedules Office contacts students who have conflicts between scheduled final examinations to notify them of the conflict examination schedule, which is announced the day after Drop Date. The Schedules Office also provides instructors with the conflict examination schedule immediately after Drop Date.

After the Last Scheduled Class. No required classes, examinations, oral presentations, exercises, or assignments of any kind may be scheduled after the last regular scheduled class in a subject except for final exams scheduled through the Schedules Office. (The architecture design reviews that occur during finals week are considered to be equivalent to final examinations and are scheduled by the Department of Architecture.)

Formal review must be held during regular class periods. However, instructors may schedule optional reviews or sessions at which the instructing staff is available to answer questions for students who choose to attend after the last day of classes. No new material may be introduced during optional events.

An instructor may give an extension to an individual student for an assignment, but blanket extensions should not be given to the entire class.

Excused Absences from Final Examinations. A student may be excused from a scheduled final examination for reasons of illness or significant personal problems. To seek an excused absence in these situations, an undergraduate student should contact a dean in Student Support and Wellbeing and a graduate student should contact the Office of Graduate Education; faculty members with questions about this process should contact the appropriate office. See definition of "O" and "OX" under Grades.

In addition, the faculty member in charge of a subject may excuse a student from a final examination for reasons such as a conflict with another examination or a religious holiday. In these cases, a mutually satisfactory agreement must be reached between the student and the faculty member, the agreement must be ratified in advance of the examination by the head of the department in which the subject is offered, and the faculty member must be prepared to submit a grade based on other evidence.

Faculty members are not required to provide make-up examinations to accommodate an individual student's personal plans at the end of term.

Undergraduate Subjects

Class Times. For undergraduate subjects taught on campus during the instructional period of the fall and spring terms, there should be no required academic exercises between 5 pm and 7 pm, Monday through Thursday, and between 5 pm Friday and 8 am Monday. This same restriction also applies to undergraduate subjects taught during the Independent Activities Period.

Beginning of Term. By the end of a subject's first week of classes, the faculty member must provide:

- A clear and complete description of the required work, including the number and kinds of assignments
- The approximate schedule of tests and due dates for major projects
- An indication of whether or not there will be a final examination
- The grading criteria and procedures to be used

The precise schedule of tests and major assignments must be provided in full-term subjects by the end of the third week and in half-term subjects by the end of the second week.

Tests and Academic Exercise Outside Scheduled Class Times. Tests, required reviews, and other academic exercises held outside scheduled class times may not be held on Monday nights.

In addition, tests will:

- Not exceed two hours in length
- Be scheduled through the Schedules Office
- Begin no earlier than 7:30 pm when held in the evening

A student who is unable to take a test that is held outside of scheduled class time owing to a conflict with a scheduled academic exercise or extracurricular activity must be allowed to do so at another time.

When a test is held outside scheduled class time, during that calendar week either:

- A regularly scheduled class session (lecture or recitation) must be cancelled, or
- No assignment will fall due

Ex Camera Finals. In some undergraduate subjects, final examinations may be ex camera (out-of-room) examinations. Ex camera examinations are a different mode of testing that gives students access to computers and libraries and evaluates their abilities to select resources and answer questions of an integrative nature. Ex camera final examinations are not intended as a way to increase the amount of material covered.

A faculty member must obtain the written permission of the Chair of the Faculty (exam-termregs@mit.edu) to hold an ex camera final examination in an undergraduate subject, and permission will be granted for no more than five years. The ex camera examination must:

- Be scheduled through the Schedules Office
• Be offered over the course of a single afternoon, starting at 1:30 pm and ending no later than 7:30 pm
• Permit students unrestricted use of resources

**End-of-Term Tests and Assignments.** For full-term subjects and H2 and H4 half-term subjects, there shall be no tests after the Last Test Date, which is defined as the Friday preceding the start of the Reading Period. Unit tests may be scheduled during the final examination period.

For each subject in which there is testing during the final examination period, no assignment may fall due after the Last Test Date.

For each subject in which there is no testing during the final examination period, at most one assignment may fall due between the Last Test Date and the end of the last scheduled class period in the subject. This single assignment may include both an oral presentation and a written report if the two derive from the same project. However, students may not be required to attend additional lecture or recitation hours beyond the assigned units to accommodate oral presentations.

Optional assignments between the Last Test Date and the last scheduled class period in the subject should be for self-study and may not be used toward part of the grade in a subject, even for extra points or as substitutes for earlier assignments.

For H1 and H3 half-term subjects, there shall be at most one assignment due or one exam held during the final week of the class, to be called the Half-Term Final Examination Period. During this week, and the end of the last regularly scheduled class in the subject: in-class test, assignment, term paper, or oral presentation. This single assignment may include both an oral presentation and a written report if the two derive from the same project. An in-class test given during this period is limited to one normal class period (or to one and one-half hours, whichever is shorter).

For H1 and H3 half-term subjects, the final week of the class shall be called the Half-Term Final Examination Period. During this week, no more than one of the following may be given or fall due between the Friday preceding the start of the Reading Period and the end of the last regularly scheduled class in the subject: in-class test, assignment, term paper, or oral presentation. This single assignment may include both an oral presentation and a written report if the two derive from the same project. An in-class test given during this period is limited to one normal class period (or to one and one-half hours, whichever is shorter).

Students must not be required to attend additional lecture or recitation hours beyond the assigned units to accommodate oral presentations.

**Graduate Subjects**

**Beginning of the Term.** By the end of the third week of classes in a full-term subject and by the end of the second week of classes in a half-term subject, the faculty member must provide:

• A clear and complete description of the required work, including the number and kinds of assignments
• The schedule of tests and due dates for major projects
• An indication of whether or not there will be a final examination
• The grading criteria and procedures to be used

**Tests and Academic Exercise Outside Scheduled Class Times.** A student who is unable to take a test that is held outside of scheduled class time owing to a conflict with another scheduled academic exercise or extracurricular activity must be allowed to do so at another time.

**End-of-Term Tests and Assignments.** For each full-term subject or H2 or H4 half-term subject with a final examination, no test should be given and no assignment, term paper, or oral presentation should fall due after the Friday preceding the start of the Reading Period.

For each full-term subject or H2 or H4 half-term subject without a final examination, no more than one of the following may be given or fall due between the Friday preceding the start of the Reading Period and the end of the last regularly scheduled class in the subject: in-class test, assignment, term paper, or oral presentation. This single assignment may include both an oral presentation and a written report if the two derive from the same project. An in-class test given during this period is limited to one normal class period (or to one and one-half hours, whichever is shorter).

For H1 and H3 half-term subjects, the final week of the class shall be called the Half-Term Final Examination Period. During this week, no more than one of the following may be given or fall due: in-class test, assignment, term paper, or oral presentation. This single assignment may include both an oral presentation and a written report if the two derive from the same project. An in-class test given during this period is limited to one normal class period (or to one and one-half hours, whichever is shorter).

Students must not be required to attend additional lecture or recitation hours beyond the assigned units to accommodate oral presentations.

**Policy for Emergency Closing during Final Exams**

*Every effort must be made to give final exams as scheduled during the final examination period.* Because students have included the final exam in their planning for the subject, faculty members may not choose to cancel exams; they must give the exam as scheduled, or as rescheduled in the event the Institute is closed because of snow or other emergency (see below).

- In case of inclement weather during exams, getting to MIT may be difficult for individuals involved with proctoring an exam. Thus, it is the responsibility of the department and the faculty member in charge to provide in advance for alternate staff who are physically at MIT and who have access to the written exam questions. Exam proctors will accommodate late student arrivals to the extent possible.
- In case of emergency closing or delayed opening during exam week, students, faculty, and staff can go to the final examination schedule ([http://finals.mit.edu](http://finals.mit.edu)) to get up-to-date information. Exam information is also available from the “snow” link that is provided on the MIT home page ([http://web.mit.edu](http://web.mit.edu)) during emergencies.
- If the Institute is closed, the exams scheduled during that period are postponed to the next available “contingency” exam periods, usually evenings 6-9 pm through the last day of the exam period, and either the second day of IAP (for fall exams) or the
day following the exam period (for spring exams). Information about postponed exams will be added to the final examination schedule (http://finals.mit.edu).

- Students who miss exams given at the rescheduled times will be excused; faculty should submit the interim grade O, to which an "X" will be added routinely. These students will take a postponed final exam given near the beginning of the next regular term.

**Student Absence for Religious Observances**

Massachusetts state law regarding student absence due to religious beliefs has been adopted by the Institute as follows:

Any student who is unable to attend classes or participate in any examination, study, or work requirement on a particular day because of his or her religious beliefs is excused from any such activity. The student will be given the opportunity to make up the work that was missed, provided that the makeup work does not create an unreasonable burden upon MIT.

The Institute will not levy fees or charges of any kind when allowing the student to make up missed work. In addition, no adverse or prejudicial effects will result because students have made use of these provisions.

For more information about religious holidays, visit the Registrar’s website (https://registrar.mit.edu/calendar/religious-holidays).

**ACADEMIC PERFORMANCE AND GRADES**

**Undergraduate Academic Standards**

The Committee on Academic Performance (CAP) ensures that the minimum academic standards proposed by the individual departments for undergraduate students are consistent throughout the Institute and conform to the rules and regulations approved by the Faculty. In view of the individual nature of student academic performance, the CAP does not establish rigid standards of academic performance to be used throughout the Institute. The Institute generally expects undergraduate students to complete the requirements for an SB degree in four years; passing an average of 48 units per term for eight terms will accomplish this goal. Normally, however, the CAP accepts a minimum academic record of at least 36 units of credit with a term rating above 3.0 (on a 5.0 scale) at the end of any regular term, unless the Committee has specifically notified an individual student that a higher level of performance is required. (The latter would only occur as a result of previously poor performance.)

When these criteria are not met, the CAP considers each student’s academic performance on an individual basis. Consideration is given not only to the grades received in the subjects for which the student is registered, but also to the total number of subject units, the nature of the subjects themselves, progress toward the degree, and personal or medical factors that may have affected academic performance in a given term. The CAP website (http://web.mit.edu/acadinfo/cap) gives more detailed information concerning end-of-term review procedures. For further information, contact the CAP administrator (cap@mit.edu), Room 7-104, 617-253-4164.

**Undergraduate Academic Standards for Federal Student Financial Assistance**

Per federal regulations, a regular undergraduate student is eligible to receive federal student financial assistance if the student is enrolled at least half time per term and maintains satisfactory academic progress in his or her course of study.


To achieve satisfactory academic progress for purposes of federal student financial assistance, an MIT undergraduate must achieve the following qualitative and quantitative standards:

- Have a cumulative grade point average (GPA) of at least a C (3.0 on MIT’s 5.0 scale); and
- Pass 67% of cumulative units attempted (defined as “pace”); and
- Not exceed 150% of the published length of the program.

Dropped subjects are not included in the GPA or pace calculations. Transfer credit, which carries no grade, is not included in the GPA calculation, but the number of units credited is included in the pace calculation. Incomplete grades are not included in the GPA calculation, but incomplete subjects are included in the pace calculation. Grades for repeated subjects are included in the GPA calculation, but repeated subjects count as only one subject in the pace calculation.

At the end of each term, the Committee on Academic Performance (CAP) considers the academic performance of undergraduate students eligible for federal student financial assistance whose performance falls below any one of the federal standards. After taking special circumstances into account, CAP decides on the appropriate action.

Students on, or eligible for, federal student financial assistance who are placed on academic warning by CAP are concurrently placed by Student Financial Services (SFS) on federal financial aid warning or federal financial aid probation.
The status of federal financial aid warning is assigned to students who were not on academic warning in the prior term, but are now placed on academic warning by CAP. Students on federal financial aid warning may continue to receive federal student financial aid for the academic warning term. Federal financial aid warning status has no effect on the amount of financial aid a student is eligible to receive from MIT, the federal government, or any other source during the federal financial aid warning term.

The status of federal financial aid probation is assigned to students who were on academic warning in the prior term and continue to be placed on academic warning by CAP. Federal regulations mandate that students may only be placed on federal financial aid probation, which allows them to retain eligibility for federal financial aid, after a successful appeal. At MIT, the CAP review of a student’s academic progress and plans constitutes the required appeal process. Any decision by the CAP other than requiring the student to take a required academic leave from MIT constitutes approval of the appeal. Federal financial aid probation status has no effect on the amount of financial aid the student is eligible to receive from MIT, the federal government, or any other source during the federal financial aid probation term.

A student under CAP review will be considered to be making satisfactory academic progress for federal student financial assistance purposes unless the CAP requires the student to take a required academic leave from MIT.

Further information on federal satisfactory academic progress rules can be found on the SFS website (http://sfs.mit.edu).

**Graduate Academic Standards**

It is the responsibility of the Graduate Academic Performance Group (GAPG), operating with the authority of the Committee on Graduate Programs (CGP), to monitor minimum academic standards for graduate students and special students in accordance with the rules and regulations of the Faculty. The GAPG reviews the academic records of all graduate students at the end of each term (including the summer session), giving particular attention to students with cumulative ratings below 3.5 to 4.0. Consideration is given to low grades and factors affecting a student’s ability to meet the requirements for the degree program in which he or she is enrolled. It is each department’s responsibility to inform students about academic performance requirements and expectations.

Recommendations for action by the GAPG are made by departmental graduate committees. Unless extenuating circumstances are found, students who are not making satisfactory progress towards a degree may be denied permission to continue or may be warned that without substantial improvement the following term, they may be refused further registration. In addition, departmental graduate committees may recommend to the GAPG that a student be allowed to register only for a less advanced degree.

More detailed information concerning procedures followed by this standing faculty committee may be found in the online publication, Graduate Policies and Procedures (http://odge.mit.edu/gpp).

**Graduate Academic Standards for Federal Student Financial Assistance**

Per federal regulations, a regular graduate student is eligible to receive federal student financial assistance if the student is enrolled at least half-time per term and maintains satisfactory academic progress in his or her course of study.

Federal student financial assistance for graduate students includes Teacher Education Assistance for College and Higher Education Grants, Federal Direct Unsubsidized Stafford Loans, Federal Direct PLUS Loans for Graduate and Professional Degree Students, and Federal Work-Study.

To achieve satisfactory academic progress for purposes of federal student financial assistance, an MIT graduate student must achieve the following qualitative and quantitative standards:

- Have a cumulative grade point average (GPA) exceeding 4.0 on MIT’s 5.0 scale; and
- Pass 67% of cumulative credit units attempted (defined as “pace”); and
- Make satisfactory progress in his/her academic milestones, as evaluated by his/her graduate program; and
- Not exceed five terms of enrollment for a Master’s candidate and 13 for a PhD or ScD candidate.

Dropped subjects are not included in the GPA or pace calculations. Transfer credit, which carries no grade, is not included in the GPA calculation, but the number of units credited is included in the pace calculation. Incomplete grades are not included in the GPA calculation, but incomplete subjects are included in the pace calculation. Grades for repeated subjects are included in the GPA calculation, but repeated subjects count as only one subject in the pace calculation.

At the end of each term, the Graduate Academic Performance Group (GAPG) considers the academic performance of all enrolled graduate students and decides on the appropriate action for those students not making satisfactory academic performance (e.g. academic warning or denial of further registration). If a student is placed on academic warning, a set of requirements (academic plan) is set forth and communicated to the student for the student to continue to be eligible for enrollment.

Students on, or eligible for, federal student financial assistance who are placed on academic warning by GAPG are concurrently placed by
ACADEMIC PERFORMANCE AND GRADES

Student Financial Services (SFS) on federal financial aid warning or federal financial aid probation.

- The status of federal financial aid warning is assigned to students who were not on academic warning in the prior term, but are now placed on academic warning by GAPG. Students on federal financial aid warning may continue to receive federal student financial assistance for the academic warning term. Federal financial aid warning status has no effect on the amount of financial aid a student is eligible to receive from MIT, the federal government, or any other source during the federal financial aid warning term.

- The status of federal financial aid probation is assigned to students who were on academic warning in the prior term and continue to be placed on academic warning by GAPG. Federal regulations mandate that students may only be placed on federal financial aid probation, which allows them to retain eligibility for federal financial aid, after a successful appeal. At MIT, graduate students on academic warning are encouraged to engage with and provide relevant information to their academic programs during the GAPG review of the students’ academic progress, which constitutes the required appeal process. Any decision by the GAPG other than requiring the student to withdraw from MIT constitutes a continuation of the student's academic plan and enables students to be placed on federal financial aid probation. Federal financial aid probation status has no effect on the amount of financial aid a student is eligible to receive from MIT, the federal government, or any other source during the federal financial aid probation term.

Further information on federal satisfactory academic progress rules can be found on the SFS website (http://sfs.mit.edu).

**Grades**

In determining a student’s grade, consideration is given for elegance of presentation, creativity, imagination, and originality where these may appropriately be called for. Grades at MIT are not awarded according to a predetermined distribution of letter grades; that is, subjects are not graded “on a curve”. The grade for each student should be determined independent of the performance of other students in the class, and should be related to the student’s mastery of the material based on the following grade descriptions.

**Passing Grades.** Undergraduate and graduate students who satisfactorily complete the work of a subject by the end of the term receive one of the following grades:

<table>
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<tr>
<th>Grade</th>
<th>Description</th>
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<tr>
<td>A</td>
<td>Exceptionally good performance demonstrating a superior understanding of the subject matter, a foundation of extensive knowledge, and a skillful use of concepts and/or materials.</td>
</tr>
<tr>
<td>B</td>
<td>Good performance demonstrating capacity to use the appropriate concepts, a good understanding of the subject matter, and an ability to handle the problems and materials encountered in the subject.</td>
</tr>
<tr>
<td>C</td>
<td>Adequate performance demonstrating an adequate understanding of the subject matter, an ability to handle relatively simple problems, and adequate preparation for moving on to more advanced work in the field.</td>
</tr>
</tbody>
</table>

Note that the MIT internal grading system includes plus (+) and minus (-) modifiers for use with the letter grades A, B, and C for all academic subjects (except advanced standing exams). These modifiers appear only on internal grade reports. They do not appear on transcripts and are not used in calculating term or cumulative grade-point averages. The MIT grading system for external purposes does not include modifiers.

**Non-Passing Grades.** The grades and notations used for subjects not passed or not completed by the end of the term are as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Minimally acceptable performance demonstrating at least partial familiarity with the subject matter and some capacity to deal with relatively simple problems, but also demonstrating deficiencies serious enough to make it inadvisable to proceed further in the field without additional work. Some departments require students with D-level performance in certain prerequisite subjects within the departmental program to do additional work, or to retake the prerequisite, before proceeding with the follow-on subject.</td>
</tr>
<tr>
<td>P</td>
<td>When use of the passing grade P is authorized, it reflects performance at the level A, B, or C (A+ to C- with modifiers used within MIT), with the student graded on a P/D/F basis.</td>
</tr>
<tr>
<td>O</td>
<td>Absent. This grade indicates that the student was progressing satisfactorily during the subject but was either (a) absent from the final examination or (b) absent during the last two weeks of the term (for a full-term subject) or the last week of the term (for a half-term subject), or both (a) and (b). An O grade carries no credit for the subject. Unsatisfactory performance because of absence throughout the term should be recorded as F.</td>
</tr>
</tbody>
</table>
OX  Absence satisfactorily explained to and excused by the Office for Undergraduate Education in the case of an undergraduate student or by the Office for Graduate Education in the case of a graduate student. The Faculty member in charge of the subject will notify when an O is changed to an OX. An OX carries no credit for the subject. However, the Faculty member in charge must provide the student the opportunity to receive a credit-carrying grade. This may be done with or without the instructor requiring a postponed final examination or other additional evaluation procedure.

I  Incomplete. The grade I indicates that a minor part of the subject requirements has not been fulfilled and that a passing grade is to be expected when the work is completed. The grade I for the term remains permanently on the student’s record even when the subject is completed. The work should normally be completed before Add Date of the succeeding term of the regular academic year; however, the faculty member in charge, in negotiation with the student, has the right to set an earlier or later date for pedagogical reasons or extenuating circumstances. Graduate students may extend the five-week deadline with the explicit approval of the faculty member in charge.

The instructor is required to submit an Instructor’s Report Form for a grade of I reported for an undergraduate. On the form, the instructor provides the date by which the outstanding work is to be completed and a default final grade. The default final grade represents the grade the student would have earned, using appropriately low scores for the missing work. If the subject has not been completed by Add Date of the succeeding regular term, the default final grade will be posted to the student’s record unless a later deadline has been specifically agreed upon by the instructor and the student.

No grade of I can be assigned to any undergraduate in the term in which he or she graduates. All grades of Incomplete must be resolved prior to graduation.

J  Notation assigned for work such as thesis, UROP, Special Subjects, or At Plant registration (internship or industrial practice), which has progressed satisfactorily, but has not been completed. Grade given upon completion of the work in a later term also covers this term. Faculty members must obtain approval from the Committee on Curricula or the Graduate Academic Performance Group to use the grade of J in subjects other than those mentioned above.

U  Notation for thesis work that has not been completed and in which progress has been unsatisfactory. Grade given upon completion of the work in a later term also covers this term. Unless a student’s progress improves significantly, the student may expect that grade to be failing.

T  Temporary notation. Used for subjects which cover the equivalent of one term’s work, but are scheduled over parts of two normal grading periods. Prior approval must have been obtained from the Committee on Curricula for undergraduate subjects or the Committee on Graduate Programs for graduate subjects. This notation is recorded only on the student’s internal record. A permanent grade must be assigned when the subject is finished.

Other Notations. The following notations are also used on the academic record.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Notation for credit awarded for work done elsewhere.</td>
</tr>
<tr>
<td>SA</td>
<td>Notation for satisfactorily completed doctoral thesis. Doctoral theses are not graded.</td>
</tr>
<tr>
<td>DR</td>
<td>Notation used only on the student’s internal record for a subject dropped after the fifth week of the regular term for full-term subjects, or after the second week of instruction for half-term subjects.</td>
</tr>
<tr>
<td>LIS</td>
<td>Notation used only on the student’s internal record for a subject the student registered for as a listener.</td>
</tr>
<tr>
<td>URN</td>
<td>Notation for a subject in UROP taken for pay or as a volunteer rather than academic credit.</td>
</tr>
<tr>
<td>VIS</td>
<td>Notation for a research subject taken as a non-degree visiting student.</td>
</tr>
</tbody>
</table>

Alternate Grades. When a significant disruption of academic activities is declared, as described in the Rules and Regulations of the Faculty (http://web.mit.edu/faculty/governance/rules/2.100.html), the use of the grades below may be authorized. These grades are not included in the calculations of grade point averages.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>Performance at any of the levels A, B, or C, under the circumstance of an Institute emergency closure.</td>
</tr>
<tr>
<td>NE</td>
<td>Performance at the level of D or F for which no record will appear on the external transcript.</td>
</tr>
<tr>
<td>IE</td>
<td>Incomplete. Indicates that a portion of the subject requirements has not been fulfilled, due to a major disruption of the Institute’s academic activities. A letter grade may be assigned if the work is subsequently completed. The grade IE remains permanently on the student’s record even when the subject is completed. To receive a letter grade, the work must be completed prior to a date set by the Chair of the Faculty. If the work is not completed prior to the established completion date, the grade will remain an IE on the student’s record and transcript. A grade of IE does not carry credit but need not be resolved prior to graduation.</td>
</tr>
</tbody>
</table>
Additional information regarding freshman grading, hidden grades, and the sophomore exploratory and junior-senior P/D/F grading options is available in the Undergraduate Education section.

Grade Reports and Transcripts

Students may view their internal grade reports on WebSIS. Transcripts are available in an unofficial version free of charge or in an official version at a cost currently set at $8 per copy. Students wishing to request a copy of their academic record should see the Registrar’s Office website (http://web.mit.edu/transcripts).

GRADUATION

Degrees are awarded by the Corporation of the Institute in September, February, and June upon recommendation of the Faculty. Favorable faculty action is based upon approval by the Committee on Academic Performance or the Committee on Graduate School Programs on recommendations from departmental committees.

Students must submit an online SB degree application or advanced degree application by the deadline for each regular term or the summer session, as established in the academic calendar. A degree will not be awarded unless all financial obligations to the Institute are clear and there are no pending disciplinary actions.

More information is available on the Registrar’s website (https://registrar.mit.edu/graduation).
INSTITUTE REGULATIONS

MIT is a community dedicated to scholarship and leadership. Student members of this community are expected to reflect upon and uphold these principles in all academic and non-academic endeavors.

MIT expects all students to be responsible individuals who conduct themselves with high standards of honesty, fairness, respect, integrity, and accountability in both their academic and non-academic lives. Students are expected to uphold a high standard of civility and to demonstrate their respect for all members of this diverse community. These expectations are fundamental to learning and professional growth, and to the maintenance of a healthy living and learning environment.

POLICIES AND PROCEDURES

Academic Integrity

Cheating, plagiarism, unauthorized collaboration, and other forms of academic dishonesty are considered serious offenses for which disciplinary penalties can be imposed.

Early in the term, the instructor should communicate specific expectations regarding academic conduct and collaboration in the subject. See the information on Term Regulations.

The Institute encourages faculty to take responses to academic dishonesty seriously, while also evaluating each case individually for the most appropriate response. In all cases, documenting the outcome with the Office of Student Conduct ensures that records of student misconduct are maintained centrally at the Institute, preventing an individual student from committing several instances of academic dishonesty without accountability. The Handbook for Academic Integrity can be found online (http://integrity.mit.edu).

Several degrees of response are available, all of which help uphold the integrity of the Institute and all students’ learning experiences. The Office of Student Conduct is responsible for facilitating these responses for faculty, as well as maintaining documentation within the Institute on the incident and response. Information for faculty regarding the options for handling academic integrity violations is online (https://studentlife.mit.edu/osc/faculty/academic-misconduct).

Voter Registration

Voter registration forms and instructions (https://registrar.mit.edu/transcripts-records/personal-information/voter-registration) are available in the Student Services Center, Room 11-120.

Institute Policy on Harassment

In order to create a respectful, welcoming and productive community, the Institute is committed to providing a living, working and learning environment that is free from harassment.

Harassment is defined as unwelcome conduct of a verbal, nonverbal or physical nature that is sufficiently severe or pervasive to create a work or academic environment that a reasonable person would consider intimidating, hostile or abusive and that adversely affects an individual’s educational, work, or living environment.

More information on MIT’s policy on Harassment can be found in Policies & Procedures Sec. 9.4, (http://web.mit.edu/policies/9/9.4.html) including detail on Sexual Misconduct, Sexual Harassment and Gender-Based Harassment.

Institute Policy on Hazing

MIT prohibits hazing by individuals or groups and defines it as follows: Any action or activity that is reasonably likely to, or is intended to, endanger the physical or mental health of a person for the purpose of initiation, admission into, affiliation with, or as a condition for continued membership in a group, organization, or living community. This definition shall apply regardless of location or consent of participants. Hazing includes, without limitation, behaviors that violate Massachusetts General Laws Chapter 269, Sections 17-19 (reproduced in their entirety below).

Endangering mental health is defined as sleep deprivation, extended isolation, public degradation, intimidation, creation of artificial and excessive stress, public nudity, and other comparable behaviors that are reasonably likely to, or are intended to, cause a significant degree of distress, disgrace, anguish, or interference with academic, professional, or personal pursuits.

Apathy or acquiescence in the presence of hazing are not neutral acts and constitute hazing as prohibited by this policy. Students and other members of the Institute community must report incidents of hazing that they witness or for which they were present. Incidents of hazing shall be reported to an appropriate law enforcement official and the Office of Student Conduct. Failure to report incidents of hazing is a violation of this policy and may be a violation of Massachusetts law (M.G.L. c. 269 Section 18).

Any retaliation against any person who reports, is a witness to, is involved with, or cooperates with the adjudication of hazing is strictly prohibited.

Prohibited forms of hazing include but are not limited to:

- **Subtle Hazing:** Behaviors that emphasize a power imbalance between new members and other members of the group or community. This is termed “subtle hazing” because these types of hazing are often taken for granted or accepted as
“harmless” or meaningless. Subtle hazing typically involves activities or attitudes that breach reasonable standards of mutual respect and place new members on the receiving end of ridicule, embarrassment, and/or humiliation tactics. New members often feel the need to endure subtle hazing to feel like part of the group or community.

Examples of subtle hazing include but are not limited to:
- Deception
- Silence periods
- Deprivation of privileges
- Social isolation
- Name calling
- Assignment of duties not assigned to other members.

**Harassment Hazing:** Behaviors that cause emotional anguish or physical discomfort in order to feel like part of the group. Harassment hazing often confuses, frustrates, and causes undue stress for new members.

Examples of harassment hazing include but are not limited to:
- Verbal abuse
- Threats or implied threats
- Sexual simulations
- Requiring situationally inappropriate attire
- Sleep deprivation.

**Violent Hazing:** Behaviors that do or could cause physical or psychological harm.

Examples of violent hazing include but are not limited to:
- Placing students in the shower against their will
- Forced or coerced alcohol or other drug consumption
- Forced or coerced sexual acts
- Beating
- Paddling, or other forms of assault
- Forced or coerced ingestion of vile substances
- Bondage
- Kidnapping
- Expected participation in illegal activity.

The sanction of disciplinary suspension or disciplinary expulsion will be strongly considered for individuals or groups found responsible for hazing.

In addition to the foregoing, students are advised that the following is the Massachusetts law on hazing:

Whoever is a principal organizer or participant in the crime of hazing, as defined herein, shall be punished by a fine of not more than three thousand dollars or by imprisonment in a house of correction for not more than one year, or both such fine and imprisonment.

The term “hazing” as used in this section and in sections eighteen and nineteen, shall mean any conduct or method of initiation into any student organization, whether on public or private property, which willfully or recklessly endangers the physical or mental health of any student or other person. Such conduct shall include whipping, beating, branding, forced calisthenics, exposure to the weather, forced consumption of any food, liquor, beverage, drug or other substance, or any other brutal treatment or forced physical activity which is likely to adversely affect the physical health or safety of any such student or other person, or which subjects such student or other person to extreme mental stress, including extended deprivation of sleep or rest or extended isolation. Notwithstanding any other provisions of this section to the contrary, consent shall not be available as a defense to any prosecution under this action.” M.G.L. c. 269 Section 17.

Whoever knows that another person is the victim of hazing as defined in section seventeen and is at the scene of such crime shall, to the extent that such a person can do so without danger or peril to himself or others, report such crime to an appropriate law enforcement official as soon as reasonably practicable. Whoever fails to report such crime shall be punished by a fine of not more than one thousand dollars.” M.G.L. c. 269 Section 18.

Each institution of secondary education and each public and private institution of post secondary education shall issue to every student group, student team or student organization which is part of such institution or is recognized by the institution or permitted by the institution to use its name or facilities or is known by the institution to exist as an unaffiliated student group, student team or student organization, a copy of this section and sections seventeen and eighteen; provided, however, that an institution’s compliance with this section’s requirements that an institution issue copies of this section and sections seventeen and eighteen to unaffiliated student groups, teams or organizations shall not constitute evidence of the institution’s recognition or endorsement of said unaffiliated student groups, teams or organizations.

Each such group, team or organization shall distribute a copy of this section and sections seventeen and eighteen to each of its members, plebes, pledges or applicants for membership. It shall be the duty of each such group, team or organization, acting through its designated officer, to deliver annually, to the institution an attested acknowledgement stating that such group, team or organization has received a copy of this section and said sections seventeen and eighteen, that each of its
members, plebes, pledges, or applicants has received a copy of sections seventeen and eighteen, and that such group, team or organization understands and agrees to comply with the provisions of this section and sections seventeen and eighteen.

Each institution of secondary education and each public or private institution of post secondary education shall, at least annually, before or at the start of enrollment, deliver to each person who enrolls as a full time student in such institution a copy of this section and sections seventeen and eighteen.

Each institution of secondary education and each public or private institution of post secondary education shall, at least annually, a report with the board of higher education and in the case of secondary institutions, the board of education, certifying that such institution has complied with its responsibility to inform student groups, teams or organizations and to notify each full time student enrolled by it of the provisions of this section and sections seventeen and eighteen and also certifying that said institution has adopted a disciplinary policy with regard to the organizers and participants of hazing, and that such policy has been set forth with appropriate emphasis in the student handbook or similar means of communicating the institution’s policies to its students. The board of higher education and, in the case of secondary institutions, the board of education shall promulgate regulations governing the content and frequency of such reports, and shall forthwith report to the attorney general any such institution which fails to make such report. M.G.L. c. 269 Section 19.

For further information about hazing and hazing prevention efforts at MIT, visit MIT's hazing resources website (http://hazefree.mit.edu) contact the Office of Student Outreach and Support in W20-507 or 617-253-3276.

Please note there is a confidential form to report hazing (https://hazefree.mit.edu/hazing-reporting-form) available for public use.

Other Personal Conduct

The Institute promotes the principle that every person brings unique qualities and talents to the community and that every individual should be treated in a respectful manner. All members of the MIT community are expected to conduct themselves with professionalism, personal integrity, and respect for the rights, differences and dignity of others. These standards of personal conduct apply to all communications, whether oral, written, or in gestures. Community members are also expected to treat the property of both the Institute and other community members with appropriate care and respect. More information on MIT’s policy on Personal Conduct and Responsibilities towards Members of the MIT Community can be found in Policies & Procedures Sec. 9.1 (http://web.mit.edu/policies/9/9.1.html).

The Institute reserves the right to take any action that it deems necessary or appropriate to protect the intellectual integrity, safety, and well-being of the campus community including interim measures such as temporary suspension. To that end, MIT students are expected to abide by the rules, regulations, and policies of the Institute, as well as city, state, and federal laws. Students are expected to be familiar with the Institute’s expectations of them, which are found in the MIT Bulletin, in the Mind and Hand Book (http://studentlife.mit.edu/mindandhandbook), and in the Institute Policies and Procedures (http://web.mit.edu/policies).

MIT expects that members of the MIT community will not engage in behavior that endangers their own sustained effectiveness or that has serious ramifications for their own physical and mental health, safety, welfare, academic well-being, professional obligations, or for that of others. In situations where an individual student’s physical illness or emotional difficulties affect not only the student, but also others in the community, it is the Institute’s responsibility to consider the well-being of the community as well as the individuals in care decisions.

Off-campus misconduct may be a basis for MIT disciplinary action if the Institute considers that such alleged misconduct may have violated Institute policy and expectations of civility, integrity, and respect. Student status in no sense renders an individual student immune from the jurisdiction of civil or criminal courts and other governmental authorities. MIT actions will take into account applicable law as well as the policies and procedures of the Institute and the standards of behavior expected of members of the educational community.

MIT handles internally some incidents that might give rise to civil or criminal liability. This is done with the understanding by the outside community that MIT deals seriously with such offenses. As is the case for many universities, local authorities often rely on MIT to resolve such issues as long as the internal policies and procedures are effective and adequate. MIT action by itself, however, does not preclude the possibility of other judicial remedy.

If an infraction causes a student to be involved both in Institute disciplinary proceedings and in criminal proceedings, the Institute generally will not delay or stop the internal process until after the criminal proceedings have been concluded.

For more information, contact the Office of Student Conduct (OSC) (citizenship@mit.edu), Room W20-507, 617-258-8423.

Complaint and Disciplinary Procedures

Students who believe that they have been treated improperly for any reason are encouraged to raise their concerns. Difficulties with other students can be pursued through the living group, department head, other appropriate venues or groups, and the Office of Student Conduct (OSC) (https://studentlife.mit.edu/osc), Room W20-507.
617-258-8423. Students may also bring concerns to the attention of an Ombudsperson (http://web.mit.edu/ombud).

It is the Institute’s policy that individuals will not be retaliated against for initiating an inquiry or complaint in good faith.

Anyone—including individual students, faculty members, and employees of the Institute—may bring a formal complaint against a student to the Committee on Discipline (COD) (http://cod.mit.edu). The COD reviews cases of academic offenses, violations of Institute regulations and standards, and other infractions alleged to have been committed by students.

A formal complaint against a student must be submitted to OSC. The charge and its documentation are transmitted to the chair of the COD. After a review of the documentation, the chair will decide the appropriate method of resolution. The COD has the authority to impose any sanction it deems appropriate. Possible sanctions include placing a letter in a student’s disciplinary file, probation, suspension, and expulsion. Sanctions may also include educational and/or restorative components meant to address the wrongdoing and serve the larger community. Detailed procedures for resolving complaints alleging that a student has violated MIT policies are available from the OSC (https://studentlife.mit.edu/osc) and from the COD.

This procedure serves also as the grievance procedure for students as required by Title IX of the Higher Education Act of 1972 with regard to grievances arising out of alleged discrimination on the basis of sex, and for disabled students alleging failure to comply with Sections 503 and 504 of the Rehabilitation Act of 1973, and the Americans with Disabilities Act of 1990.

A complaint against anyone employed by MIT may be discussed with the immediate or higher supervisor in the center, lab, department, or school where the concern arose, with an Administrative Officer (AO) if applicable, or with the Human Resources Office on campus or at Lincoln Laboratory. A written request for a formal review of a complaint should be made to a human resources officer.

### PRIVACY OF STUDENT RECORDS

MIT adheres to the Family Educational Rights and Privacy Act of 1974 (FERPA) which governs the release of and access to student education records. FERPA affords students the right to have access to their education records, the right to seek to have their records amended, and the right to have some control over the disclosure of personally identifiable information from their education records. In accordance with FERPA, MIT has set the following definitions and policies regarding the release of student education records.

### Education Records

Under FERPA, “education records” are defined as records that are directly related to a student and are maintained by an educational agency or institution, or by a party acting for the agency or institution. Education records can exist in any medium, including: typed, handwritten, digital, computer generated, videotape, audiotape, film, microfilm, microfiche, and email, among others.

As described more fully in FERPA, records that are kept in the sole possession of the maker and not shared with others, certain medical treatment records, law enforcement unit records, certain employment records, and records created or received after an individual is no longer a student and which are not directly related to the individual’s attendance as a student are not education records and therefore are not governed by FERPA.

### Directory Information

MIT defines Directory Information as follows:

- Name
- Address (term and permanent)
- MIT office address
- Term phone number
- Term email address
- Date of birth
- Course
- Year and registration type
- Degrees received
- Dates of attendance
- Any honors and awards received
- Height and weight for an intercollegiate athletic team member

In accordance with FERPA, MIT may disclose Directory Information without a student’s consent and without a record being made of these disclosures. MIT acknowledges that date of birth, while Directory Information, may be considered somewhat more sensitive to some community members and therefore reasonable efforts should be made to release date of birth only to those who have a legitimate need to obtain such information.

Students may withhold their Directory Information from disclosure. Information on the procedure to be followed is available on the Registrar’s Office website (https://registrar.mit.edu/transcripts-records/records-privacy-access/ferpa/suppressing-directory-information).

### Disclosure Of Education Records

In general, the Institute may not disclose personally identifiable information from a student’s education records without the student’s prior consent. However, FERPA allows the Institute to disclose such information under the following conditions, among others:

- To Institute officials, staff, and others engaged in activities on behalf of the Institute with a legitimate educational interest
• In connection with a health or safety emergency
• In compliance with a subpoena, provided certain conditions are met
• To officials of other academic institutions to which a student seeks or intends to enroll or in which they are concurrently enrolled
• To authorized representatives of certain federal, state and local government agencies

MIT does not usually disclose information from education records to a student's parents or guardians unless the student requests or consents to the disclosure. In certain situations, appropriate MIT officials may disclose information when such disclosure seems important for the well-being of the student or others (e.g., in a health or safety emergency).

Schools, academic departments, laboratories, and centers that have longstanding traditions of public disclosure of student work for pedagogical purposes (e.g., products of design studios, collaborative/team class work, and graduate research results and reports) may make such work publicly available but should bring this to their students' attention in advance and give them the opportunity to opt out of the disclosure if it will not otherwise constrain the educational process.

Unless otherwise required by law, MIT will not share library circulation records and other records that identify the intellectual pursuits of a student, even within the Institute.

Inspection of Education Records

Students have the right to inspect and review their education records. Requests to inspect records can be submitted to the Registrar’s Office (records@mit.edu?subject=Inspection of Education Records). MIT does not maintain education records in any one central office but the Registrar’s Office will provide contact details of the appropriate official in each office to the requesting student. Requests for access will receive a response within 45 days and the student will be notified of the time and place where the records may be inspected.

Students do not have the right to access certain records, such as:

• Confidential letters of recommendation if the student has waived the right of access in writing
• Records of Institute faculty and staff members that are made for, and restricted to, their personal use
• Parents' financial records
• Records that also contain information on other students. Unless otherwise permitted or required by law, students may only inspect, review, or be informed of information directly related to themselves.

Amending Education Records

Students have the right to have their education records maintained accurately and may request amendment of records that they believe are inaccurate, misleading, or in violation of their rights under FERPA. Requests for amendment should be submitted to the custodian of the record or through the Registrar's Office (records@mit.edu?subject=Amendment of Education Records). If the office to which the request is presented decides not to amend the record, the student may request a hearing. If, after such a hearing, the record is not amended as the student requests, the student may submit a statement to be included with the record commenting on the information and stating disagreement with the decision not to amend the record as requested.

The process of amending records or requesting hearings applies only to information that has been recorded inaccurately, incorrectly, or that violates the student's rights under FERPA. It is not a process to appeal grades or other subjective judgments with which a student disagrees but that have been recorded correctly.

Complaint Procedure

Students have the right to file a complaint with the Family Policy Compliance Office of the US Department of Education concerning alleged failures by the Institute to comply with the requirements of FERPA. Complaints must be submitted within 180 days of the date of the alleged violation or of the date that the student knew or reasonably should have known of the alleged violation, and must contain specific factual allegations giving reasonable cause to believe that a violation of FERPA has occurred. Complaints may be sent to:

Family Policy Compliance Office
US Department of Education
400 Maryland Avenue, SW
Washington, DC 20202-4605
RESEARCH AND STUDY

Research can be an invaluable way to broaden a student's education. Through the Undergraduate Research Opportunities Program (http://web.mit.edu/urop), undergraduates discover avenues for participation in research projects that can count toward their major, including possibilities for thesis work. For graduate students, research opportunities can often lead to thesis topics—and research assistantships—as well as advanced degrees.

Some interdepartmental educational programs have been approved for graduate students by the Committee on Graduate Programs. Students must be admitted by a regular academic department in order to participate in one of these programs (with the exception of the Operations Research Center, which accepts students directly). Each has a standing faculty committee that administers the program, but degrees in the field of study are granted by the student's department of registration. The program descriptions in this section indicate any advanced degrees that may be offered.

MIT Centers, Labs, and Programs, and Affiliated Institutions

- Abdul Latif Jameel Poverty Action Lab (p. 89)
- Broad Institute of MIT and Harvard (p. 89)
- Center for Archaeological Materials (p. 89)
- Center for Bits and Atoms (p. 90)
- Center for Collective Intelligence (p. 90)
- Center for Computational Engineering (p. 90)
- Center for Energy and Environmental Policy Research (p. 91)
- Center for Environmental Health Sciences (p. 91)
- Center for Global Change Science (p. 91)
- Center for International Studies (p. 92)
- Center for Real Estate (p. 93)
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- Clinical Research Center (p. 95)
- Computer Science and Artificial Intelligence Laboratory (p. 95)
- Concrete Sustainability Hub (p. 95)
- D-Lab (p. 96)
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- Division of Comparative Medicine (p. 97)
- Draper (p. 97)
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- Initiative on the Digital Economy (p. 98)
- Institute for Medical Engineering and Science (p. 98)
- Institute for Soldier Nanotechnologies (p. 98)
- Institute for Work and Employment Research (p. 99)
- Internet Policy Research Initiative (p. 99)
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- Knight Science Journalism Program (p. 100)
- Koch Institute for Integrative Cancer Research (p. 101)
- Laboratory for Financial Engineering (p. 101)
- Laboratory for Information and Decision Systems (p. 102)
- Laboratory for Manufacturing and Productivity (p. 102)
- Laboratory for Nuclear Science (p. 102)
- Legatum Center for Development and Entrepreneurship (p. 103)
- Lincoln Laboratory (p. 104)
- Martin Trust Center for MIT Entrepreneurship (p. 104)
- Materials Research Laboratory (p. 104)
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- Microsystems Technology Laboratories (p. 105)
- MIT Center for Art, Science, and Technology (p. 105)
- MIT Energy Initiative (p. 106)
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- MIT Kavli Institute for Astrophysics and Space Research (p. 107)
- MIT Media Lab (p. 108)
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- Nuclear Reactor Laboratory (p. 110)
- Operations Research Center (p. 110)
- Picower Institute for Learning and Memory (p. 111)
- Plasma Science and Fusion Center (p. 111)
- Research Laboratory of Electronics (p. 112)
- Simons Center for the Social Brain (p. 113)
- Singapore-MIT Alliance for Research and Technology Centre (p. 113)
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ABDUL LATIF JAMEEL POVERTY ACTION LAB

Despite massive investments in development programs over the last 70 years, more than 700 million people across the globe still live in extreme poverty. Improving their lives through better programs and policies is the mission of the Abdul Latif Jameel Poverty Action Lab (J-PAL) (https://www.povertyactionlab.org) at MIT.

J-PAL’s affiliated professors and staff believe that essential questions of social policy—e.g., effectively reducing the dropout rates of girls in Peru, increasing the yields of small farmers in Kenya, boosting immunization rates in India, or preventing crime in US cities—can be answered through rigorous empirical evaluation and innovation. J-PAL works closely with governments and non-profits to design new programs and improve existing ones, scientifically test whether these programs work in practice, help scale up effective programs, and institutionalize a culture of evidence-informed policymaking.

Founded at MIT’s Economics Department in 2003, J-PAL is directed by MIT researchers Abhijit Banerjee, Esther Duflo, Rachel Glennerster, and Benjamin Olken, some of the world’s foremost development economists. The J-PAL network now includes more than 160 affiliated professors around the world. J-PAL affiliates have conducted more than 800 evaluations in 58 countries. More than 300 million people have been reached by programs shown to be successful through J-PAL evaluations.

MIT students can be involved with J-PAL’s work in various ways:

- **Undergraduates**: J-PAL hosts 10 to 15 UROPs annually. UROPs provide valuable assistance to J-PAL projects while allowing students to gain practical experience in data analysis. UROP positions are available through the academic year, IAP, and the summer period.

- **New graduates**: J-PAL hires highly qualified graduates with strong backgrounds in economics for entry-level positions in research, policy, and training. Though not reserved for MIT students, MIT graduates are strong candidates for positions at J-PAL in Cambridge or with our international partners.

- **Graduate students**: J-PAL staff and economics faculty support graduate student research by advising on project design and analysis, particularly during weekly Development Lunches and Development Teas. J-PAL partner offices around the world work with MIT graduate students to implement projects, find partners, and hire local staff.

- **Postdoctoral fellows**: J-PAL hosts several postdoctoral students in cooperation with the Prize Fellowship in Economics, History, and Politics at Harvard, and also provides grant-funded fellowships directly.

Contact J-PAL (info@povertyactionlab.org) for further information.

BROAD INSTITUTE OF MIT AND HARVARD

The Broad Institute of MIT and Harvard (http://www.broadinstitute.org) seeks to transform medicine by empowering creative and energetic scientists of all disciplines from across the MIT, Harvard, and the Harvard-affiliated hospital communities to work together to address even the most difficult challenges in biomedical research.

Faculty members at the Broad Institute are faculty members at MIT, Harvard, or one of the Harvard-affiliated hospitals and have teaching and other responsibilities at their home institution. Currently there are 12 core faculty members whose primary laboratory is located at the Broad, and over 300 associate members whose primarily lab is located at one of the affiliated universities or hospitals.

The Broad Institute is also home to many postdoctoral and graduate students who perform some or all of their research at the Broad Institute, although graduate students earn their degrees from their respective home institutions. In addition, the Broad Institute offers numerous research opportunities for undergraduate and high school students. To learn more about these programs, visit the Broad website.

The Broad Institute primary research labs are at 415 Main Street (across the street from MIT’s Biology Department and adjacent to the Whitehead Institute), at 320 Charles Street, and at 75 Ames Street.

Further information may be obtained by contacting the Broad Institute Communications Office at 617-714-7000.

CENTER FOR ARCHAEOLOGICAL MATERIALS

The purpose of the Center for Archaeological Materials (http://web.mit.edu/cmrae/cmrae_home.htm) is to encourage incorporation of the natural sciences and engineering in the normal pursuit of anthropological, archaeological, and art historical inquiry.

The center’s particular emphasis is on examining and explaining the nature of prehistoric and non-industrial technologies, especially those technologies of unusual importance in the development of ancient and pre-industrial societies. The center considers not only technologies of subsistence, communication, and production, but technologies whose purposes are largely symbolic, such as information-bearing technologies of art.

The center is concerned with the remains of human activities in the past and the exploration of the imprint of these activities on the environment: what people did in the environment and what the environment was like. Determination of palaeoecologies—climates, floral and faunal populations, food chains, and so forth—provides a strong research focus. The center uses as its evidence all of material culture, and explores cultural and environmental materials through the most up-to-date methods common to chemistry,
physics, biology, geology, and materials science and engineering, in conjunction with appropriate mathematical and statistical analyses.

The center’s teaching and research programs incorporate materials science and engineering among the range of methods that archaeologists use to try to render culture history, cultural lifeways, and culture process from what little is preserved of society’s material culture. Research activities are carried out in a network of materials laboratories that include metallurgy, ceramics, photomicrography, and computation. The center emphasizes rigorous laboratory study of artifacts and other kinds of cultural remains to determine the nature and structure of the materials of which they are composed and the extraction and processing regimes they have undergone.

Open to graduate students and senior undergraduates, the center offers graduate-level subjects in the Graduate Archaeological Science Laboratory. Subjects are heavily laboratory-oriented and often cover a single class of materials (e.g., ceramics or metals), or a method for interpreting archaeological data (e.g., computers in archaeology).

The center is administered by the Office of the Provost. Further information about the center may be obtained from the director, Professor Heather Lechtman, Department of Materials Science and Engineering, Room 8-138, 617-253-2172.

CENTER FOR BITS AND ATOMS

MIT’s Center for Bits and Atoms (CBA) (http://cba.mit.edu) is an interdisciplinary initiative exploring the boundary between computer science and physical science. CBA studies how to turn data into things, and things into data. Its personnel have participated in projects ranging from the creation of among the first quantum computers and synthetic organisms, to the invention of microfluidic bubble logic and physical one-way cryptographic functions, up to the development of intelligent infrastructure and the automated assembly of discrete materials for record-setting ultralight aero and space structures.

CBA is funded by a mix of government agencies, corporate sponsors, and international collaborations. It was launched by a National Science Foundation award to create a unique digital fabrication facility that gathers tools across disciplines and length scales for making and measuring things. These include electron microscopes and focused ion beam probes for nanostructures, laser micromachining and X-ray microtomography for microstructures, and multi-axis machining and multi-material 3D printing for macrostructures. These are supported by instrumentation for processing and characterizing materials and devices, and infrastructure for high-performance computing and communication.

CBA’s tools are used to teach the popular rapid-prototyping subject MAS.863[J] How To Make (almost) Anything, and its capabilities are shared through an outreach program to establish community fab labs, which have grown into a global network of over 1,000 sites.

CBA’s students apply to work in participating research groups through associated academic departments. Most of its graduate students are fully funded by research assistantships, and undergraduate students are supported through MIT’s Undergraduate Research Opportunities Program (UROP) (p. 44).

CBA is directed by Professor Neil Gershenfeld. Its office is located in E15-401, and may be contacted at (617) 253-0392 or via email (cba_info@cba.mit.edu).

CENTER FOR COLLECTIVE INTELLIGENCE

The MIT Center for Collective Intelligence (CCI) (http://cci.mit.edu) brings together faculty from across MIT to conduct research on how new information technologies, especially the internet, now allow huge numbers of people all over the world to work together in new ways. The center’s basic research question is: How can people and computers be connected so that—collectively—they act more intelligently than any individuals, groups, or computers have ever done before?

This first-of-its-kind research effort draws on the strengths of many diverse organizations across MIT including the MIT Media Lab, the Computer Science and Artificial Intelligence Laboratory, the Department of Brain and Cognitive Sciences, and the MIT Sloan School of Management.

CCI frequently employs graduate students and undergraduates to assist with its research projects.

CCI is directed by Professor Thomas W. Malone. For further information about the center or about student employment opportunities, contact Robert Laubacher (rjl@mit.edu), 617-253-0526.

CENTER FOR COMPUTATIONAL ENGINEERING

The broad mission of the Center for Computational Engineering (CCE) (http://computationalengineering.mit.edu) is to support computational engineering at MIT. The center is comprised of faculty and research partners from across the School of Engineering as well as other departments and units involved in computational engineering research and education around the Institute.

The center’s research focus is on computational approaches for engineering problems: the formulation and implementation of new approaches that are more efficient and capable, and the informed application of existing approaches to important engineering questions. Our emphasis is on the development of
the next generation of computational engineering innovators and computational engineering innovations.

CCE oversees a master’s program in Computation for Design and Optimization (CDO) (p. 368) and a doctoral program in Computational Science and Engineering (CSE) (p. 370). CDO is an interdisciplinary program that provides students with a strong foundation in computational methods for the design and operation of complex engineered systems. The CSE PhD program allows students to specialize in a computation-related field of their choice through focused coursework and a doctoral thesis. The CSE program is offered through a number of participating departments, including Aeronautics and Astronautics, Chemical Engineering, Civil and Environmental Engineering, Mathematics, Mechanical Engineering, and Nuclear Science and Engineering.

For more information about the Center for Computational Engineering, the CDO SM program, and the CSE PhD program, contact Kate Nelson (cdo_info@mit.edu), Room 35-434, 617-253-3725.

CENTER FOR ENERGY AND ENVIRONMENTAL POLICY RESEARCH

Since 1977, the Center for Energy and Environmental Policy Research (CEEPR) (http://ceeer.mit.edu) has been a focal point for research on energy and environmental policy at MIT. CEEPR promotes rigorous, objective research for improved decision making in government and the private sector, and secures the relevance of its work through close cooperation with industry partners from around the globe. Drawing on the unparalleled resources available at MIT, affiliated faculty and research staff as well as international research associates contribute to the empirical study of a wide range of policy issues related to energy supply, energy demand, and the environment. Research outputs include working papers, policy briefs, and contributions to larger interdisciplinary studies that leverage MIT’s unique research capabilities across the sciences and engineering. Additional dissemination channels include workshops, educational programs, and public outreach activities.

CEEPR is jointly sponsored at MIT by the MIT Energy Initiative, the Department of Economics, and the Sloan School of Management. Financial support comes from a variety of sources, including state and federal government research funds, foundation grants, and contributions from our corporate and government associates. CEEPR is directed by Professor Christopher R. Knittel. For more information, contact the executive director, Joshua Hodge, Room E39-411, 617-324-7354, or email (ceehr@mit.edu) us.

CENTER FOR ENVIRONMENTAL HEALTH SCIENCES

The Center for Environmental Health Sciences (CEHS) (http://cehs.mit.edu) consists of approximately 38 research groups across MIT and one group at the Broad Institute that work to address the effects of hazardous agents in the environment on humans and the human ecosystem. A signature element of our research portfolio is the integration of science, engineering and policy to solve complex problems in environmental health. The center is funded primarily by the National Institute of Environmental Health Sciences, which is part of the National Institutes of Health.

The CEHS program encompasses five research themes: DNA damage, DNA repair, and genomic stability; microbiomes and environmentally induced disease susceptibility; inflammation chemistry and biology; bioengineering for environmental health; and chemistry and transport of pollutants in the atmosphere, water, and soil. Traction on our research themes is enabled by four Facilities Cores, which provide state-of-the-art technology or approaches to research problems in the following areas: animal models; biomaging and chemical analysis; genomics and informatics; and integrative health sciences. The CEHS runs a robust pilot project program that stimulates integration of new ideas and early-stage investigators into the CEHS mission. The center also has a global environmental health program, several seminar and poster presentation activities, a career development program, and a responsible conduct of research training program. Lastly, a central component of our mission is to engage our local community bi-directionally in our activities through our Community Outreach Education and Engagement Core.

Graduate and undergraduate courses dealing with toxicology and environmental health are offered mainly through the Department of Biological Engineering (p. 158), which also manages MIT undergraduate minor in toxicology and environmental health. The CEHS also partners with many departments in the Schools of Science and Engineering to create cross-disciplinary opportunities in environmental health science and engineering. The PhD program offered by the Department of Biological Engineering integrates chemistry, molecular biology, and genetics with bioengineering approaches to the understanding of how organisms respond to environmental agents. The CEHS also manages a T32 Training Grant in Environmental Toxicology, which supports graduate students and postdoctoral researchers and offers a robust Responsible Conduct of Research program, as well as a Superfund Research Program funded in September 2017.

For further information, email (cehs@mit.edu), call 617-452-2072, or visit our website (http://cehs.mit.edu).

CENTER FOR GLOBAL CHANGE SCIENCE

The MIT Center for Global Change Science (CGCS) (http://cgcs.mit.edu) seeks to better understand the natural mechanisms in the ocean, atmosphere, and land systems that together control the Earth’s climate, and to apply improved knowledge to problems of predicting global environmental change. The center utilizes theory, observations, and numerical models of the natural processes in
the global environment, concentrating on the circulation, cycles, and interactions of water, air, energy, and nutrients in the Earth system, the linkages among them, and their potential feedbacks in a changing climate.

CGCS was founded in 1990 to foster cooperative effort among faculty, students, and research scientists in meteorology, oceanography, hydrology, atmospheric sciences, climate physics, chemistry, biology, ecology, and satellite remote sensing. Participants are drawn primarily from the departments of Earth, Atmospheric and Planetary Sciences; Civil and Environmental Engineering; Biology; and Electrical Engineering and Computer Science.

The major research initiatives in CGCS are the MIT Climate Modeling Initiative (CMI), the Advanced Global Atmospheric Gases Experiment (AGAGE), and the MIT Joint Program on the Science and Policy of Global Change. Through the latter, CGCS sustains substantial collaborative effort with faculty, students, and researchers in Economics; the Sloan School of Management; Urban Studies and Planning; Institute for Data, Systems, and Society; Political Science; Aeronautics and Astronautics; and the MIT Energy Initiative.

CMI is an open-source collaborative that has developed the MIT General Circulation Model (MITgcm), which is applied to a wide range of modeling challenges in atmospheres, oceans, the cryosphere, biogeochemical cycles, ocean ecology, and the coupling together of all these processes.

AGAGE measures greenhouse gases globally and infers their sources and sinks using inverse methods. It is distinguished by its capability to measure over the globe at high frequency almost all of the important gas species in the Montreal Protocol (e.g., CFCs, HCFCs) to protect the ozone layer and almost all of the significant non-CO gases in the Kyoto Protocol (e.g., HFCs, methane, and nitrous oxide) to mitigate climate change.

Professor Ronald Prinn is the CGCS director. For more information, contact CGCS (cgcs@mit.edu) at Room 54-1312, 617-253-4902.

CENTER FOR INTERNATIONAL STUDIES

The Center for International Studies (CIS) (http://web.mit.edu/cis) supports and promotes international research and education at MIT.

CIS includes 120 members of the MIT faculty and staff, mainly drawn from the departments of Political Science and Urban Studies and Planning, and visiting scholars from around the world. We sponsor formal programs, multidisciplinary working groups and numerous public events. While CIS does not offer courses, students engage with the center’s faculty and staff as colleagues in research, dissertation students, participants in a range of events, and interns in the MIT Science and Technology Initiative (MISTI), the groundbreaking international education program. The center also provides other services to MIT students: internships, other opportunities to work in programs, and help with finding resources for research.

Within CIS is the MIT Security Studies Program (SSP), a graduate-level research and educational program. SSP’s teaching ties are with the Political Science Department. Courses offered emphasize grand strategy, the causes and prevention of international and civil conflict, military technology, nuclear proliferation, bureaucratic politics, national security, budgetary issues, and security issues in Asia. A special feature of the program is the integration of knowledge on technology with knowledge from the social sciences in the study of international security problems. SSP’s primary task is educating the next generation of security scholars and practitioners.

For more information on SSP, contact Joli Divon Saraf (joli@mit.edu), Room E40-477, 617-258-7608, fax 617-258-7858.

MISTI (http://misti.mit.edu) is MIT’s pioneering international education program. MISTI matches over 1,000 MIT undergrads and graduate students with internship, research, and teaching opportunities abroad each year. The MISTI Global Seed Funds program facilitates international faculty collaborations. A nucleus of international activity at MIT, MISTI develops partnerships with leading companies, research institutes and universities around the world.

Email MISTI (misti@mit.edu) for more information.

Seminar XXI (https://semxxi.mit.edu) is an educational program for senior military officers, government and NGO officials, and executives in the national security policy community. The program’s objective is to provide future leaders of that community with enhanced analytic skills for understanding foreign countries and the relations among them. The fundamental criterion for fellows is that candidates should reach top decision-making levels in the next three to five years. The program explores key policy issues by examining countries and problems critical to American interests through a variety of paradigmatic lenses.

For more information, contact Tisha Gomes Voss (tishag@mit.edu), Room E40-445, 617-258-6862.

The International Policy Lab (IPL) (http://policylab.mit.edu) works to enhance the impact of MIT research on public policy, in order to best serve the nation and the world in the 21st century. The IPL provides funding and staff assistance to translate and disseminate research findings to public policy makers. It is available through an annual call for proposals, which is open to any faculty or research staff with principal investigator status.

For more information, contact Daniel Pomeroy (dpmoreroy@mit.edu).

The Inter-University Committee on International Migration (http://web.mit.edu/cis/www/migration), created 30 years ago, organizes the Myron Weiner seminar series, honoring the late MIT professor and pioneer in migration studies. The committee also undertakes other projects on an ad hoc basis. Member institutions are Boston
University, Brandeis University, the Fletcher School of Law and Diplomacy, Harvard, MIT, Tufts University, and Wellesley College. The committee is hosted at MIT by CIS.

Email (cis-migration@mit.edu) for more information.

The Program on Emerging Technologies (PoET) (http://poet.mit.edu) encourages responsible technological innovation, with research on the political economy of innovation and on adaptive risk governance. Work on synthetic biology is conducted in partnership with technologists at the MIT Synthetic Biology Center and the Harvard Wyss Institute. Work on biomedical issues is conducted in partnership with the MIT Center for Biomedical Innovation and the Tufts Center for Translational Medicine. Work on information security and privacy is conducted in partnership with the Internet Policy Research institute of the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL). PoET provides policy recommendations to a wide range of governmental and nongovernmental organizations, including the White House Office of Science and Technology Policy and the President's Council of Advisors on Science and Technology, NIH National Science Advisory Board on Biosecurity, Environmental Protection Agency, Defense Intelligence Board, UN World Health Organization, UN Biological Weapons Convention, European Medicines Agency, and the National Academy of Sciences.

For more information, contact PoET director Kenneth Oye (oye@mit.edu), E40-437, 617-253-3412.

The Persian Gulf Initiative (http://web.mit.edu/cis/act_pgi.html) was launched in 2005 and has now held workshops on political violence, stability and legitimacy, energy security, the regional impacts of the Iraq war, and other topics. It sponsors research such as the Iraq mortality study, publications, and public forums, several of which have been held in Washington, DC, and New York.

For more information, contact John Tirman (tirman@mit.edu), Room E40-447, 617-253-9861.

CIS manages the MIT-Japan International Studies Fund Grants (http://web.mit.edu/cis/fo2_2.html), intended for advanced doctoral students at MIT working in close collaboration with faculty members on any international aspect of energy, environment, and international affairs.

Among the public events sponsored by CIS are the Starr Forum, the Emile Bustani Middle East Seminar, and the Security Studies Seminar Series. The Starr Forum mounts major public events for the MIT community and the broader public. The center's website is also a source of information and analysis, news about CIS activities, and a fellowship database. Recent op-eds and articles by CIS scholars, videos of talks, and other resources are found online.

Each year the center appoints as visiting fellows a few academics and government officials, both from the United States and abroad. Supported by their universities, governments, or foundations, these fellows work on problems relevant to the center's research and training interests. The Robert Wilhelm Visiting Fellow in International Studies is a distinguished visitor with extensive experience in government. The Elizabeth Neuffer Fellow is a woman journalist who reports on human rights and social justice.

For more information, contact executive director John Tirman (tirman@mit.edu), Room E40-447, 617-253-9861.

**CENTER FOR REAL ESTATE**

The Center for Real Estate (MIT CRE) (http://web.mit.edu/cre) provides an intellectual focus for research on issues affecting the real estate industry. Faculty associated with the center are drawn from the departments of Architecture, Urban Studies and Planning, Civil and Environmental Engineering, and the MIT Sloan School of Management.

The center is home to the Master of Science in Real Estate Development (MSRED) program (https://mitcre.mit.edu/masters-program/about-the-program), an interdepartmental degree program that combines education in design, planning, construction, management, finance, development, and marketing. It prepares students to assume positions of responsibility in private real estate companies, financial institutions, government agencies, nonprofit development organizations, and consulting firms. The program requires 11 months of intensive study.

MIT CRE's research initiatives cover a range of disciplines and areas of application within real estate, and all offer synergy between the real world of practice and MIT's faculty and research capabilities. Home to several labs, 14 faculty and lecturers, two research scientists, and three postdoctoral researchers, the center is as diversified as it is innovative.

The Real Estate Price Dynamics Platform (https://mitcre.mit.edu/research-publications/real-estate-price-dynamics-platform), headed by Professor David Geltner and Research Scientist Alex van de Minne, serves at the intersection between academics and the real estate industry. Their research focuses on developing applications and models used for real estate price indices for markets with scarce observations, forecasting prices, and for the mass valuation of real estate using machine learning.

The Real Estate Innovation Lab (http://realestateinnovationlab.mit.edu), headed by Research Scientist Andrea Chegut and principal investigators Professors Dennis Frenchman and David Geltner, researches the frontier in real estate products, processes, and data technologies to impact cities and the built environment. The team creates the built environment through design, computation, finance, and planning. The team works at the forefront of big data and innovation to make buildings in cities better places to live, work, and play.
The Urban Economics Lab (https://urbaneconomics.mit.edu/home), headed by Professor Albert Saiz, focuses on studying economic activity and economic trends in cities. The Lab uses analytical models and big data to understand what makes cities thrive or decline, how housing values are formed and oscillate, and how local politics and social phenomena manifest in the context of increasing global urbanization.

The center is supported in part through corporate partnerships (https://mitcre.mit.edu/industry-partners/partners-overview) and individuals active in the real estate industry.

MIT CRE encourages interaction between members of the Professional Certificate in Real Estate Finance and Development (http://professional.mit.edu/programs/short-programs/certificates/professional-certificate-program-real-estate), which provides an unparalleled opportunity for professionals and executives to obtain state-of-the-art insights and skills about the key factors and investment strategies driving real estate markets. By joining our professional program, students will further their understanding of the real estate development process.

For further information about the MIT CRE, contact Lisa Thoma (lthoma@mit.edu), associate director. For more information about the MSRED program, contact Patricia Nesti (tnesti@mit.edu), MSRED program coordinator, Center for Real Estate, Room 9-343.

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**CENTER FOR TRANSPORTATION & LOGISTICS**

The MIT Center for Transportation & Logistics (MIT CTL) (http://ctl.mit.edu) is a world leader in supply chain management and transportation education and research. MIT CTL engages in three principal activities: research, outreach, and education.

**Research**

The center’s world-renowned research programs directly involve over 75 faculty and research staff from a wide range of academic disciplines, as well as researchers in various affiliate organizations around the world. MIT CTL has four main research programs: supply chain management and logistics; transportation; humanitarian and responsible supply chains; and the impact of aging on mobility, health, and wellness.

Supply chain management and logistics projects include FreightLab, Responsible Supply Chain Lab, Supply Chain Innovation, Supply Chain Resilience, Sustainable Logistics, and Visual Analytics Lab.

Transportation programs and projects include the MIT Program in Intelligent Transportation Systems and the Megacity Logistics Lab.

The Humanitarian Response Lab works with the UN, USAID, and various NGOs to improve the effectiveness of response to humanitarian disasters globally. The Responsible Supply Chains Lab works on both green/sustainable supply chain projects and social and environmental challenges.

The MIT AgeLab conducts research to improve quality of life for older adults and those who care for them, creating new ideas and translating technology into practical applications such as autonomous vehicles, community accessibility, and design and home service logistics.

**Outreach**

MIT CTL partners with industry to turn the center’s innovative research into market-winning applications. MIT CTL currently has more than 50 corporate partners worldwide who participate in events, interact with researchers, and contribute to and help steer research projects.

**Education**

MIT CTL’s top-ranked Supply Chain Management Program (SCM) (p. 376) offers two professional master’s degrees: a Master of Engineering (MEng) in Supply Chain Management, for students who wish to continue on in research of who plan to pursue a PhD, and a Master of Applied Science (MASc) in Supply Chain Management, for students who wish to pursue a career in various industries, including consulting, manufacturing, distribution, retail, software, and services. Students have the option of a 10-month residential program or those who successfully complete the MITx MicroMasters credential in Supply Chain Management can apply to complete the remaining degree requirements during an intensive five-month program in residence at MIT. Students interested in studying supply chain management and logistics, or in learning more about the center and its educational programs, should write to Dr. Bruce Arntzen (barntzen@mit.edu), MIT Center for Transportation & Logistics, Room E40-379.

MIT CTL runs the Global Supply Chain and Logistics Excellence (SCALE) Network. SCALE consists of six centers of excellence. There are two centers in Europe (Zaragoza, Spain and Luxembourg), one in South America (Bogota, Colombia), and two centers in Asia (Kuala Lumpur, Malaysia and Ningbo, China). All offer a graduate program that mirrors MIT’s SCM program, with the exception of the South American program, which offers a certificate program. Students from all six SCALE centers work on common projects and participate in a global exchange.

Students interested in the interdepartmental Master of Science in Transportation (MST) (p. 377) program administered through the Department of Civil and Environmental Engineering should contact the director of the Transportation Graduate Program. Several departments offer both master’s and doctoral degrees that allow a focus on transportation, including Aeronautics and Astronautics, Civil and Environmental Engineering, Urban Studies and Planning, and the Institute for Data, Systems, and Society.
CLINICAL RESEARCH CENTER

Supported by the Vice President for Research and a longstanding National Institutes of Health Clinical Translational Award, the Clinical Research Center (http://crc.mit.edu) provides an infrastructure for interested scientists to perform biomedical research involving human subjects.

The center's mission is to facilitate and help accelerate the translation of basic discoveries into clinical (human) research that may improve the lives of patients and their families. The center allows faculty and students at all levels to gain experience with human subjects and human disease as their research transitions to first-in-human studies in an ethical and safe manner, while also helping to offset translational risks through an interdisciplinary and cross-sectoral approach. As part of the Institute for Medical Engineering and Science, the CRC links MIT to an extensive network of area hospitals/resources and helps support major partnerships with Brigham and Women’s Hospital, Children’s Hospital Boston, Massachusetts General Hospital, Spaulding Rehabilitation Network, and Tufts Medical Center.

Center facilities are open to all departments in the Institute. Principal investigators are faculty members and research scientists from many different departments. A full spectrum of clinical research resources are available to facilitate all aspects of research involving human subjects from early planning, clinical consultation, and assistance with regulatory and institutional review board navigation to specialized clinical research spaces, study management tools, and an experienced clinical staff.

Research opportunities are available for undergraduate and graduate students contemplating careers in the medical sciences. The Undergraduate Research Opportunities Program (UROP) (p. 44) allows undergraduate students the opportunity to participate in the research process at the Clinical Research Center, either for credit, pay, or on a volunteer basis.

For further information, contact Dr. Elazer Edelman, program director; Dr. Kumaran Kolandaivelu, medical director; or Dr. Catherine Ricciardi, nurse director; E25-201, 617-253-6332

COMPUTER SCIENCE AND ARTIFICIAL INTELLIGENCE LABORATORY

The Computer Science and Artificial Intelligence Laboratory (CSAIL) (http://www.csail.mit.edu) pursues fundamental research across the entire breadth of computer science and artificial intelligence. CSAIL is committed to leading the field both in new theoretical approaches and in the creation of applications that have broad societal impact.

CSAIL’s current research activities span three principal areas:

• Artificial Intelligence (AI). This area of research aims to understand and develop systems—living and artificial—capable of intelligent reasoning, perception, and behavior. Specific research includes core AI computational biology, computer graphics, computer vision, human language technology, machine learning, medical informatics, robotics, and the semantic web.

• Systems. This area of research aims to discover common principles, models, metrics, and tools of computer systems, both hardware and software. Specific research includes compilers, computer architecture and chip design, operating systems, programming languages, and computer networks.

• Theory. This area of research studies the mathematics of computation and its consequences. Specific research includes algorithms, complexity theory, computations geometry, cryptography, distrusted computing, information security, and quantum computing.

CSAIL encourages student participation in its research projects. Undergraduates may become involved through the Undergraduate Research Opportunities Program (UROP) (p. 44), and research assistantships are available to graduate students. CSAIL graduate students are typically enrolled in the departments of Electrical Engineering and Computer Science, Mathematics, Aeronautics and Astronautics, Brain and Cognitive Sciences, and Mechanical Engineering, and the MIT-Harvard Health Sciences and Technology Program.

Other related opportunities include:

• MIT App Inventor (http://appinventor.mit.edu), a visual programming environment aimed at allowing new coders to build apps for smartphones and tablets

• The Internet Policy Research Initiative (http://internetpolicy.mit.edu), an effort to conduct research and engage with public policy leaders on key issues in cybersecurity and technology

CONCRETE SUSTAINABILITY HUB

The mission of the Concrete Sustainability Hub (CSH) (http://cshub.mit.edu) is to advance the technology transfer from concrete science into engineering practice, by translating the synergy of three fields of study into a powerful hub for concrete sustainability studies relevant to industry and decision makers. CSH fosters a close alliance among academia, industry, and government to facilitate the transfer of knowledge by aligning world-leading research with end-user needs.

More concrete is produced than any other synthetic material on Earth. In the foreseeable future there is no other material that can replace concrete to meet our societies' legitimate needs for housing, shelter, schools, infrastructure, etc. But concrete faces an uncertain
future due to a non-negligible ecological footprint that amounts to 5–10% of worldwide CO₂ production.

Emerging breakthroughs in concrete science and engineering hold the promise that concrete can be part of the solution of contributing to sustainable infrastructure development that enables economic growth, and social progress while minimizing the ecological footprint. This requires a holistic approach in which progress in concrete science seamlessly feeds into innovative structural concrete engineering applications, ranging from concrete pavement solutions to wall systems, whose impact on sustainable development are evaluated with advanced environmental-econometric impact studies. An interdisciplinary team of faculty from several MIT departments participates in the CSH. Email (CSHub@mit.edu) for more information.

D-LAB

MIT D-Lab (https://d-lab.mit.edu) works with people around the world to develop and advance collaborative approaches and practical solutions to global poverty challenges. The program’s mission is pursued through interdisciplinary MIT courses, research in collaboration with global partners, technology development, and community initiatives—all of which emphasize experiential learning, real-world projects, community-led development, scalability, and impact assessment.

Academics. D-Lab challenges and inspires talented students to use their math, science, engineering, social science, and business skills to tackle global poverty issues. D-Lab offers more than 20 courses (http://d-lab.mit.edu/courses) that introduce students to D-Lab’s approach to co-design, design for scale, collaborative design, supply chain management, and business venture development as well as sector-specific courses on energy, mobility, water and sanitation, prosthetics, education, school architecture, and more. Many courses provide an option for fieldwork.

Research. MIT D-Lab’s research team creates and shares actionable findings, accessible knowledge, collaborative research approaches, and tools that support technology-enabled solutions to global poverty challenges. D-Lab’s research groups (http://d-lab.mit.edu/research-about) include Food, Energy, Water, Health, Local Innovation, and Lean Research. The team has fieldwork projects in the following countries: Colombia, Guatemala, India, Indonesia, Mali, Mexico, Morocco, Nepal, Niger, Tanzania, and Uganda.

Innovation Practice. D-Lab’s Innovation Practice group works with diverse partners to develop, advance, and apply participatory innovation as a methodology for tackling poverty. Innovation Practice includes the following programs: D-Lab Scale-Ups Fellowship, Humanitarian Innovation, Inclusive Markets, Innovation Ecosystem Builder Fellowship, the Practical Impact Alliance, and Global Trainings.

D-Lab Workshop. The D-Lab workshop, the heart and soul of D-Lab, is a place for D-Lab students, fellows, innovators-in-residence, and others to bring technologies for the developing world to life. The workshop includes a large collection of hand and power tools, steel fabrication and welding tools, an open shop with multiple workbenches, and a dedicated wood shop and long-term projects room.

Email D-Lab (d-lab@mit.edu) for more information.

DESHPANDE CENTER FOR TECHNOLOGICAL INNOVATION

The Deshpande Center (http://deshpande.mit.edu) was established at the MIT School of Engineering to increase the impact of MIT technologies in the marketplace. Founded with an initial donation from Jaishree and Desh Deshpande, the Deshpande Center supports a wide range of emerging technologies including biotechnology, biomedical devices, information technology, new materials, tiny tech, and energy innovations.

Since 2002, the Deshpande Center has awarded over $15 million in grants to support more than 125 MIT faculty-led projects. The objective of the funding is to nurture ideas with market potential and reduce the uncertainty around them so that an external party would invest in the technology. In addition to the funding, the grants bring with them publicity, mentoring, and connections with the business community.

This funding enables MIT faculty and their students to pursue exciting new avenues of research on novel technologies. As a result, 32 projects have spun out of the center as independent startups, collectively raising more than $600M in outside financing from top-tier venture capital firms and other investors.

There are two ways for students to get involved in projects funded by the Deshpande Center.

- **Deshpande Center Grant Program**: The grant program identifies and supports MIT research that can address important market opportunities. To support this research, the center awards Ignition Grants and Innovation Grants (ranging from $50,000 to $250,000 per project) to MIT faculty. Students may participate through a thesis or research assistantship in the laboratory of a faculty member. A portfolio of projects can be found on the website (http://deshpande.mit.edu/grants-resources).

- **I-Teams (Innovation Teams)**: I-Teams is a course that selects ambitious and highly qualified students interested in helping to bring leading-edge technologies from MIT's world-renowned research laboratories to market. The students join teams devoted to evaluating commercial feasibility and creating go-to-market strategies for technologies within the Deshpande Center portfolio. The course is taught jointly through the Sloan School of Management and the School of Engineering. More information
In addition to applied research, engineering development, and technology transfer, Draper’s mission includes advanced technical education—part of Draper’s charter since it incorporated as a not-for-profit in 1973, becoming independent of MIT, where it had begun as a teaching laboratory in the 1930s.

MIT faculty and students work with Draper in a variety of ways. Faculty collaborate with Draper staff on a wide range of research activities in hardware, software, systems, and materials engineering. The Draper Fellow Program (http://www.draper.com/careers/fellow-program) gives graduate students the opportunity to conduct their thesis research at Draper under the supervision of both an MIT faculty advisor and a member of Draper’s technical staff in an area of mutual interest. Draper Fellows’ graduate degree tuition and stipends are funded by Draper. Draper also employs undergraduate and graduate students directly to work on projects during the summer as well as the school year.

All students working at Draper are in direct daily contact with Draper engineers and scientists, benefiting from their collective knowledge and experience and from access to Draper’s advanced laboratory facilities and equipment in Kendall Square. Working on real-world projects for Draper customers, students can gain insight into customers’ and end users’ needs and concerns, ranging from usability to cost.

For information, contact (education@draper.com) the Draper Education Office.

DIVISION OF COMPARATIVE MEDICINE

The Division of Comparative Medicine (http://web.mit.edu/comp-med) has three basic missions: education, research, and the provision of comprehensive animal husbandry, clinical, and diagnostic services for all research animals at MIT. The division serves as the centralized animal resource on campus and provides the necessary expertise for investigators conducting biomedical research using animal models.

Division staff members educate the MIT research community in the biology and use of research animals as models for biomedical research. The division provides online training materials for researchers working with animals as well as one-on-one training based on individual requirements. Division members teach graduate-level courses in the Department of Biological Engineering (p. 158) and provide mentorship for Undergraduate Research Opportunities Program (UROP) (p. 44) and graduate students.

With a postdoctoral training program for veterinarians specializing in biomedical research, the major long-range goal of the research at the division is to develop animal models or in vitro systems that are pertinent to biomedical research. The division is internationally recognized for characterizing new Helicobacter species and studying the relationship of Helicobacter to human diseases that are prevalent throughout the world.

DRAPER

The Charles Stark Draper Laboratory, Inc. (http://www.draper.com) is a not-for-profit engineering solutions company focused on the design, development, and deployment of advanced technological capabilities for the world’s most challenging and important problems. Draper provides engineering solutions directly to government, industry and academia; works on teams as prime contractor or subcontractor; and participates as collaborator in consortia. Draper engineers and scientists apply multidisciplinary approaches that deliver new capabilities to customers, whether formulating a concept and developing each component to achieve a field-ready prototype or combining existing technologies in new ways.

HAYSTACK OBSERVATORY

MIT Haystack Observatory (http://www.haystack.mit.edu) provides opportunities for undergraduate and graduate student research in radio astronomy, geodesy, atmospheric sciences, and informatics.

Haystack Observatory holds a worldwide leadership position in the development and deployment of the Very Long Baseline (VLBI) technique, which uses a global array of radio telescopes to make high-resolution observations of galactic and extragalactic radio sources and to perform precision geodetic studies of the Earth’s plate tectonics and motions in space. Using radio telescopes at Haystack and elsewhere around the world, the observatory supports strong programs in both science and technology using VLBI, including unique mm-wavelength observations of the black hole at the center of our galaxy on event-horizon scales.

High-power radars using 46-m and 67-m antennas are used, in conjunction with a variety of other techniques, to study the structure and dynamics of Earth’s upper atmosphere. Emphasis is given to the study of the effects of geomagnetic storms induced by solar disturbances on Earth’s ionosphere as well as the coupling of atmospheric layers. Haystack researchers also study thermal effects in the upper atmosphere, including signatures associated with global climate change.
INITIATIVE ON THE DIGITAL ECONOMY

The MIT Initiative on the Digital Economy (IDE) (http://ide.mit.edu) is a team of internationally recognized thought leaders and researchers who examine the way people and businesses work, interact, and will ultimately prosper in a time of rapid digital transformation.

Technology advances quickly, yet organizations and skills tend to move at a slower pace. In the coming decades, the divide between swiftly evolving technology and the slower pace of human development will grow wider as exponential improvements in artificial intelligence, robotics, networks, analytics, and digitization affect more and more of the economy and society.

Inventing effective organizations and institutions suited for the digital economy is the grand challenge of our time, and for MIT in particular. Our research helps companies adapt to new ways of doing business in the digital economy. It helps NGOs and other organizations understand how the digital transformation is affecting society and everyday life. It also helps people become more productive and thrive in a time of great and uncertain change.

Activities include research, events, fellowships, an Inclusive Innovation Challenge (https://www.mitinclusiveinnovation.com), and education—including the Analytics Lab, which is taught in the fall term. IDE offers opportunities to participate in its work through the Undergraduate Research Opportunities Program (UROP) (p. 44), research assistantships, and postdoctoral study.

IDE is part of the MIT Sloan School of Management. Our team is led by MIT Sloan’s Erik Brynjolfsson and Andrew McAfee, who have co-authored several highly respected publications detailing the interaction of digital technology and employment, including The Second Machine Age and Machine, Platform, Crowd.

For further information, contact IDE executive director David L. Verrill (dverrill@mit.edu) at 617-452-3216.

INSTITUTE FOR MEDICAL ENGINEERING AND SCIENCE

Launched in 2012, the Institute for Medical Engineering and Science (IMES) (https://imes.mit.edu) aims to create a focused and effective platform for research and education in medical engineering and science at MIT. IMES is dedicated to addressing major health challenges using novel technologies and approaches. A community of scholars from across MIT and collaborating local-area hospitals—with work focused at the intersections of engineering, basic sciences, clinical research, and clinical practice—contribute expertise to IMES.

Through its research and educational programs, and as a home to the Harvard-MIT Program in Health Sciences and Technology (https://imes.mit.edu/academics/hst), IMES pioneers new research paradigms and novel curricula to advance human health and to educate a generation of leaders who will work at the convergence of engineering, science, and clinical medicine. In partnership with Harvard Medical School, IMES plays a significant role in educating physician-scientists and physician-engineers who integrate approaches from the physical sciences and engineering into the practice of medicine. IMES is also home to the Medical Electronic Device Realization Center (MEDRC) (http://medrc.mit.edu), Clinical Research Center (https://imes.mit.edu/initiatives/clinical-research), and the MIT-MGH Center for Microbiome Informatics and Therapeutics (http://microbiome.mit.edu).

Opportunities for undergraduate research are available through the home department of faculty who are participating in IMES research, and through the Undergraduate Research Opportunities Program (UROP) (p. 44). For further information, contact the office of the director, Room E25-338, 617-324-4019.

INSTITUTE FOR SOLDIER NANOTECHNOLOGIES

The Institute for Soldier Nanotechnologies (ISN) (http://isnweb.mit.edu) was established by the Army as an interdisciplinary research center at MIT in 2002.

The ISN mission is to help the Army dramatically improve protection, survivability, and mission capabilities of the soldier and of soldier-supporting platforms and systems. A major ISN goal is to enable high-tech protection and survivability capabilities through affordable clothing and equipage of lighter weight, increased comfort, and decreased energy demand. To this end, the ISN performs research to enable improved blast and ballistic protection, detection and detoxification of chemical and biological substances in the environment, portable electric power, physiological monitoring and medical care in mission theatres and remote locations, and to provide the soldier with reliable situational awareness and secure means to receive and transmit voice and data communications.
ISN researchers have access to state-of-the-art instrumentation for nanotechnology research at its 40,000-sq-ft facility. Most ISN research is performed by graduate students as part of master’s and doctoral theses in MIT academic departments, by postdoctoral researchers, or by undergraduates participating in the Undergraduate Research Opportunities Program (UROP) (p. 44). Many theses are co-supervised by two or more faculty members representing different areas of technical expertise. Each year, more than 30 faculty members from a dozen MIT departments participate in ISN research.

In addition, visiting researchers from industry and Army laboratories participate in ISN research and tech transfer, bringing knowledge and practical perspectives that greatly enrich the ISN learning environment. Industry partners provide expertise on product development, systems integration and affordable manufacturing in quantities needed by particular customers and thus help bring laboratory-scale ISN innovations closer to real-world applications for the soldier. Army partners collaborate with the ISN on basic and applied research, provide guidance on the soldier relevancy of ISN research, and participate in tech transfer.

Students seeking to perform thesis or UROP research at the ISN should contact faculty and professional research staff members listed on the ISN website (http://isnweb.mit.edu/investigators.html). For further information, contact ISN (isn@mit.edu), 617-324-4700.

INTERNET POLICY RESEARCH INITIATIVE

Faculty and students at the Internet Policy Research Initiative (IPRI) (http://internetpolicy.mit.edu) see a pressing need to bridge the gap between the technical and policy communities, and do so via an interdisciplinary research approach that pulls together expertise from departments across MIT. IPRI has made significant progress in three core areas: leading the development of the field of cyber/Internet policy through influential academic research (research), creating an educational pathway for a new pipeline of students trained in cyber policy (education), and actively engaging with US and international policy makers on a range of cyber issues (engagement). IPRI is led by faculty researchers from engineering, social science, and management departments at MIT, and is located at the MIT Computer Science and Artificial Intelligence Lab (CSAIL).

Research

IPRI’s core research can be broken down into six evolving categories: cybersecurity, privacy, networks, machine explanation and accountability, critical infrastructure security, and the Internet experience. IPRI has pioneered an approach to addressing the societal challenges of new technology. The groups engages with policy makers and other stakeholders in order to understand the impact of new technology on societies’ core values, and uses the fruits of these engagements both to inform further engineering research and also to develop technically informed policy options. All through this process, IPRI students are learning how to bring policy awareness to their research.

Education

IPRI’s expanded curriculum and collaborations among MIT, leading law schools, and international partners are creating the career paths for students who will lead the next generation technologically of informed policy making.

One way MIT graduates create change for the good in the world is by pairing their strong technical education with social awareness and sensitivity for improving the lives of others. IPRI offers residential
policy courses such as STS.085[J] Foundations of Information Policy to engineering students to help them approach engineering challenges with deeper context and an expanded policy toolkit for social impact. IPRI faculty also teach 6.S978 Privacy Legislation: Law and Technology as a joint course with Georgetown Law School, pairing engineering and law students in teams to develop privacy legislation around current issues. Final projects from that course have been picked up by law journals and requested by state legislatures.

Engagement

Through open and closed-door conferences/meetings, speeches, and visits by government officials and technical experts to MIT, IPRI engages with policy makers, industry partners, and civil society organizations both to inform its own research, and to share insights.

For additional information visit the website (http://internetpolicy.mit.edu) or IPRI's offices at 32-G526.

JOINT PROGRAM ON THE SCIENCE AND POLICY OF GLOBAL CHANGE

The MIT Joint Program on the Science and Policy of Global Change (http://globalchange.mit.edu) integrates natural and social science to produce analyses relevant to global change and energy policy debates. By bringing together both science and policy, the Joint Program provides an independent assessment of the impacts of global change and the expected values of responsive action. The research conducted at the Joint Program is valuable to government agencies, who aim to formulate efficient and effective policies; to industry leaders, who aim to create risk management strategies within national, regional, and global market realities; and to other decision-makers, who value a systemic view of the broad interactions inherent in global change. The effort involves an interdisciplinary group of faculty, staff, and student researchers.

The Joint Program combines the capabilities of two complementary research centers: the Center for Global Change Science (CGCS) (p. 91) and the Center for Energy and Environmental Policy Research (CEEPR) (p. 91). Resources of the parent centers are strengthened by links to the Marine Biological Laboratory’s Ecosystems Center in Woods Hole, MA; the MIT Climate Modeling Initiative; and other MIT programs. Cooperative efforts engage the Joint Program with leading research institutions and nonprofit organizations worldwide. Financial support is provided by an international partnership of government, industry and foundation sponsors, and by private donations.

At the heart of the Joint Program’s work lies the MIT Integrated Global System Model (IGSM) framework. Designed to analyze interactions between humans and the Earth system, this comprehensive set of models is used to study the causes, consequences, and solutions to problems that arise from global change. We define global change broadly and consider the unintended impacts of global economic and population growth on natural resource availability, the climate, and air and water quality. The IGSM framework consists primarily of two interacting components: the Economic Projection and Policy Analysis (EPPA) model and the MIT Earth System model. Together they are used to evaluate probabilities, uncertainties, risk, and costs and benefits—information crucial to policy decision making.

Joint Program members communicate research results and interpret policy relevance of analytical work through many professional activities, including publications, workshops, corporate and public briefings, and media interviews. Special briefings from program members have been requested by the US Congress and federal and state agencies, by governmental ministries and international organizations, and by independent research panels. Research findings are also communicated through the MIT Global Change Forum, which brings together representatives of industry, government, international entities, and research groups for analysis and discussion of science and policy aspects of global change, and for independent assessment of studies and policy proposals.

Ronald Prinn, director of the Center for Global Change Science and professor within the Department of Earth, Atmospheric, and Planetary Sciences and John Reilly, senior lecturer in the Sloan School of Management co-direct the program.

For further information, contact the joint program office (globalchange@mit.edu), Room E19-411, 617-253-7492, fax 617-253-9845.

KNIGHT SCIENCE JOURNALISM PROGRAM

The Knight Science Journalism Program (http://web.mit.edu/knight-science) offers fellowships for mid-career journalists who cover science, technology, medicine, or the environment for the general public. The program offers fellowships to reporters, writers, editors, producers, illustrators, and photographers.

Journalists who are selected spend one academic year on campus, taking courses at MIT and Harvard, participating in twice-a-week seminars with top researchers, visiting laboratories, going on field trips, and pursuing independent projects. They also do a research project, building expertise in a particular area of interest, which may lead to publication program’s highly regarded science magazine, Undark, or help create a book proposal, video, podcast or other final product.

Science journalists face some of the most difficult challenges of reporting. They must convey complex, technical subjects in direct, simple terms to readers and viewers who demand—and have a right to—accurate, fair, and clear information about scientific developments that affect not only their views of the world, but their lives and livelihoods. Reporting both the news and its implications
is further complicated by the naturally advancing complexity of science.

Knight fellowships are designed to help journalists face these challenges by widening their knowledge of science and technology and deepening their understanding of how these fields interact with society. Through both classes and through a series of seminars and workshops, the program provides an opportunity for journalists to re-examine old ways—and develop new ways—of practicing their craft.

The John S. and James L. Knight Foundation is the principal sponsor of the fellowships, the only nine-month, mid-career program reserved for science journalists. The fellowships are part of MIT's Program in Science, Technology, and Society (p. 278).

For further information, contact Deborah Blum (dlblum@mit.edu), program director.

KOCH INSTITUTE FOR INTEGRATIVE CANCER RESEARCH

The Koch Institute for Integrative Cancer Research at MIT (http://ki.mit.edu) is one of the two National Cancer Institute-designated centers in the Greater Boston area. The Koch Institute brings scientists and engineers together under one roof to develop new ways to detect, diagnose, treat, and manage cancer. The Koch Institute’s researchers include cancer biologists; chemists; materials science, chemical, electrical, and biological engineers; computer scientists; and others, all dedicated to bringing the most advanced science and technology to bear in the fight against cancer.

The Koch Institute draws its faculty from both the School of Science and the School of Engineering. While graduate students typically enroll in their respective departmental program, students in any MIT department may ask to do doctoral thesis research under the supervision of a Koch Institute faculty member. If accepted, they may be eligible for support as research assistants.

Opportunities for graduate research are available through the Graduate Student Research Opportunities Program (p. 44). If an undergraduate student is interested in working in a particular lab, they may also contact the appropriate faculty member directly. In addition, the Koch Institute regularly presents seminars on cancer research and public events throughout the year.

For further information, contact Terry Clewley (tclewley@mit.edu), senior human resources and administration manager, 617-258-7448.

LABORATORY FOR FINANCIAL ENGINEERING

The MIT Laboratory for Financial Engineering (LFE) (http://lfe.mit.edu) is a research center focused on the quantitative analysis of financial markets and institutions using mathematical, statistical, and computational models and methods. The goal of the LFE is to support and promote academic advances in financial engineering and computational finance that can be directly applied for the betterment of the world. To do that, LFE faculty, students, and staff engage with industry professionals, regulators, policymakers, and other stakeholders to develop and apply new financial technologies to practical and socially important settings.

The LFE’s research projects fall into five areas:

- **Foundations of financial behavior and adaptive markets.** The LFE is working to understand the impact of human behavior on financial markets and policy through research that explores the psychophysiology and behavioral biases of market participants. In taking an interdisciplinary approach to understanding financial markets, the LFE aims to reconcile human behavior with the Efficient Markets Hypothesis, which serves as the basis for much of modern investment theory and practice today.

- **Risk management.** Development of new methods for measuring and managing risks of various types, including systemic risk, in the financial system. A priority is to construct and test early warning signs for instabilities, and to understand the interplay between policy and the financial industry and its impact.

- **Healthcare finance.** LFE researchers are working to promote and develop new business models and financing structures for raising and deploying funds to support biomedical research and therapeutic development in a scalable and profitable manner.

- **Financial technology and artificial intelligence.** Drawing upon computer science and artificial intelligence, research in this area applies techniques like machine learning and natural language processing to large datasets to develop real-world solutions to common industry challenges. As part of this research, the LFE also explores the positive and negative aspects of big data and financial technology, including privacy concerns and cybersecurity threats, and new technologies for addressing these issues.

- **Capital markets and asset-market dynamics.** Explores quantitative models for portfolio management, trading, and asset allocation, including industry-level studies of the hedge fund industry, indexation and smart beta algorithms, and the impact of technology such as high-frequency trading on financial market dynamics.

Students are encouraged to participate in current research projects, which include measuring illiquidity risk in hedge-fund returns; modeling and analyzing the growth of systemic risk in the financial industry, in particular the hedge fund industry; developing evolutionary and neurobiological models of individual risk preferences and financial-market dynamics; developing new approaches to financing biomedical innovation; and examining the public policy implications of this research. The LFE is a research lab for MIT faculty and students and does not offer any degree programs.
The Laboratory for Information and Decision Systems (LIDS) at MIT is an interdepartmental laboratory devoted to research and education in systems, networks, and control, staffed by faculty, research scientists, and graduate students from many departments and centers across MIT. The mission of LIDS is to develop and apply rigorous approaches and tools for system modeling, analysis, design, and optimization. It encompasses the development of novel analytical methodologies, as well as the adaptation and application of advanced methods to specific contexts and application domains. LIDS research addresses physical and man-made systems, their dynamics, and the associated information processing. Some of the lab’s core research areas are as follows.

**Statistical Inference and Machine Learning:** This area deals with complex systems, phenomena, and data that are subject to uncertainty and statistical variability. It also includes the development of large-scale data processing software systems. Research ranges from development of basic theory, methodologies, algorithms, and computational infrastructures to adaptations of this work for challenging applications in a broad array of fields. Typical applications involve causal inference in experimental design, social data processing and e-commerce, as well as image processing, computer vision, and automation of data engineering. Other current topics include reinforcement learning and online optimization, recommendation systems, graphical models, large scale software systems for data engineering, medical image processing, causal inference in genomics, and high-dimensional statistics.

**Optimization:** This area aims to develop analytical and computational methods for solving optimization problems in engineering, data science, and operations research, with applications in communication networks, control theory, power systems, machine learning, and computer-aided manufacturing. In addition to linear, nonlinear, dynamic, convex, and network programming, methods that exploit the algebraic structure of large-scale problems as well as simulation-based methods are also studied.

**Systems Theory, Control, and Autonomy:** This area deals with all aspects of system identification, inference, estimation, control, and learning for feedback systems. Theoretical research includes quantification of fundamental capabilities and limitations of feedback systems, development of practical methods and algorithms for decision making under uncertainty, robot sensing and perception, inference and control over networks, as well as architecting and coordinating autonomy-enabled infrastructures for transportation, energy, and beyond.

**Networks:** This area includes communications, information theory, and networking, with applications to wireless and optical systems, and data centers. Additional recent directions include the analysis of social networks and of agent interactions in networked systems, with applications ranging from the analysis of data generated by large-scale social networks to the study of dynamics and risk in large interconnected financial, transportation, and power systems.

**LABORATORY FOR MANUFACTURING AND PRODUCTIVITY**

The Laboratory for Manufacturing and Productivity (LMP) is a center for education and research in manufacturing and productivity at MIT. The laboratory seeks to establish a rational foundation for manufacturing based on a systematic understanding of the complex interactions among the many areas of manufacturing. The three major objectives are:

- The development of the fundamental principles of manufacturing processes, equipment, and systems
- The application of those principles to the manufacturing sector
- The education of engineering leaders

LMP’s three research focus areas are micro- and nanoscale manufacturing processes and equipment, manufacturing systems and information technology, and sustainability, including photovoltaics and environmentally benign manufacturing.

Opportunities for undergraduate and graduate students are available for thesis research and Undergraduate Research Opportunities Program (UROP) projects, as are a limited number of postdoctoral research positions.

For additional information, contact the director, Professor Jung-Hoon Chun, Room 35-233, 617-253-1759.
Hadron Collider (LHC) at CERN in Switzerland, and neutrons at the Spallation Neutron Source at the Oak Ridge National Laboratory. The high-energy particle physics program involves experiments with high-energy protons at the LHC; the search for antimatter and dark matter in space with the Alpha Magnetic Spectrometer on the International Space Station; an additional dark matter experiment, DarkLight, at the Jefferson Laboratory; exploration of cosmic X-rays with the NuSTAR satellite; and silicon detector development for cosmic-ray signatures of dark matter with the GAPS experiment. Properties of neutrinos are being explored through experiments at various sites, including Fermi National Accelerator Laboratory; Karlsruhe, Germany; Kamioka Observatory, Japan; the South Pole; through the development of a new technique to measure neutrino mass through Cyclotron Radiation Emission Spectroscopy; and through research and development to build a cyclotron-based high-intensity source of neutrinos. Searches for extremely rare, neutrino-less nuclear decays are taking place underground in Gran Sasso, Italy. A theoretical program investigates the properties of high-energy plasmas.

LNS supports research interests of faculty in the Department of Physics by supporting and administering facilities for studies of nuclear and particle physics, including the Center for Theoretical Physics, the MIT-Bates Research and Engineering Center, the MIT-Bates High Performance Research Computing Facility, and the MIT Central Machine Shop. Students participate in the entire range of research programs in fulfilling their graduate and undergraduate degree requirements or as participants in the Undergraduate Research Opportunities Program.

For further information, contact the director, Professor B. Wyslouch, Room 26-505, 617-253-2395.

The Center for Theoretical Physics is engaged in a broad range of fundamental research activities in theoretical nuclear and particle physics, including study of the fundamental constituents of matter and the theory that governs them, the structure and interactions of nuclei and hadrons, electroweak physics, lattice hadron physics, field theory, string theory and quantum gravity, many-body physics, mathematical physics, cosmology, and quantum computation.

For further information, contact the director, Professor W. Taylor, Room 6-317, 617-258-0729.

The William H. Bates Research and Engineering Center (Bates Lab) is operated by LNS as a research and engineering center with particular emphasis on accelerator science and technology. Current efforts include the design, construction, and testing of new detector systems; the design, construction, and testing of a high-intensity polarized electron source for a future high-luminosity electron-positron collider; development and testing of an atomic beam source of polarized 3He for an experiment to search for the electric dipole moment of the neutron; and development of new accelerator-based techniques to be used for cancer therapy.

For further information, contact the director, Professor B. Wyslouch, Room 26-505, 617-253-2395.

**LEGATUM CENTER FOR DEVELOPMENT AND ENTREPRENEURSHIP**

The Legatum Center for Development and Entrepreneurship ([http://legatum.mit.edu](http://legatum.mit.edu)) at MIT is a global learning platform for principled innovation-driven entrepreneurs building a better world. We are committed to providing entrepreneurs with education, funding, and community resources—as well as helping to cultivate principled leadership skills and a strong sense of purpose—in order to give them the greatest chance of succeeding as change agents in the developing world.

Our capstone initiative is a competitive fellowship program ([http://legatum.mit.edu/resources/legatum-fellowships](http://legatum.mit.edu/resources/legatum-fellowships)). Each year we build a cohort of the most promising 20–25 students who are committed to building and scaling ventures in the developing world. We provide them with tuition, travel, and prototyping support as well as access to mentors, targeted coursework, special seminars, and other cross-campus resources tailored to their educational and venture needs.

We also create pathways for the broader student community to engage with the Legatum Center and “entrepreneurship for development.” These pathways include Seed Grants ([http://legatum.mit.edu/resources/seed-grant-program-developing-world-entrepreneurs](http://legatum.mit.edu/resources/seed-grant-program-developing-world-entrepreneurs)) for students looking to explore and refine an idea in the developing world (e.g., by conducting primary market research or running pilots on the ground). Our Entrepreneur-in-Residence ([http://legatum.mit.edu/resources/entrepreneur-residence-office-hours](http://legatum.mit.edu/resources/entrepreneur-residence-office-hours)) provides office hours and workshops for those seeking mentorship and guidance. In collaboration with other MIT partners we run for-credit classes, thematic conversations, practical workshops, and a campus-wide summit. For faculty and research-oriented students, we have begun to offer research grants and student research assistantships focused on understanding and shaping the conditions for systems change.

As we continue to learn the most effective methods of supporting entrepreneurs in the developing world, we also create pathways to engage with them beyond the MIT campus. We run international activities such as Open Mic Africa, the Zambezi Prize ([http://zambezi.mit.edu](http://zambezi.mit.edu)), and convene events such as our annual regional summit. We also support research related to the transformational power of entrepreneurship in society and we are developing a library of resources including case studies and media content featuring founders from around the world.
LINCOLN LABORATORY

MIT’s Lincoln Laboratory (http://www.ll.mit.edu), in Lexington, MA, is operated as a federally funded research and development center for advanced technologies in support of national security.

Lincoln Laboratory’s activities focus on the design and development of complex systems, usually incorporating new technologies, devices, and components. The Laboratory’s mission areas are space systems and technology; air, missile, and maritime defense technology; communication systems; cyber security and information sciences; intelligence, surveillance, and reconnaissance systems and technology; advanced technology; tactical systems; homeland protection; air traffic control; and engineering.

MIT Lincoln Laboratory Beaver Works is a campus resource that supports project-based learning. Contact Beaver Works (llbw-info@ll.mit.edu) or call 617-324-7457.

The Laboratory offers student employment opportunities, which may be viewed on its website (http://www.ll.mit.edu/college/studentprograms.html).

MARTIN TRUST CENTER FOR MIT ENTREPRENEURSHIP

The Martin Trust Center for MIT Entrepreneurship (http://entrepreneurship.mit.edu) educates and nurtures students from across the Institute who are interested in learning the skills to design, launch, and grow innovation-driven ventures. The center supports a variety of teaching activities in all aspects of entrepreneurship, which provide a combination of project-based and theory-based learning. Project-based classes include New Enterprises, Innovation Teams, and Entrepreneurship Lab; theory-based classes include Venture Engineering, Entrepreneurial Finance, Strategic Management of Innovation and Entrepreneurship, Dilemmas in Founding New Ventures, and Regional Entrepreneurship Acceleration Lab. Over 30 subjects are offered, involving more than 25 faculty members.

All entrepreneurship subjects, described in the online MIT Subject Listing & Schedule (http://student.mit.edu/catalog), are open to students from all MIT departments, and support the strong community of MIT entrepreneurship and innovation. Subjects frequently feature lecturers who have significant real-world experience to share. The classes provide students with insights based on leading-edge research on entrepreneurship and related topics, such as the role of science and innovation in economic growth, and the characteristics of effective entrepreneurial firms.

The Martin Trust Center supports and cooperates closely with a wide array of related organizations at MIT, including the Deshpande Center for Technological Innovation, the Venture Mentoring Service, and the Legatum Center for Development and Entrepreneurship. It also supports a range of student activities including the MIT $100K Entrepreneurship Competition, the MIT Clean Energy Prize, the MIT Entrepreneurship Review, the MIT Venture Capital and Private Equity Club, the MIT Healthcare Club, the MIT Sloan Sales Club, MIT Sloan Entrepreneurs for International Development, and the MIT Energy Club.

Bill Aulet is the managing director, Professor Scott Stern is the faculty director, and Professor Edward B. Roberts is the founder and chair. The Martin Trust Center is also supported each semester by a group of entrepreneurs-in-residence who have founded high-impact innovation-based companies and organizations from scratch and provide advice to students with similar goals.

For more information, contact the Martin Trust Center (trustcenter@mit.edu), Room E40-160, 617-253-8653, fax 617-253-8633.

MATERIALS RESEARCH LABORATORY

The Materials Research Laboratory (MRL) (https://mrl.mit.edu) provides a unified nexus for interactions among materials researchers within MIT, and a portal for external interactions of the community with industry, government, and other academic institutions.

The MRL enables the broad materials science and engineering community at MIT to conduct research that benefits society, helps companies and federal agencies address fundamental challenges, creates opportunities for technology transfer and practical engineering applications, and encourages collaboration through interdisciplinary research groups, shared experimental facilities, and educational outreach programs.

The MRL encompasses research on energy conversion and storage, quantum materials, spintronics, photonics, metals, integrated microsystems, materials sustainability, solid-state ionicics, complex oxide electronic properties, biogels, and functional fibers. These are all interdisciplinary topics in materials. Each plays a critical role with the focus on scientific discovery, and how to design and make materials that lead to systems that have improved performance or that enable new approaches to existing problems.

The MRL also encourages exchanges between academia and industry with visiting scientists and adjunct faculty appointments, industrial internships, and educational opportunities. The MRL sponsors a major workshop involving both students and faculty during its Materials Day symposium and poster session each fall.

Each year for nine weeks during the summer, the MRL sponsors a research internship program, inviting outstanding undergraduate students nationwide to participate in ongoing MIT materials research. The program has brought hundreds of the best science and engineering undergraduates from across the country to conduct...
graduate-level materials research. Students can select from a wide array of projects available.

For more information about the Materials Research Laboratory, contact Mark Beals (mbeals@mit.edu), associate director, 617-253-2122. For more information about the summer scholars program, please visit our website (https://mrl.mit.edu).

MCGOVERN INSTITUTE FOR BRAIN RESEARCH

The McGovern Institute for Brain Research (http://mcgovern.mit.edu) at MIT is a research and teaching institute committed to meeting two great challenges of modern science: understanding how the brain works and discovering new ways to prevent or treat brain disorders.

Our research employs the full range of modern neuroscience techniques, from molecular genetics to functional neuroimaging and computational modeling. A deeper knowledge of the human brain will have profound implications, both for our understanding of our own minds and for the treatment of the many brain diseases that lead to human suffering.

The institute currently has 20 investigators and continues to grow. All McGovern Institute faculty members hold dual appointments in departments at MIT. Each of our faculty members leads a research team, and the institute as a whole comprises a community of more than 200 researchers and support staff.

The main focus for undergraduate neuroscience education at MIT is Course 9, leading to the Bachelor of Science in Brain and Cognitive Sciences. There are many opportunities for undergraduates to work in McGovern labs, for example through the MIT Undergraduate Research Opportunities Program.

The McGovern Institute does not operate its own graduate program. Instead, graduate students must enroll in one of the departmental or interdepartmental graduate programs at MIT. The majority of graduate students within the McGovern Institute are enrolled in the Brain and Cognitive Sciences graduate program.

For more information about undergraduate and graduate opportunities at the McGovern Institute, visit the website (http://mcgovern.mit.edu/work-here/types-of-positions). To learn more about the institute, contact Gayle Lutchen, Room 46-3160, 617-452-2507.

MICROSYSTEMS TECHNOLOGY LABORATORIES

The Microsystems Technology Laboratories (MTL) (http://www.mtl.mit.edu) provide modern fabrication facilities to enable research and education in nano- and micro-technologies.

The MTL facilities consist of fully equipped cleanroom laboratories and associated design, simulation, testing, and characterization infrastructure, as well as an extensive computational network, supporting wide array of design and layout tools. These facilities are available to the entire MIT community as well as to researchers from other universities or government laboratories. MTL labs are also available for limited industrial participation.

Research at MTL is conducted in four separate spaces: the Integrated Circuits Laboratory (ICL), the Technology Research Laboratory (TRL), the Exploratory Materials Laboratory (EML), and the Electron Beam Lithography Laboratory (EBL). ICL has been designed and equipped to serve as a highly advanced integrated circuit, device, structures, and process research facility. TRL supports the development of new process technologies by providing facilities for the fabrication of novel micro- and nano-structures. EML is a highly flexible lab with all basic fabrication capabilities and almost no restrictions on materials. The EBL provides advanced electron beam lithography using a high-resolution, fast through-put Elionix F-125 e-beam writer; it is jointly managed by MTL and the Research Laboratory of Electronics.

More than 130 MIT faculty and senior research staff, 550 graduate students and postdoctoral associates, and 14 undergraduates are involved in shared-facilities activities at MTL. Approximately 38 PhD and 20 SM and MEng degrees whose primary area of research is strongly coupled to MTL facilities are awarded each academic year in more than 10 academic departments.

For information regarding MTL’s technical operations and capabilities, contact Dr. Vicky Diadiuk (diadiuk@mit.edu), associate director for operations, 617-253-0731. For information regarding MTL programs and other general information, contact Sherene Aram (smaram@mit.edu), administrative officer, 617-253-0151.

MIT CENTER FOR ART, SCIENCE & TECHNOLOGY

The Center for Art, Science & Technology (MIT CAST) (http://arts.mit.edu/cast) facilitates and creates opportunities for exchange and collaboration among artists, engineers, and scientists. A joint initiative of the Office of the Provost, the School of Architecture and Planning, and the School of Humanities, Arts, and Social Sciences, the center is committed to fostering a culture where the arts, science and technology thrive as interrelated, mutually informing modes of exploration, knowledge and discovery.

CAST’s activities include:

• Soliciting and supporting cross-disciplinary curricular initiatives that integrate the arts into the core curriculum and create new artistic work or materials, media, and technologies for artistic expression
• Spearheading a visiting artists program that emphasizes creative process, extensive interaction with MIT faculty, students, and researchers, and cross-fertilization among disciplines
The MIT Energy Initiative (MITEI) (http://energy.mit.edu) is MIT's hub for energy research, education, and outreach. Founded in 2006, MITEI helps develop technologies and solutions to deliver clean, affordable, and plentiful sources of energy to efficiently meet global energy needs while minimizing environmental impacts, dramatically reducing greenhouse gas emissions, and mitigating climate change.

Research

MITEI pairs world-class research teams from across the Institute with its industry and government members to respond to specific energy challenges. Through MITEI's Low-Carbon Energy Centers (http://energy.mit.edu/lcec), currently under development, companies and government entities work together to advance MIT student and faculty research focused on particular technology areas: solar energy; energy storage; advanced nuclear energy systems; nuclear fusion; materials for energy and extreme environments; carbon capture, utilization, and storage; energy bioscience; and electric power systems. MITEI's Low-Carbon Energy Centers are a key element of MIT's Plan for Action on Climate Change (http://climateaction.mit.edu).

The MITEI Seed Fund Program (http://energy.mit.edu/funding) supports innovative, early-stage research across the energy spectrum—from gas monetization to advanced materials to big data to related environmental areas. The program seeks to encourage researchers from across MIT to collaborate in exploring new energy-related ideas and opening up new avenues for research. Each year, the program attracts well-established energy experts as well as new faculty who need start-up support and others who are applying their expertise in different fields to energy for the first time. Funding is provided by MITEI's Founding and Sustaining Members and by philanthropic contributors. To date, the program has provided approximately $22.75 million for 170 early-stage research projects.

Education

MITEI's Education Program (http://energy.mit.edu/landing-page/education) develops cross-disciplinary learning opportunities for undergraduate and graduate students, supporting students through a variety of programs—inside and outside the classroom:

- A popular Institute-wide undergraduate Minor in Energy Studies (p. 355) complements the deep expertise obtained in a student's major with a broad understanding of the interlinked realms of science, technology, and social sciences as they relate to energy and associated environmental challenges.
- Named MIT Energy Fellowships
- MITEI Undergraduate Research Opportunities Program (UROP) (http://energy.mit.edu/urop) placements and support
- Web database with information on energy classes in departments across all five schools
- Support for student groups focusing on energy and related environmental topics
- An Undergraduate Energy Commons under the dome in Building 10 that provides undergraduate students studying energy with a place to gather, form teams, and discuss projects

The education program supports the Energy Education Task Force with developing the energy curriculum and establishing and communicating a model for interdisciplinary energy education at the Institute.

Outreach

MITEI provides in-depth, high-quality analysis about current energy topics for policymakers, industry leaders, and the public. MITEI has produced seven major "Future of..." (http://energy.mit.edu/research-type/future-of) reports, which stem from multiyear, multidisciplinary studies, and are designed to provide policy makers, researchers, environmentalists, and industry with technically grounded analyses to inform options for a clean energy future. These studies have focused on the future of solar energy, the future of the electric grid, and the future of natural gas, to name a few.

Another recent multidisciplinary research report, “Utility of the Future (http://energy.mit.edu/research/utility-future-study),” was released in December 2016 to provide guidance to regulators, policymakers, and industry leaders to enable an efficient evolution of the electric power sector. A new study, “Mobility of the Future (https://energy.mit.edu/research/mobility-future-study),” is currently underway, and examines how developments in technology, fuel, infrastructure, policy, and consumer preference will drive changes in future transportation.

MITEI sponsors numerous colloquia and seminars each year. Seminars are designed to share current research from MIT and
elsewhere, and are attended by students, faculty, and staff involved in energy research as well as by the local community. Colloquia bring together much larger and diverse MIT constituencies, and feature talks by prominent policymakers followed by more general-interest energy discussions.

MITEI also publishes *Energy Futures*, a semiannual magazine of energy research, education, and innovation.

Within MIT, MITEI fosters a sense of community among those interested in energy and provides opportunities, including funding opportunities for faculty and students, supporting student-led energy groups, and hosting events with thought leaders across the energy spectrum.

**MIT ENVIRONMENTAL SOLUTIONS INITIATIVE**

The MIT Environmental Solutions Initiative (ESI) (https://environmentsolutions.mit.edu) advances science, engineering, policy and social science, design, the humanities, and the arts toward a people-centric and planet-positive future.

Founded in 2014, ESI’s overarching goal is to accelerate solutions to the world’s environmental challenges. To do so, ESI channels MIT’s research and education capacity to advance science, invent technologies, and innovate policies for mitigating carbon emissions and adapting to a changing climate in the face of global development needs and growing pressures on natural resources.

ESI also leverages MIT’s proven convening power to engage with key stakeholders and decision-makers in supporting the deployment of solutions worldwide.

ESI’s approach is fundamentally multidisciplinary. Education priorities include an undergraduate minor in Environment and Sustainability (p. 358) open to students in all majors, and the incorporation of environmental content into the GIRs. Research priorities include climate science and earth systems; cities and infrastructure; and sustainable production and consumption.

ESI is directed by John E. Fernández, professor of architecture. For more information, please email (esi@mit.edu) headquarters.

**MIT INNOVATION INITIATIVE**

The MIT Innovation Initiative (MITii) (http://innovation.mit.edu) works with all five MIT Schools to strengthen the educational pathways and networks for students, alumni, and partners to move ideas from conception to impact. In MIT’s tradition of *mens et manus*, we do so by combining hands-on, global opportunities for building expertise in the innovation process with insights developed from the evidence-based science of innovation.

MITii administers the interdisciplinary Entrepreneurship and Innovation (E&I) Minor (http://innovation.mit.edu/minor). The E&I Minor is designed to prepare MIT undergraduates to serve as leaders in the innovation economy with the knowledge, skills, and confidence to develop, scale, and deliver breakthrough solutions to real-world problems.

The initiative also leads several efforts to strengthen MIT’s ability to provide students with hands-on opportunities to learn about making, prototyping, and manufacturing. These activities are delivered through Project Manus (http://project-manus.mit.edu/about), the MIT Hong Kong Innovation Node, and new campus innovation hubs for co-working and collaboration.

Through the MIT Innovation Initiative Laboratory for Innovation Science and Policy, MITii is systematically investigating the factors that shape innovation outcomes—including policies, incentives, institutions, and infrastructure—at every level from individual and organizational to region, national, and global.

**MIT KAVLI INSTITUTE FOR ASTROPHYSICS AND SPACE RESEARCH**

The MIT Kavli Institute for Astrophysics and Space Research (MKI) (http://space.mit.edu) offers students, faculty, and professional research staff opportunities to participate in a broadly based program of astrophysics and space-related research. For example, research programs are conducted in X-ray, radio, and optical/infrared astronomy; gravitational physics and space plasma physics; and space engineering. Areas of research include cosmology, exoplanets, the oldest stars, galaxies and intergalactic matter in the early universe, high-energy astrophysics, astrophysics in strong gravitational fields, and theoretical astrophysics, among other topics.

Studies often involve experiments carried by sounding rockets, the International Space Station, orbiting satellites, or deep space probes. The experimental programs are complemented by ground-based research in similar fields and by laboratory development of suitable instrumentation for the space-based and ground-based experiments. An active program of theoretical studies in astrophysics and space physics is also supported.

MKI is the focus for MIT’s participation in the Magellan Observatory Consortium in Chile, the Laser Interferometer Gravitational-Wave Observatory (LIGO), the Chandra X-ray Observatory Science Center, the Hydrogen Epoch of Reionization Array (HERA), and the Neutron Star Interior Composition Explorer (NICER). MKI leads the development of the Transiting Exoplanet Survey Satellite (TESS), a NASA-supported Explorer mission scheduled for launch in 2018.

Extensive data handling and computational facilities are available for the analysis and reduction of scientific data. An experienced, well-equipped group of engineers and technicians provides design, construction, and testing of instrumentation in support of the ground-based and flight programs.
The variety of scientific and technical problems that arise in these investigations affords numerous opportunities for graduate thesis research. In addition, there is major participation by undergraduate students in programs of theoretical studies, data analysis and the development of new instruments.

For further information, contact the director, Professor Jacqueline N. Hewitt, Room 37-241, 617-253-3071.

MIT MEDIA LAB

Actively promoting a unique, multidisciplinary culture, the MIT Media Lab (http://www.media.mit.edu) encourages an unconventional mixing and matching of seemingly disparate research areas. Since opening its doors in 1985, the Lab has pioneered such areas as wearable computing, tangible interfaces, and affective computing. Today, faculty members, research staff, and students at the Lab work in more than 25 research groups on some 350 projects that range from digital approaches for treating neurological disorders; to a stackable, electric car for sustainable cities; to smart prostheses; to advanced imaging technologies that can “see around a corner.” The Lab is supported by more than 70 sponsors, including some of the world's leading corporations. These sponsors provide a majority of the Lab's approximately $45 million annual operating budget. Research at the Media Lab is tightly coupled with the graduate academic Program in Media Arts and Sciences (p. 130), which offers master's and doctoral degrees.

MIT OPEN LEARNING

MIT undergraduate and graduate students can become involved in research and in creating digital courses, modules and tools, which can serve as vehicles to advance understanding of pedagogy and learning.

The Mitx Digital Learning Lab (https://openlearning.mit.edu/mitx-faculty/mitx-digital-learning-lab) is a collaborative program between MIT Open Learning (http://openlearning.mit.edu) and MIT's academic departments with a mission to learn about, progress, and innovate in digital learning on campus and beyond. Members of the Digital Learning Lab (Digital Learning Scientists and Digital Learning Fellows) serve as ambassadors to MIT departments, collaborating with faculty in developing and delivering digital learning projects.

There are opportunities for postdoctoral, graduate and undergraduate students to join individual course teams or undertake digital learning projects. Mitx UROPs have developed a host of tools (http://web.mit.edu/6.mitx/www/#line-fitting-600) from mathlets (http://mathlets.org/about)—highly interactive applets designed to enhance STEM classes—to Shakespeare Visualizations.

For further information, contact MIT Open Learning (http://openlearning.mit.edu/contact-us).

MIT PORTUGAL PROGRAM

The MIT Portugal Program (MPP) was launched in 2006 by MIT and the Portuguese Ministry of Science, Technology, and Higher Education as a large-scale international collaboration bringing together MIT and leading universities, industry, and government in Portugal. The aim of this partnership is to strengthen Portugal’s knowledge base and international competitiveness through a strategic investment in people, knowledge, and ideas in innovative technology sectors.

MPP has developed PhD and master's programs in four key areas—Bioengineering Systems, Sustainable Energy Systems, Transportation Systems, and Engineering Design and Advanced Manufacturing. Collaborative research projects involve faculty, students, and industry from both sides of the Atlantic. In general, MPP activities include faculty and students from MIT departments in all five schools at the Institute. MIT faculty regularly contribute to PhD and master's courses in Portugal, either in person or via videoconference. MIT students working with MIT faculty involved in the program, might make research trips to Portugal to enhance collaborative relationships on joint projects and serve as research and occasionally teaching assistants. In addition, MPP supports MISTI Portugal (http://misti.mit.edu/student-programs/location/portugal), which offers internship opportunities for MIT students to conduct research related to their work at Portuguese companies.

For further information, contact Christian Prothmann (ckp@mit.edu), director of research.

MIT PROFESSIONAL EDUCATION

The mission of MIT Professional Education (http://web.mit.edu/professional) is to provide a gateway to MIT research and expertise for professionals around the globe. These programs offer lifelong learning opportunities—whether on-campus, online, in an international location, or at your company site. Professionals from all industries have the opportunity to gain crucial knowledge in specialized fields to advance their careers, help their companies, and have an impact on the world. More than 100 MIT faculty teach in these courses, enabling them to serve and enhance MIT's connections with the global practitioner community.

Short Programs. Held primarily in the summer, MIT Professional Education Short Programs offers more than 50 on-campus courses that explore wide-ranging topics and are led by prominent MIT faculty—all recognized leaders in their respective fields.
A cornerstone of the ACT program is what we call “embedded research,” engaging sites and publics beyond the MIT campus. CAVS inspired this commitment with its sustained, culturally significant engagement with the city of Boston. Embedded research is not only a way for our program to build bridges to other sites and communities in flux or in conflict, it is also a way for us to encourage our students to foster meaningful, sustained engagements as part of their practice, as artists and as citizens. This emphasis on embedded research, we believe, is part of what makes ACT unique.

ACT offers a rigorous and highly selective two-year graduate program, the Master of Science in Art Culture and Technology (SMACT), as well as an undergraduate minor and concentration. It also offers a variety of introductory courses to the general MIT student population and subjects tailored to undergraduates majoring in architecture. Advanced courses related to specific media and topics are offered as electives for both undergraduate and graduate students. ACT studio courses are complemented by practical workshops and discussions in theory and criticism, often provided by fellows and visitors to the program. Studios also regularly involve research field trips, which, in addition to their research/pedagogical value, help ACT promote new circuits of artistic and scholarly collaboration.

For further information, contact ACT (act@mit.edu), Room E15-212, 617-253-5229, fax 617-253-3977.

MIT Sea Grant College Program

Founded in 1966 by Congress, the National Sea Grant College Program is a network of 33 programs working to promote the conservation and sustainable development of our marine resources through research, education, and outreach. Sea Grant is funded by the US Department of Commerce’s National Oceanic and Atmospheric Administration.

MIT was designated a Sea Grant College Program (http://seagrant.mit.edu) in 1976 and was the first Sea Grant program to receive funding for research. The program's competitive annual funding for Massachusetts academic investigators supports innovative research that responds to human health and safety concerns, along with efforts that produce new tools, instruments, and pioneering technologies. Projects range from the development of biomimetic underwater sensors to water quality monitoring in the Boston Harbor.

The program's Marine Advisory Services (MAS) conducts research and outreach that informs management decisions. MAS staff includes specialists in marine ecology and biology, coastal policy, social sciences, and communication. The team works together to offer scientific guidance, training, workshops, access to databases, and informational materials to stakeholders.
MIT Sea Grant has two in-house research labs. The Autonomous Underwater Vehicle (AUV) Laboratory designs marine robots with a multitude of applications in oceanography, environmental monitoring, and underwater resource studies. The Design Lab develops and applies high-fidelity numerical models to address coastal inundation and wave storm surges and innovative tools for high efficiency, low carbon footprint ships, high-speed marine vehicles, including autonomous surface crafts.

Community partners and advisory committees include individuals from academic circles, non-government organizations, industry leaders, and state and local government agencies. Constituents include Massachusetts coastal communities, seafood harvesters and consumers, fellow ocean scientists and engineers, and the general public relying on the ocean for sustenance, energy, recreation, travel, and wonder.

Graduate and undergraduate MIT and visiting students participate in many Sea Grant research projects with support available to them from UROP or from their home institutions.

For more information, contact the director, Professor Michael Triantafyllou (seagrantinfo@mit.edu), Room NW98-157, 617-253-9614.

NUCLEAR REACTOR LABORATORY

The MIT Nuclear Reactor Laboratory (NRL) (http://web.mit.edu/nrl/www) is an interdepartmental center that operates a 6 MW research reactor known as the MITR. The NRL has a distinguished history of providing faculty and students from MIT and other institutions with a state-of-the-art neutron source along with a highly efficient, well-organized staff and infrastructure.

The MITR is integrated into the national research and development program as a partner facility of the Department of Energy’s Nuclear Science User Facilities (NSUF). A wide variety of sample irradiation facilities is available in the MITR, with fast (E>0.1 MeV) and thermal neutron fluxes up to $1.3 \times 10^{14}$ and $5 \times 10^{13}$ per cm$^2$ per second. These include temperature-controlled in-pile facilities, a neutron diffractometer, pneumatic rabbits for short-term irradiations and neutron activation analysis, and other irradiation and beam ports. In-pile loops that closely simulate the environment in light water power reactors are available for corrosion and irradiation damage testing. An in-pile high-temperature irradiation facility for advanced materials studies has been successfully demonstrated to operate up to 1400 °C.

Other experimental facilities and instrumentation include radiochemistry laboratories; hot cells for dismantling or testing; a shielded hot box for handling and nondestructive testing of radioactive materials; radiation detection equipment; delayed and prompt gamma activation analysis facilities; an inductively coupled plasma spectrometer (ICP-OES); and a materials characterization laboratory. A thermal hydraulic lab was established with the Nuclear Science and Engineering Department to study heat transfer properties of nanofluids for nuclear reactor and other thermal management applications.

Currently, one of the major research areas at the reactor involves in-core irradiations to support materials and fuel development for existing and next generation power reactors. Accident tolerant fuel development for light water reactors and material behavior and tritium transport studies for fluoride-salt-cooled, high-temperature reactors are the subjects of extensive irradiation programs. Other active research areas are in-core sensor development and testing, advanced fuel irradiation testing, neutron optics and nuclear trace analysis application to nutritional studies and other life science, geoscience, environmental and nuclear engineering problems. The NRL is also involved in the development of compact, high-intensity, X-ray light sources.

Undergraduates can be involved in the operation of the reactor by completing the reactor operator training program, which can lead to being employed part-time by the NRL as an NRC-licensed reactor operator, and/or utilize the reactor in research activities through special projects or senior theses. In addition, graduate thesis research can be carried out in the various research areas mentioned above.

Additional information is available on the website (http://web.mit.edu/nrl/www).

OPERATIONS RESEARCH CENTER

The Operations Research Center (ORC) (http://web.mit.edu/orc/www) provides academic and research opportunities for graduate students and faculty interested in an interdisciplinary field that draws upon ideas from engineering, management, and mathematics in order to apply scientific methods to decision making. ORC includes faculty participants from the Sloan School of Management, as well as from the departments of Electrical Engineering and Computer Science, Aeronautics and Astronautics, Mathematics, Civil and Environmental Engineering, Mechanical Engineering, Urban Studies and Planning, and Economics. More than 50 faculty and 85 graduate students are affiliated with the center.

The center coordinates SM and PhD programs (p. 375) in operations research, which provides a strong background in theory as well as the practical techniques used in building models for a wide variety of applications.

For further information about the Operations Research Center and its degree programs, contact Laura Rose (lrose@mit.edu), Room E40-107, 617-253-9303.
PIECOWER INSTITUTE FOR LEARNING AND MEMORY

The Picower Institute for Learning and Memory (http://picower.mit.edu) is an interdisciplinary research entity within MIT’s School of Science, with 14 faculty members holding academic appointments in the Department of Brain and Cognitive Sciences, the Department of Biology, the Institute for Medical Engineering & Science, and the Department of Chemical Engineering.

The Picower Institute is a community of scientists dedicated to understanding the mechanisms that drive learning and memory and related functions such as cognition, emotion, perception, and consciousness. Institute researchers explore the brain at multiple scales, from genes and molecules, to cells and synapses, to circuits and systems, producing novel insights into how disruptions in these mechanisms can lead to developmental, psychiatric, or neurodegenerative disease. The institute offers exciting research opportunities from undergraduate to postdoctoral levels.

Picower Institute investigators explore:

- The genetic, molecular, cellular, circuit and systems means by which memory is formed, stored and recalled
- How sleep and dreams affect memory
- How neurons form synaptic connections and how those connections transmit information and change with experience
- How different brain regions communicate in decision making, working memory and assigning feelings to memories
- The intricacies underlying the executive functions of the cerebral cortex

The institute’s highly collaborative, cross-disciplinary strategy spawns exciting joint projects among its various laboratories. Many Picower faculty also are inventors of unique technologies and techniques that are redefining the practice of neuroscience.

Key Picower Institute discoveries are shedding light on disorders ranging from Down syndrome and autism to Alzheimer’s, Huntington’s and Parkinson’s diseases, schizophrenia, depression and addiction.

For further information, contact the director, Professor Li-Huei Tsai (lhtsai@mit.edu), Room 46-4235A, 617-324-1660.

PLASMA SCIENCE AND FUSION CENTER

The timely development of practical fusion energy in the 21st century is arguably one of the most important challenges facing the scientific and engineering community worldwide. The Plasma Science and Fusion Center (PSFC) provides a focus for experimental and theoretical studies in plasma science, magnetic and inertial fusion research, and the development of related enabling technologies. The center fosters independent creativity and provides the intellectual environment for the educational training of students, research scientists, and engineers. Research activities at the Plasma Science and Fusion Center fall into five major programmatic divisions as described below.

The Magnetic Fusion Experiments (MFE) Division is developing a basic understanding of the stability and transport properties of high-temperature magnetically confined toroidal plasmas at reactor-relevant conditions. The group’s present research program seeks to understand energy, particle, and momentum transport, coupling between the core plasma and boundary plasma, pedestal physics, and heating and current drive in fusion plasmas. The division is actively researching ways novel divertors can withstand the first wall power loadings comparable to those of future fusion reactors. In addition, the group seeks to optimize plasma performance with Radio Frequency (RF) heating and non-inductive current profile control using novel configurations and deployment of high-power RF transmitters (8 MW at 40–80 MHz) and microwaves (3 MW at 4.6 GHz frequency). The experimental team of scientists, postdocs, students, and engineers collaborates with other fusion facilities, domestically primarily at DIII-D, and internationally with European and Asian facilities. High performance computing at national supercomputing centers, as well as local clusters, plays a critical role in validating models with experiments; close collaboration between experimentalists and computational physicists is a foundational aspect of research in MFE at PSFC. The high magnetic field tokamak approach, long a focus of the division’s research on the Alcator series of facilities, is a promising avenue to practical fusion energy production, enabled by the recent commercial development of high temperature rare-earth barium copper oxide superconducting tapes. Starting in 2018, the MFE Division, working closely with the Magnets and Cryogenics Division, has entered a partnership with a private company, Commonwealth Fusion Systems (CFS). CFS is sponsoring research at the PSFC to develop this new superconducting technology. After successful development of fusion-scale magnets, we intend to design, build and operate the world’s first net energy gain tokamak, SPARC.

The Plasma Theory and Computation Division is composed of scientists, students, and faculty. It carries out research in support of the national and international magnetic fusion energy programs as well as research on basic plasma science, and space and astrophysics. The research consists of elements involving analytic theory, high performance computation and integrated modeling, verification of computational models, validation of theoretical/computational predictions against experimental results, and the development of advanced reduced models applicable to whole device simulations. The division collaborates extensively with major plasma and fusion research centers in the US, England, Europe, Japan, China, and Korea.

The High-Energy-Density Physics Division designs and implements experiments on national facilities, such as the OMEGA laser facility at the University of Rochester Laboratory for Laser Energetics, and the National Ignition Facility at Lawrence Livermore National Facility.
This division discovered the existence of megagauss magnetic fields in laser-compressed pellets. This division also performs related theoretical calculations to study and explore the nonlinear dynamics and properties of plasmas in inertial fusion and those under the extreme conditions of density (~1000 g/cc), pressure (~1000 gigabar), and field strength (~megagauss). Most recently the division has conducted pioneering nuclear science experiments using high-energy-density plasmas, ushering in a new and exciting field of research, plasma nuclear science, blending the separate disciplines of plasma and nuclear physics.

The Plasma Science and Technology Division conducts experimental and theoretical research on a wide range of topics, primarily in plasma-related areas, that are not directly part of the program of fusion energy research. A major research effort investigates the physical principles of novel sources of high-power, coherent radiation ranging from the microwave to the terahertz region of the electromagnetic spectrum. Current research focuses on the gyrotron (or cyclotron resonance maser), a novel source of millimeter wave and terahertz radiation using high magnetic fields, and on novel forms of the traveling wave tube amplifier. One promising application of the gyrotron, being studied experimentally and theoretically, is in boring through hard rock by melting and vaporizing the rock material. In addition, the division conducts research on novel concepts for high-gradient acceleration of electrons to demonstrate the principles required for future generations of electron linear accelerators. Research is also conducted on the use of low-temperatures plasmas and ions in the modification of materials. A strong effort is also carried out on spintronics, novel topological insulator systems and spin polarized transport in nanostructures of metals and semiconductors.

The Magnets and Cryogenics Division provides critical engineering support to the national fusion energy sciences program for both operating magnetic confinement fusion experiments and advanced fusion design projects. The division has extensive experience in design, analysis, development, and fabrication of advanced high-field copper and superconducting magnet technology. Present research is focused on developing second-generation high-temperature superconductors for high-field, high-current cables for fusion magnets, and for applications of superconducting DC power transmission and distribution. The division is also developing very high-field, compact cyclotron accelerators for applications such as proton and carbon radiotherapy for cancer treatment, active detection of strategic nuclear materials for protection against weapons of mass destruction, and variable energy, heavy-ion accelerators for fusion materials research.

The Magnetic Resonance Division, including the members of Francis Bitter Magnet Laboratory, encompasses the research focused on the use of magnetic resonance for scientific investigation, and the development of experimental tools to carry out those investigations. The division seeks to develop sophisticated technologies for magnetic resonance in the areas of solution-state nuclear magnetic resonance (NMR), solid-state NMR, electron paramagnetic resonance (EPR), and dynamic nuclear polarization (DNP); to apply those technologies to biologically and medically significant research, both in-house and collaboratively; to operate a state-of-the-art instrument facility to serve needs of researchers in chemistry, biology, and medicine; and to openly disseminate and provide training in technological developments at the center. In addition, the division has programs to design and construct the next generation NMR magnet operating at a 1H frequency of 1.3 GHz using high temperature superconductor.

Many academic departments are affiliated with PSFC, including Physics, Nuclear Science and Engineering, Electrical Engineering and Computer Science, Materials Science and Engineering, Mechanical Engineering, Chemical Engineering, and Aeronautics. The center’s programs and laboratories provide excellent forums for training students and professional researchers, and offer world-class research facilities to faculty members from many departments. Forty-five graduate students are currently involved at all levels of thesis work. Undergraduates also can participate through the Undergraduate Research Opportunities Program.

For further information contact the director, Professor Dennis Whyte (whyte@psfc.mit.edu), Room NW17-288, 617-253-1748.

RESEARCH LABORATORY OF ELECTRONICS

The Research Laboratory of Electronics (RLE) (http://www.rle.mit.edu) was founded in 1946 as the first of the Institute’s great modern interdepartmental research centers. Today, it is one of MIT’s largest, as well as the most diverse in intellectual interests.

RLE research is focused on seven major themes:

- Atomic physics
- Information science and systems
- Quantum computation and communication
- Energy, power, and electromagnetics
- Photonic materials, devices, and systems
- Nanoscale materials, devices, and systems
- Biomedical science and engineering

Over 70 principal investigators—of whom 64 are MIT faculty members—direct RLE’s research projects. These faculty members are drawn from seven MIT departments, including Biological Engineering, Electrical Engineering and Computer Science, Materials Science and Engineering, Mathematics, Mechanical Engineering, Nuclear Science and Engineering, and Physics, and from MIT’s Institute for Medical Engineering and Science.

More than 400 MIT graduate and undergraduate students—also drawn from these departments and divisions—make RLE one of the primary environments for student learning at MIT. In fact, it is the
combination of forefront research with student participation across multiple academic disciplines that characterizes the RLE culture.

RLE’s research efforts are supported by the most diverse sponsor base at MIT. Principal sponsors include the Department of Defense, National Institutes of Health, National Science Foundation, Department of Energy, industry, and nonprofit foundations and organizations.

In addition, a significant share of RLE’s activities is self-funded from gifts and from the discretionary resources of the laboratory and its principal investigators. Approximately a third of RLE’s activities involves extramural collaborations with universities, institutions, and industry, making the laboratory one of MIT’s principal points of connection with peer institutions, government, and the business world.

Nearly all RLE activities take place at MIT’s main campus in Cambridge. Some also take place at the Massachusetts Eye and Ear Infirmary in Boston.

For further information, contact the RLE Headquarters, Room 36-413, 617-253-2519.

**SIMONS CENTER FOR THE SOCIAL BRAIN**

The Simons Center for the Social Brain (http://web.mit.edu/scsb) at MIT was established in 2012. The mission of the Simons Center for the Social Brain is to understand the neural mechanisms underlying social cognition and behavior, and to translate this knowledge into better diagnosis and treatment of autism spectrum disorders (ASD).

The Simons Center studies the underlying mechanisms of ASD in both humans and relevant model organisms and systems, as neural correlates of social cognition and behavior exist in diverse species. Our approaches take advantage of MIT’s strengths in genetics and genomics, molecular and cell biology, analyses of neural circuits and systems, cognitive psychology, computation, and engineering.

Our programs include funding for innovative, collaborative team projects and postdoctoral fellowships, as well as events that reach wide audience, including a colloquium series and a lunchtime talks series.

For further information, contact the program administrator, Eleana Ricci, Room 46-6216, 617-253-9340.

**SINGAPORE-MIT ALLIANCE FOR RESEARCH AND TECHNOLOGY CENTRE**

The Singapore-MIT Alliance for Research and Technology (SMART) (http://smart.mit.edu) Centre is a major research enterprise established by MIT in partnership with the National Research Foundation of Singapore (NRF). The SMART Centre serves as an intellectual hub for research interactions between MIT and Singapore at the frontiers of science and technology. The goals and aims of the SMART Centre are to:

- Identify and carry out research on critical problems of societal significance and develop innovative solutions through its Interdisciplinary Research Groups (IRGs)
- Become a magnet for attracting and anchoring global research talent to Singapore
- Develop robust partnerships with local universities and institutions in Singapore
- Engage in graduate education by co-advising local doctoral students and postdoctoral associates
- Help instill a culture of translational research, entrepreneurship and technology transfer through the SMART Innovation Centre

Established in 2007, the SMART Center further expands and develops this partnership between MIT and Singapore and allows faculty, researchers and graduate students from MIT to collaborate with their counterparts from universities, polytechnics, research institutes, governmental agencies, and industry in Singapore and in Asia.

The SMART Centre is MIT’s first research centre outside of Cambridge, and its largest international research endeavor. The centre is also the first entity in the Campus for Research Excellence and Technological Enterprise (CREATE). Other universities located at CREATE are ETH Zurich, Cambridge University, Technical University Munich, Peking University, Technion Israel Institute of Technology, and University of California, Berkeley.

**SMART Interdisciplinary Research Groups**

The SMART Centre allows researchers from MIT to collaborate with their counterparts from universities, research institutes and industries in Singapore and Asia to perform interdisciplinary, experimental, computational and translational research. With many MIT faculty members, postdoctoral fellows, PhD students, and staff participating at SMART, these IRGs are helping promote a vibrant knowledge-based atmosphere in Singapore.

Five IRGs are under the SMART Centre, each headed by a senior MIT faculty member: Antimicrobial Resistance, BioSystems and Micromechanics, Disruptive & Sustainable Technologies for Agricultural Precision, Future Urban Mobility, and Low Energy Electronic Systems.

**Innovation Centre**

In addition to the IRGs that carry out research, SMART has also set up an Innovation Centre (https://smart.mit.edu/innovation-centre/about-smart-innovation-centre) modeled on MIT’s Deshpande Center but adapted to the culture and practices of Singapore. Its mission is to instill a culture of translational research, entrepreneurship, and technology transfer. Two types of awards are given: Ignition Grants,
for very early proof-of-principle development and Innovation Grants, for further proof-of-concept development.

SMART Centre Graduate Fellowship Programme

The Graduate Fellowship Programme (https://smart.mit.edu/fellowships/for-graduates-smart-graduates) is open to currently enrolled first-year students and entering doctoral students from the Nanyang Technological University (NTU) and the National University of Singapore (NUS), Singapore University for Technology and Design (SUTD), and Singapore Management University (SMU). Its goal is to attract and retain the best and most talented doctoral students from Singapore, the region and beyond, giving them the unique opportunity to be involved in strategic research at the SMART Centre and to work with faculty members from MIT, NTU, NUS, SUTD, and SMU.

Students selected for the programme receive up to four years of full tuition fees at the student’s home university, a monthly stipend, and a travel grant for a six-month residency at MIT.

SMART Centre Undergraduate Research Opportunities Programme

The SMART Undergraduate Research Fellowship Programme (SMURF) (https://smart.mit.edu/fellowships/for-undergraduate-smurf) allows undergraduates from MIT, NTU, and NUS to participate in an MIT faculty member’s research projects at the SMART Centre and interact with students, researchers, and faculty members. Students selected spend a summer at the SMART Centre. Each undergraduate has an MIT faculty member as a mentor/supervisor and the undergraduate has access and use of the faculty’s laboratory and equipment.

Students are paid a competitive stipend; those from MIT also have their travel and accommodation paid for. The aim of the SMART SMURF Programme is to expose undergraduate students to research experiences involving an internationally diverse group of investigators.

SMART Centre Postdoctoral Research Fellows Programme

The highly selective Postdoctoral Research Fellows Programme (https://smart.mit.edu/fellowships/for-post-doctoral-smart-scholars) aims to attract exceptionally talented postdoctoral researchers to Singapore. These awards provide a unique opportunity for recent PhD graduates to participate in the SMART Centre in Singapore. The awards, to be given annually, are open to those with less than three years postdoctoral experience.

In contrast to typical postdoctoral programmes where the postdoctoral works for a supervisor on a project defined by the supervisor, this programme allows the investigators to conduct research into questions of their own interest. The fellowship recipient is able to conduct research of his/her own choice in Singapore within, but not necessarily tied closely to, a current project in one of the existing SMART IRGs. In addition to a generous stipend each fellow also receives a research grant and travel funds.

For more information about SMART, contact the executive director, John C. Desforge, Room 8-407, 617-452-3014.

SOCIOTECHNICAL SYSTEMS RESEARCH CENTER

The Sociotechnical Systems Research Center (SSRC) (http://ssrc.mit.edu) is an interdisciplinary research center at MIT that focuses on the high-impact, complex, sociotechnical systems that shape our world.

SSRC brings together faculty, researchers, students, and staff from across MIT to study and seek solutions to complex systems challenges that span healthcare, energy, infrastructure networks, the environment, and international development.

SSRC research partners include:

- Center for Biomedical Innovation (CBI) (http://cbi.mit.edu)
- Center for Complex Engineering Systems (CCES) (http://ssrc.mit.edu/programs/center-complex-engineering-systems-cces)
- Connection Science (http://connection.mit.edu)
- Ford-MIT Alliance (http://ssrc.mit.edu/ford-mit-alliance)
- MIT Consortium for Engineering Program Excellence (CEPE) (http://ssrc.mit.edu/programs/mit-consortium-engineering-program-excellence)
- Systems Engineering Advancement Research Initiative (SEArI) (http://seari.mit.edu)

WHITEHEAD INSTITUTE FOR BIOMEDICAL RESEARCH

Whitehead Institute for Biomedical Research (http://wi.mit.edu) provides educational and research opportunities for postdoctoral researchers, and graduate and undergraduate students in the biological sciences.

A nonprofit, independent research institution, Whitehead Institute is affiliated with MIT through its members, who hold faculty positions at MIT. Bright young investigators direct labs at Whitehead Institute through the Whitehead Fellows program; and a larger number of young investigators hold traditional postdoctoral positions.

Each year, MIT students pursue graduate degrees at Whitehead Institute through the Department of Biology. Undergraduate students pursue research objectives through MIT’s Undergraduate Research Opportunities Program (p. 44).

Whitehead’s research excellence is nurtured by the collaborative spirit of its faculty and the creativity and dedication of its student investigators and postdoctoral scientists. Whitehead’s primary
research focus is basic developmental biology, with an emphasis on molecular and cell biology, genetics and genomics, epigenetics, metabolism, plant biology, and development of new model systems. Areas of inquiry at Whitehead include cancer, neurodevelopment and neurological disorders, transgenic science, stem cells, regenerative biology, cell division, and vertebrate development. Its scientists are at the forefront of metabolomics and CRISPR technologies.

Whitehead Institute is engaged in research collaborations with numerous academic and industrial partners worldwide. These partnerships expand the scope of Whitehead research, as well as aid the translation of basic research into advances in disease prevention, diagnosis, and therapy.

Whitehead Institute also supports a suite of programs that foster high school science education and public engagement with science and technology. Students and postdoctoral scientists interested in science education and community outreach are encouraged to participate in these programs.

Further information may be obtained by visiting Whitehead Institute’s website (http://wi.mit.edu); by contacting Human Resources, Whitehead Institute, 455 Main Street, Cambridge, MA 02142-1479; or by calling 617-258-5555.

WOMEN’S AND GENDER STUDIES PROGRAM

The Program in Women’s and Gender Studies (WGS) (http://wgs.mit.edu/about-us) educates MIT undergraduates on the importance of gender equity, and promotes a broad understanding of gender and its complex intersection with sexuality, race, ethnicity, class, ability, religious affiliation, and other categories of identity. Courses offer new perspectives in a variety of subjects relating to historical and contemporary questions of gender and sexuality as manifested in the US and across the globe. WGS faculty come from multiple units across the Institute, including Anthropology; Architecture; Comparative Media Studies/Writing; Global Studies and Languages; History; Linguistics and Philosophy; Literature; Political Science; Science, Technology and Society; and Urban Studies and Planning.

Undergraduates can choose a concentration or a minor in WGS and can petition for an interdisciplinary major in WGS or complete the joint major in Humanities and Engineering or Science (21E/21S). The curriculum includes a core subject, WGS.101 Introduction to Women’s and Gender Studies for the minor and major, a higher level theory subject, WGS.301[J] Feminist Thought, and a selection of subjects from many departments at the Institute. Special independent study topics and Undergraduate Research Opportunities Program (UROP) (p. 44) projects can be arranged.

Graduate students may receive graduate credit in designated WGS subjects, and may also enroll in courses offered through the


For more information, contact the program manager, Emily Neill (erneill@mit.edu), Room 14E-316, 617-253-2642.
SCHOOLS AND COURSES

Schools

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- School of Engineering (p. 142)
- School of Humanities, Arts, and Social Sciences (p. 238)
- MIT Sloan School of Management (p. 281)
- School of Science (p. 298)

Courses

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- Anthropology (Course 21A) (p. 241)
- Architecture (Course 4) (p. 120)
- Biological Engineering (Course 20) (p. 158)
- Biology (Course 7) (p. 301)
- Brain and Cognitive Sciences (Course 9) (p. 307)
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- Mathematics (Course 18) (p. 324)
- Mechanical Engineering (Course 2) (p. 213)
- Media Arts and Sciences (MAS) (p. 130)
- Music and Theater Arts (Course 21M) (p. 269)
- Nuclear Science and Engineering (Course 22) (p. 230)
- Physics (Course 8) (p. 330)
- Political Science (Course 17) (p. 274)
- Science, Technology, and Society (STS) (p. 278)
- Urban Studies and Planning (Course 11) (p. 132)
The School of Architecture and Planning (SA+P) has supported MIT’s mission of meeting the world’s greatest challenges since its start in 1865. While advocating the forward-looking, technologically driven optimism of MIT, the School also invests in critically reflecting on technological innovation—its social impact and confrontation with cultural values.

SA+P is made up of six main divisions—the Department of Architecture; the Department of Urban Studies and Planning; the Media Lab; the MIT Center for Real Estate; the Program in Art, Culture, and Technology; and the Leventhal Center for Advanced Urbanism. Over the years, the School has embraced a broader range of fields that address and improve human environments.

What binds these fields together is a strong commitment to the deployment of technology toward social good. What also binds them is the use of design and deliberation approaches toward action that are distinct from but complementary to the engineering approach to problem solving.

Design is a main unifying approach of SA+P activities. We believe that design and policy interventions should be grounded in a commitment to improving individual human lives, equity and social justice, cultural enrichment, and the responsible use of resources through creative problem solving and project execution. Our curriculum empowers students with skills that enable them to design physical spaces, policies, and technologies that will shape how those spaces are used, with the goal of sustaining and enhancing the quality of the human environment at all scales, from the personal to the global.

Students

The School of Architecture and Planning enrolls an average of 600–700 students a year in a collection of courses ranging from Renaissance architecture to the cities of tomorrow, digital fabrication, motion graphics, shape grammars, photography, sensor systems, integrative design across disciplines, news and participatory media, and construction finance. By far the largest number of those students enter our graduate programs, and many pursue cross-disciplinary studies and dual degrees among those programs and others at the Institute.

Throughout the years, we have been noted for the diversity of our student body, drawing on candidates from around the world and from all walks of life. The Department of Architecture graduated its first woman, Sophia Hayden, in 1890, and three years later, Robert Taylor became the first African American to graduate from an American architecture program—a tradition of inclusiveness that continues today.

Global Projects

One of MIT’s founding principles is the belief that professional competence is best fostered by focusing teaching and research on real problems in the real world. Accordingly, a central aspect of our teaching and research is our ongoing participation in global initiatives—many of them collaborative undertakings among our six divisions, with other divisions of MIT, and with public and private institutions in the United States and abroad.

SA+P is fully committed to the mission of leadership both locally and globally. As a result of this commitment, faculty play a central role in preparing students to be leaders and good global citizens who engage with the problems facing countries at all stages of development by taking part in the public discussion of issues on a global scale and studying, developing, and applying best practices around the world.

History

Our history stretches back a century and a half, providing our current students with a legacy and long tradition of pioneering excellence. The Department of Architecture was the first such department in the nation (1865) and became a leader in introducing Modernism to America. The program in city planning was the second of its kind in the country (1932), later evolving into the current Department of Urban Studies and Planning, the longest continuous planning program in the United States and repeatedly ranked number one in the nation.

The Media Lab, the birthplace of multimedia computing (1985), has come to be known around the world as a world-class incubator of new design ideas; the Center for Real Estate established the nation’s first one-year graduate program in real estate development (1984); and the Center for Advanced Visual Studies (1967), now part of the new Program in Art, Culture, and Technology, pioneered the use of technologies such as lasers, plasma sculptures, sky art, and holography as tools of expression in public and environmental art. The Leventhal Center for Advanced Urbanism (2012), established as a premier research center focused on the design and planning of large-scale, complex 21st-century metropolitan environments, aims to redefine the field of urban design to meet contemporary challenges, utilizing interdisciplinary collaborative practices and the most advanced analytical and representational tools.

More recently, the Samuel Tak Lee Real Estate Entrepreneurship Lab (2015) promotes social responsibility among entrepreneurs and academics in the real estate profession worldwide, with a particular focus on China. Research topics include development and urbanization through private action and entrepreneurship, urban resilience and adaptation, land-use reform regulations and codes, new construction materials, data and
technology, affordable housing, environmental aspects of urban growth and development, and land and real property rights.

Resources

The Rotch Library is one of the nation’s premier resources in architecture and planning, offering extensive depth in architecture, building technology, art history, photography, environmental studies, land use, urban design, housing and community development, regional planning, urban transportation, and real estate. Its visual collections hold more than 60,000 digital images and 380,000 slides.

The School’s Wolk Gallery mounts several shows a year in its exhibition space, overseen by the curator of architecture and design at the MIT Museum. The Keller Gallery, a vest-pocket space of about 200 square feet, shows a steady stream of faculty, student, and experimental projects, including work from alumni and friends. The PLAZmA Digital Gallery is an electronic showcase of work and events on display in the School’s public areas, featuring faculty and student work.

The MIT Museum frequently features exhibitions on architecture and visual studies in its main galleries at 265 Massachusetts Avenue, as well as in its Compton Gallery, located in the heart of campus under the big dome. The Museum’s website spotlights its wide range of collections as well as exhibitions no longer on display in its galleries.

The List Visual Arts Center, three galleries on the first floor of the Media Lab’s Wiesner Building, presents 5–8 shows a year exploring contemporary artmaking in all media. Rotch Library also features exhibitions of student, staff, and faculty work, as well as shows drawing from its collections, in its space in Building 7-238.

Degrees Offered in the School of Architecture and Planning

Architecture (Course 4)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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</thead>
<tbody>
<tr>
<td>SB</td>
<td>Architecture</td>
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<tr>
<td>SB</td>
<td>Art and Design</td>
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<tr>
<td>MArch</td>
<td>Architecture</td>
</tr>
<tr>
<td>SM</td>
<td>Architecture Studies</td>
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<tr>
<td>SM</td>
<td>Art, Culture and Technology</td>
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<tr>
<td>SM</td>
<td>Building Technology</td>
</tr>
<tr>
<td>PhD</td>
<td>Architecture: Building Technology</td>
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<tr>
<td>PhD</td>
<td>Architecture: Design and Computation</td>
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<tr>
<td>PhD</td>
<td>Architecture: History and Theory of Architecture</td>
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<tr>
<td>PhD</td>
<td>Architecture: History and Theory of Art</td>
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<tr>
<td>Dual Degrees</td>
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Media Arts and Sciences (MAS)

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<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SM</td>
<td>Media Technology</td>
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<tr>
<td>SM</td>
<td>Media Arts and Sciences</td>
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<tr>
<td>PhD</td>
<td>Media Arts and Sciences</td>
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Urban Studies and Planning (Course 11)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SB</td>
<td>Urban Science and Planning with Computer Science</td>
</tr>
<tr>
<td>SB</td>
<td>Planning</td>
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<tr>
<td>MCP</td>
<td>City Planning</td>
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<tr>
<td>SM</td>
<td>Urban Studies and Planning</td>
</tr>
<tr>
<td>PhD</td>
<td>Urban and Regional Planning</td>
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<tr>
<td>PhD</td>
<td>Urban and Regional Studies</td>
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</table>

Dual Degrees

Certificates: Urban Design, Environmental Planning

Urban Science and Planning with Computer Science (Course 11-6)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SB</td>
<td>Urban Science and Planning with Computer Science</td>
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Center for Real Estate

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<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>MS</td>
<td>Real Estate Development</td>
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Notes

Many departments make it possible for a graduate student to pursue a simultaneous master’s degree.

Several departments also offer undesignated degrees, which lead to the Bachelor of Science without departmental designation. The curricula for these programs offer students opportunities to pursue broader programs of study than can be accommodated within a four-year departmental program.

1 See Interdisciplinary Programs (p. 337).

Admissions

The selection process at MIT is holistic and student centered: each application is evaluated within its unique context. Selection is based on outstanding academic achievement as well as a strong match between the applicant and the Institute.

Undergraduate applicants do not apply to a particular school, department or program and, although the application asks about a preferred field of study, most admitted undergraduates do not declare a major until the second semester of their first year.
Admissions information for regular, transfer, and non-degree applicants is provided in the section on Undergraduate Education (p. 31).

Applicants for graduate study apply directly to the particular department or program of interest. See the individual department and program descriptions for specific requirements.

Office of the Dean
Hashim Sarkis, MArch, PhD
Professor of Architecture
Professor of Urban Planning
Dean, School of Architecture and Planning

Peggy Cain
Assistant to the Dean

Ken Goldsmith
Assistant Dean for Finance and Administration

Ramona Allen
Assistant Dean for Human Resources

Kwadwo Poku
Manager of Diversity Recruitment and Initiatives

Dineen Doucette
Finance and Human Resources Administrator

Barbara Feldman
Assistant Dean for Development

Lori B. Gans
Individual Giving Officer

Tom Gearty
Director of Communications

Melissa Vaughn
Associate Director of Communications

Amanda Moore
Communications Coordinator

James Harrington
Facilities Manager
DEPARTMENT OF ARCHITECTURE
The Department of Architecture (http://architecture.mit.edu) offers degrees at the bachelor, master, and doctoral levels. The department is composed of five discipline groups: Architecture and Urbanism; Building Technology; Computation; History, Theory and Criticism of Architecture and Art (HTC); and the Program in Art, Culture and Technology (ACT). The Aga Khan Program in Islamic Architecture (AKPIA) is a research group offering its own Master of Science in Architecture Studies and a PhD in association with HTC. The Center for Advanced Urbanism supports both the architecture stream and the Master of Science in Architecture Studies program in urbanism, while acting as an umbrella for research initiatives and collaborative projects between the Departments of Architecture and Urban Studies and Planning. The varied disciplines support substantial research activity.

The department offers seven degree programs: the Bachelor of Science in Architecture (BSA), Bachelor of Science in Art and Design (BSAD), Master of Architecture (MArch), Master of Science in Architecture Studies (SMArchS), Master of Science in Building Technology (SMBT), Master of Science in Art, Culture and Technology (SMACT), and the Doctor of Philosophy (PhD). The SMArchS and PhD programs offer concentrations in multiple research streams.

Architecture and Urbanism is taught from a broad range of perspectives and scales, from buildings to cities and metropolitan regions. The teaching of the Architecture and Urbanism faculty occurs primarily in the studio. However, workshops, lectures, seminars, and research projects all contribute to architectural education. A broad range of topics are introduced and integrated in the curriculum, including sustainability, computation, materials, fabrication, infrastructure, politics, social engagement, and cultural theory. The architecture design studio is the laboratory where these topics intermingle and students synthesize design concepts. The Architecture and Urbanism area of study offers a BSA, a BSAD, a Minor in Architecture, and a Minor in Design, as well as MArch and SMArchS degrees.

The undergraduate BSA is a pre-professional degree program. The undergraduate studio sequence begins with instruction in design fundamentals and continues with design projects of increasing complexity. It is useful for those seeking a foundation in the field of architecture as preparation for either continued education in a professional degree program or for employment options in fields related to architecture and design.

The MArch is a three and one-half-year graduate degree. In exceptional circumstances, a student may be admitted with “advanced entry,” subject to prior academic qualifications in architecture, and complete the program in two and one-half years. These professional degrees are structured to educate those who aspire to registration and licensure as architects. Entering MArch students enroll in a three-term core program that is tightly integrated with complementary subjects in design skills, geometric disciplines, cultural and theoretical precedents, and materials and construction. Advanced “option” studios give students the opportunity to broaden their experience of culture, contexts, and varying scales for design, and to develop their own attitudes and positions toward architectural production. In thesis, a student develops a hypothesis and design strategy for a comprehensive architectural project or a research inquiry that is carried out as an independent, critical project—from concept to completion—under the guidance of an advising committee.

Building Technology includes teaching and applications of the fundamentals of technology as well as research in critical topics for the future of the built environment. The program explores ways to use design and technology to create buildings that contribute to a more humane and environmentally responsible built world. This includes integrated architectural design strategies to improve structural performance, construction and fabrication technologies, access to daylight and thermal comfort, resource accounting through material flow analysis and life-cycle assessment, building and urban energy modeling, control design and engineering, and other technologically informed design methods. Through lecture subjects, laboratories, workshops, and independent research projects, students study innovative materials and assemblies, emerging and nontraditional building materials, resource-efficient building systems, innovative analysis and modeling of historic structures, energy-efficient buildings, early-stage design computation and optimization, and various issues of energy and material resources at the urban scale, including urban environmental sensing and the urban heat island effect. Some of the research of the Building Technology Program is organized through laboratories dedicated to digital structures, urban metabolism, developing countries, and sustainable design. Research facilities of other departments, such as Mechanical Engineering and Civil and Environmental Engineering, are also used in joint research projects.

This area of study offers an SMBT, an SMArchS, and a doctoral degree with an emphasis on building technology.

The Computation group inquires into the varied nature and practice of computation in architectural design, and the ways in which design meaning, intentions, and knowledge are constructed through computational thinking, representing, sensing, and making. They focus on the development of innovative computational tools, processes, and theories, and the application of these in creative, socially meaningful responses to challenging design problems. Topics taught cover visualization, digital fabrication and construction processes and technologies, shape representation and synthesis, building information modeling, generative and parametric design, critical studies of digital and information technologies, digital heritage, and software and hardware development of advanced tools for spatial design and analysis. Students are encouraged to acquire both the technical skills and the theoretical and conceptual foundations to rethink and challenge the limits of
current design processes and practices, and to consider the social and cultural implications of their positions.

This area of study offers a concentration in the SMArchS program and a doctoral program. SMArchS and PhD students are encouraged to take subjects in other relevant departments as a means to explore and develop their interests.

The History, Theory and Criticism of Architecture and Art (HTC) group teaches subjects that deal with the history of architecture, art and design, placing strong emphasis on historiography and analytical methodologies. Offerings deal with the social and physical context of the built environment, the significant issues in current disciplinary thinking, as well as with the philosophical, political, and material contexts for works of art and architecture. Subjects are taught from the Renaissance to the present, with emphasis on topics of modern art and architecture. They focus on materials that are both abstract and concrete, with scales that range from the architectural drawing to the art installation to the urban environment. There is a special emphasis on topics of modern art and architecture in Europe as well as the Americas, with a comparable set of offerings on the Islamic world developed by AKPIA and taught within the HTC group.

HTC offers a HASS concentration and Minor in the History of Architecture, Art and Design that are open to all MIT undergraduates. There is an SMArchS concentration in HTC, and a doctoral program.

The Aga Khan Program for Islamic Architecture (AKPIA) at MIT is a graduate program dedicated to the study of architecture, urbanism, history, landscape, reconstruction, and conservation in the Islamic world. The program prepares students for careers in research, design, and teaching. Topics covered in its curriculum include critical study of the history and historiography of Islamic architecture; the interaction between architecture, society, and culture; strategies of urban and architectural preservation; and environmental and material-sensitive landscape and design research.

Established in 1979, AKPIA offers students a concentration in Islamic architecture and urbanism as part of the two-year SMArchS degree and the PhD program in HTC. Undergraduates may concentrate in Middle Eastern Studies using subjects offered by AKPIA. The program also has links with the City Design and Development and Environmental Planning and Policy programs in the Department of Urban Studies and Planning, ArchNet, the Aga Khan Programs at Harvard, the Aga Khan Trust for Culture (AKTC), and the Aga Khan Development Network (AKDN).

The Program in Art, Culture and Technology (ACT) explores art broadly and globally in its historic and contemporary forms, relating it to culture, science, technology, and design. This is reflected not only in ACT’s academic offerings, but in its public programs and the research of faculty, fellows, and guests. The program aims to build bridges between MIT discipline areas and departments. Research and pedagogy are intertwined, and MIT’s culture of scientific inquiry informs work in all artistic arenas: cinema, video, sound, performance, photography, experimental media, and new genres; conceptual and spatial experiments with architecture and design; interventions in public spaces; and writings and publications. Critical thinking, knowledge mining, and creative engagement—along with explorations of changing public and private spheres—are of particular relevance. The program also maintains and supports the Center for Advanced Visual Studies Special Collection, which preserves the legacy of the center as set forth by artist and educator György Kepes, and serves as a resource for scholars.

ACT offers a HASS minor and concentration, and a two-year graduate program leading to an SMACT.

Computer resources for educational purposes are distributed in the laboratories and studios of the department and overseen by the staff of the School of Architecture and Planning’s computer resources office. Students are required to learn the techniques and applications of computational-based design, production, and advanced representation. Other computation subjects and studio work permit further experimentation with modeling techniques, graphic representations, design methods, technical analysis, prototyping, and assistance with the design process.

Inquiries
Further information concerning undergraduate and graduate academic programs in the department, admissions, financial aid, and assistantships may be obtained from the Department of Architecture (http://architecture.mit.edu), Room 7-337, 617-253-7387.

Undergraduate Study

The Department of Architecture offers two undergraduate courses of study. They provide a broad undergraduate education for students who have clear professional goals and for those who desire a solid foundation for a number of possible careers. Course 4 leads to the Bachelor of Science in Architecture and Course 4-B leads to the Bachelor of Science in Art and Design.

Bachelor of Science in Architecture (Course 4)
Course 4 (p. 383) offers a program introducing students to the department’s five discipline areas: art, culture and technology; architectural design and urbanism; building technology; design and computation; and history, theory and criticism of architecture, art and design.

The requirements for the SB in Architecture (BSA) (p. 383) curriculum begin with two introductory subjects taken in sequence, 4.021 Design Studio: How to Design and 4.022 Design Studio: Introduction to Design Techniques and Technologies, intended for sophomores. The remaining core subjects include study
in the arts, design and computation, building technology, and the history of architecture.

The BSA includes four or five sequential architecture design studios. The approach fosters investigation and discussion in the development of sensitivity to the built environment. These sensibilities are linked to values and responsibilities to the community at large. Students in design studios develop technical and analytical skills and learn synthesis and invention using the elements of architectural form: material, structure, construction, light, sound, memory, and place. A thesis is optional and taken during the senior year.

Students who plan to continue their studies in a professional graduate program in architecture must apply for admission to a school offering the Master of Architecture (MArch).

**Bachelor of Science in Art and Design (Course 4-B)**

The Bachelor of Science in Art and Design (BSAD) (p. 386) provides undergraduates with a cohesive program of study that exposes them to cross-disciplinary fields of art and design. It provides a rigorous conceptual foundation along with strong practical skills that can be applied across diverse design domains. Students will be introduced to the design process, from concept to completion, through contextual critical thinking, experimentation, representation, and physical production techniques, critique, iteration, and reflection. The objective is to prepare students to pursue diverse career paths from product design to visual communication to information design to 2D and 3D art practices and more. Study in this program will enable students to take advantage of emerging opportunities in industry and academia.

The requirements for the BSAD curriculum begin with two introductory subjects taken in sequence, 4.021 Design Studio: How to Design and 4.022 Design Studio: Introduction to Design Techniques and Technologies, intended for sophomores. A choice of a third design studio is taken in the junior or senior year along with four additional core foundational subjects in design, art, computation, and history. The remaining four requirements are selected from a list of interdisciplinary subject offerings grouped around the following themes: objects, information, and art and experience. A thesis preparation subject is taken and a thesis presented in the senior year.

**Minor in Architecture**

The requirements for a Minor in Architecture are as follows:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.021</td>
<td>Design Studio: How to Design</td>
<td>9-12</td>
</tr>
<tr>
<td>or 4.02A</td>
<td>Design Studio: How to Design Intensive</td>
<td></td>
</tr>
<tr>
<td>4.022</td>
<td>Design Studio: Introduction to Design Techniques and Technologies</td>
<td>12</td>
</tr>
</tbody>
</table>

**Option 1**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.023</td>
<td>Architecture Design Studio I</td>
<td></td>
</tr>
</tbody>
</table>

**Option 2**

Select two from the list of elective subjects below

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.211(J)</td>
<td>The Once and Future City</td>
<td>12</td>
</tr>
<tr>
<td>4.218</td>
<td>Disaster Resilient Design</td>
<td>12</td>
</tr>
<tr>
<td>4.231</td>
<td>SIGUS Workshop</td>
<td>12</td>
</tr>
<tr>
<td>4.250(J)</td>
<td>Introduction to Urban Design and Development</td>
<td>12</td>
</tr>
</tbody>
</table>

**Elective Subjects**

**Architecture and Urbanism**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.211(J)</td>
<td>The Once and Future City</td>
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<td>Disaster Resilient Design</td>
<td>12</td>
</tr>
<tr>
<td>4.231</td>
<td>SIGUS Workshop</td>
<td>12</td>
</tr>
<tr>
<td>4.250(J)</td>
<td>Introduction to Urban Design and Development</td>
<td>12</td>
</tr>
</tbody>
</table>

**Art, Culture and Technology**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.301</td>
<td>Introduction to Artistic Experimentation</td>
<td>12</td>
</tr>
<tr>
<td>4.307</td>
<td>Art, Architecture, and Urbanism in Dialogue</td>
<td>12</td>
</tr>
</tbody>
</table>

**Building Technology**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.401</td>
<td>Environmental Technologies in Buildings</td>
<td>12</td>
</tr>
<tr>
<td>4.411(J)</td>
<td>D-Lab Schools: Building Technology Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>4.432</td>
<td>Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods</td>
<td>12</td>
</tr>
<tr>
<td>4.440(J)</td>
<td>Introduction to Structural Design</td>
<td>12</td>
</tr>
<tr>
<td>4.451</td>
<td>Computational Structural Design and Optimization</td>
<td>12</td>
</tr>
</tbody>
</table>

**Computation**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.500</td>
<td>Design Computation: Art, Objects and Space</td>
<td>12</td>
</tr>
<tr>
<td>4.501</td>
<td>Design and Fabrication of Tiny Homes</td>
<td>12</td>
</tr>
<tr>
<td>4.502</td>
<td>Advanced Visualization: Architecture in Motion Graphics</td>
<td>12</td>
</tr>
<tr>
<td>4.504</td>
<td>Design Scripting</td>
<td>12</td>
</tr>
</tbody>
</table>

**History and Theory of Architecture and Art**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.603</td>
<td>Understanding Modern Architecture</td>
<td>12</td>
</tr>
<tr>
<td>4.605</td>
<td>A Global History of Architecture</td>
<td>12</td>
</tr>
<tr>
<td>4.609</td>
<td>Seminar in the History of Art and Architecture</td>
<td>12</td>
</tr>
<tr>
<td>4.614</td>
<td>Building Islam</td>
<td>12</td>
</tr>
<tr>
<td>4.635</td>
<td>Early Modern Architecture and Art</td>
<td>12</td>
</tr>
<tr>
<td>4.636</td>
<td>Topics in European Medieval Architecture and Art</td>
<td>12</td>
</tr>
</tbody>
</table>
### Minor in Art, Culture and Technology

The HASS Minor in Art, Culture and Technology is designed to explore the conjunction of art with culture, science, technology, and design, and to develop critical and production practices.

The minor consists of six subjects arranged into three levels of study and chosen as follows:

#### Tier I

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.301</td>
<td>Introduction to Artistic Experimentation</td>
<td>12</td>
</tr>
<tr>
<td>or 4.302</td>
<td>Foundations in Art, Design, and Spatial Practices</td>
<td></td>
</tr>
</tbody>
</table>

Select one of the following:

- 4.601 Introduction to Art History
- 4.602 Modern Art and Mass Culture
- 4.606 Visual Perception and Art
- 4.635 Early Modern Architecture and Art
- 4.641 19th-Century Art
- 4.651 Art Since 1940
- 4.671 Nationalism, Internationalism, and Globalism in Modern Art

#### Tier II

Select two of the following:

- 4.320 Introduction to Sound Creations
- 4.322 Introduction to Three-Dimensional Art Work
- 4.341 Introduction to Photography and Related Media
- 4.354 Introduction to Video and Related Media

#### Tier III

Select two of the following:

- 4.312 Advanced Studio on the Production of Space
- 4.314 Advanced Workshop in Artistic Practice and Transdisciplinary Research
- 4.344 Advanced Photography and Related Media
- 4.352 Advanced Video and Related Media
- 4.356 Cinematic Migrations
- 4.361 Performance Art Workshop
- 4.368 Studio Seminar in Art and the Public Sphere
- 4.373 Advanced Projects in Art, Culture and Technology

Total Units: 66-72

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### Minor in Design

The Minor in Design provides undergraduates with a cohesive program of study that exposes them to the cross-disciplinary field of design. The minor provides a rigorous conceptual foundation in design along with strong design skills. Students will be introduced to design from concept to completion through contextual critical thinking, experimentation, representation, and physical production techniques, critique, iteration and reflection. The minor prepares students to pursue diverse career paths or further education in multiple areas of design, from product design to 3D design to visual communication, and enables them to take advantage of emerging opportunities in industry and academia.

The minor consists of six subjects:

#### Required Subjects

**Design Studios**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.021</td>
<td>Design Studio: How to Design</td>
<td></td>
</tr>
<tr>
<td>or 4.02A</td>
<td>Design Studio: How to Design Intensive</td>
<td></td>
</tr>
<tr>
<td>4.022</td>
<td>Design Studio: Introduction to Design Techniques</td>
<td></td>
</tr>
<tr>
<td>4.031</td>
<td>Design Studio: Objects and Interaction</td>
<td></td>
</tr>
<tr>
<td>or 4.032</td>
<td>Design Studio: Information and Visualization</td>
<td></td>
</tr>
</tbody>
</table>

**Electives**

Select 30-36 units of the following (from any category):

- 2.007 Design and Manufacturing [2]
- 4.031 Design Studio: Objects and Interaction [1]
- 4.041 Design Studio: Advanced Product Design
- 4.043 Design Studio: Advanced Interactions
- 4.110 Design Across Scales and Disciplines
- 4.118 Creative Computation
- 4.125 Furniture Making Workshop
- 4.451 Computational Structural Design and Optimization
- 4.501 Design and Fabrication of Tiny Homes
- 4.657 Design: The History of Making Things
### Minor in the History of Architecture, Art and Design

The HASS Minor in the History of Architecture, Art and Design is designed to enable students to concentrate on the historical, theoretical, and critical issues associated with artistic and architectural production. Introductions to the historical frameworks and stylistic conventions of art and architectural history are followed by more concentrated study of particular periods and theoretical problems in visual culture and in cultural history in general.

The minor consists of six subjects arranged into three levels of study and chosen as follows:

<table>
<thead>
<tr>
<th>Tier I</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.605</td>
<td>A Global History of Architecture 12</td>
</tr>
<tr>
<td>or 4.614</td>
<td>Building Islam</td>
</tr>
<tr>
<td>4.601</td>
<td>Introduction to Art History 12</td>
</tr>
<tr>
<td>or 4.602</td>
<td>Modern Art and Mass Culture</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier II</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Select three from the lists below, including at least one from each category:</td>
<td>36</td>
</tr>
<tr>
<td>History of Architecture and Design</td>
<td></td>
</tr>
<tr>
<td>4.603</td>
<td>Understanding Modern Architecture</td>
</tr>
<tr>
<td>4.622</td>
<td>Islamic Gardens and Geographies</td>
</tr>
<tr>
<td>4.657</td>
<td>Design: The History of Making Things</td>
</tr>
<tr>
<td>History of Art</td>
<td></td>
</tr>
<tr>
<td>4.606</td>
<td>Visual Perception and Art</td>
</tr>
<tr>
<td>4.635</td>
<td>Early Modern Architecture and Art</td>
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<tr>
<td>4.636</td>
<td>Topics in European Medieval Architecture and Art</td>
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</tr>
<tr>
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<td>Art Since 1940</td>
</tr>
<tr>
<td>4.671</td>
<td>Nationalism, Internationalism, and Globalism in Modern Art</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier III</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>4.609</td>
<td>Seminar in the History of Art and Architecture</td>
</tr>
</tbody>
</table>

Other advanced seminar in the history of art, design and/or architecture, including offerings from Harvard or Wellesley, with permission of the HASS Minor Advisor and the instructor.

Total Units 72

For a general description of minors, see Undergraduate Education (p. 35).

### Graduate Study

The Department of Architecture offers five graduate degree programs—the Master of Architecture (MArch), Master of Science in Architecture Studies (SMArchS), Master of Science in Building Technology (SMBT), Master of Science in Art, Culture and Technology (SMACT), and the Doctor of Philosophy (PhD).
The MArch is awarded to students who complete a program, accredited by the National Architectural Accrediting Board, which is an essential step toward licensure for architectural practice.

The SMArchS program stresses research and inquiry in the built environment; the degree is meant both for students who already have their first professional architecture degree and those whose previous education orients them toward non-professional graduate study in architecture.

The SMBT program is run jointly by the Departments of Architecture, Civil and Environmental Engineering, and Mechanical Engineering. This degree program is intended for students interested in pursuing topics of significant technical and engineering depth.

The SMACT focuses on the development of artist-thinkers in the context of an advanced technological and scientific community. Discussion of contemporary and historical theory and criticism complements rigorous and innovative transdisciplinary studio production.

The PhD program is an advanced degree program in the areas of History, Theory and Criticism; Building Technology; and Design and Computation.

**Master of Architecture**

The Master of Architecture is awarded upon the satisfactory completion of an approved program of at least 312 units and an acceptable thesis. The program requires three and one-half academic years of residence.

Advanced entry may be considered in exceptional circumstances for students who have majored in architectural design at a "4 plus 2" architecture school. These students may be considered for completion of the program in two and one-half years depending on their academic experience and accomplishments.

The professional MArch program is diverse and open-ended, with many views of appropriate research and practice of architecture available. Shared concerns include an interest in materials, fabrication, and technology; drawing and geometry; theory and criticism; sustainability and climate change; and culture in an age of rapid change and globalization. They also include a commitment to design as it engages related disciplines aligned with architectural production, a view of the environment as an ecologically structured phenomenon, a regard for the fabrication processes of building, a perspective on new technologies and their impact on practice, and a concern for the spatial, temporal, social, and urban contexts of buildings. Given the varied perspectives from which the curriculum is conceived, an important aspect of the student’s development is to be able to establish links between different areas of focus and its many disciplines.

The focus of the MArch degree program is through architecture design studios integrated with supporting subjects central to the curriculum. While the professional curriculum specifies that a student study a range of subjects in several interrelated fields, students in the MArch program have some choice and are required to develop a concentration in a self-determined area. Required and elective subjects taught by the various discipline groups within the department and in other related departments offer a way of charting multiple paths for future professional possibilities. Therefore, students are expected to develop a cohesive structure for their individual educational interests within the MArch program at MIT beyond the core curriculum and toward the development of a design thesis.

**Accreditation for MArch Program in the United States**

Most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit US professional degree programs in architecture, recognizes three types of degrees—the Bachelor of Architecture, the Master of Architecture, and the Doctor of Architecture. A program may be granted a six-year, three-year, or two-year term of accreditation depending on the extent of its conformance with established educational standards. Doctor of Architecture and Master of Architecture degree programs may consist of a preprofessional undergraduate degree and a professional graduate degree that, when earned sequentially, constitute an accredited professional education. However, the preprofessional degree is not, by itself, recognized as an accredited degree. The Massachusetts Institute of Technology Department of Architecture offers one NAAB-accredited degree program: MArch (non-preprofessional degree plus 312 units and an acceptable 24-unit thesis). The next accreditation visit is in 2023.

**Master of Science in Architecture Studies**

The Master of Science in Architecture Studies (SMArchS) is a two-year program of advanced study founded on research and inquiry in architecture as a discipline and as a practice. First established at MIT in 1979, the program is intended both for students who already have a professional degree in architecture and those interested in advanced non-professional graduate study. The degree may be pursued in one of six areas described below. Students select one area as their intellectual home and are encouraged to explore connections in their research across the other areas, and beyond to other programs and departments throughout MIT. SMArchS students work closely with one or more faculty who guide them in planning their course of study and in directing them purposefully towards a thesis. Notable strengths of the program are its range of concentration areas, its curricular flexibility and cross-disciplinary research focus, as well as its high faculty-to-student ratio.

The **Architectural Design** program nurtures research that contributes to current thinking about design in the field of architecture. It aims to advance architectural design by cultivating lateral thinking between design expertise and a range of allied fields, such as material sciences, media arts and technology, cultural studies, computation, sustainability, and emerging fabrication protocols. The
program provides opportunity for designers to explore theoretical foundations of architectural design as well as its pedagogy, and to provide a platform for applied research and new forms of design practice.

In Architecture and Urbanism, design methods are employed to create new knowledge about cities and metropolitan regions. It encompasses, and yet strives to go beyond, the theory and practice of urban design. Recent Urbanism studios have occurred on every continent. This program has close collaboration with the Department of Urban Studies and Planning's City Design and Development field, and with the Norman B. Leventhal Center for Advanced Urbanism. Areas of faculty interest include theory of urban form and design, urban ecology and landscape, collective housing design, and urban risk.

The Aga Khan Program for Islamic Architecture supports students interested in pursuing research on architecture, architectural history, landscape, and urbanism in the Islamic world. Faculty interests include Islamic architectural and urban history and historiography, strategies for landscape and urban preservation and reconstruction, and the critique of contemporary architecture in Islamic countries.

The Computation group inquires into the varied nature and practice of computation in architectural design and the ways in which design meaning, intention, and knowledge are constructed through sensing, thinking, and making computationally. It focuses on developing innovative computational tools, processes, and theories, and applying them in creative, socially meaningful responses to challenging design problems.

Building Technology focuses on the intersection of design and technical issues for buildings that positively contribute to a more humane and environmentally responsible built world. Research within the group include integrated architectural and urban design strategies to improve structural performance, construction and fabrication technologies, access to daylight and thermal comfort, resource accounting through material flow analysis and the life-cycle assessment, building and urban energy modeling, control design and engineering as well as other technologically informed design methods. Some of the research is organized through laboratories dedicated to digital structures, urban metabolism, developing countries, and sustainable design.

SMArchS students in History, Theory and Criticism of Architecture and Art will expand upon prior experience (which can be in design, theory, history, practice, or other post-undergraduate work) to explore compelling research that links historical or contemporary topics with methodological issues. Working alongside doctoral students in the program, SMArchS students are exposed to a wide range of historical periods and theoretical approaches. It is expected that research topics will be developed in close discussion with HTC faculty, building on the required Methods seminar (taken twice) to clarify the appropriate scope and original sources required for the master’s thesis. The HTC program is intensely interdisciplinary, and students are expected to enrich their core disciplines of history and theory with inquiry into other fields as appropriate for their research interests. Opportunities occasionally emerge for HTC students to become involved in editing, organizing research symposia, and preparing exhibitions; students will also be brought into discussion with colleagues from across the discipline groups in the SMArchS program.

Simultaneous Master’s Degrees in Architecture and City Planning

Students admitted to the Department of Architecture can propose a program of joint work in Architecture and Urban Studies and Planning that will lead to the simultaneous award of two degrees. Degree combinations may be MArch/Master in City Planning (MCP) or SMArchS/MCP. All candidates for simultaneous degrees must meet the requirements of both programs, but may submit a joint thesis. A student must apply by January 2 before beginning the last full year of graduate study in architecture. Dual-degree applications are submitted to Sonny Oram in 10-485. Students are first approved by the Dual-Degree Committee and then considered during the spring admissions process. For more information, contact Sonny Oram at 617-253-5115.

Master of Science in Building Technology

This program provides a focus for graduate students interested in the development and application of advanced technology for buildings and cities. Students in this program take relevant subjects in basic engineering disciplines along with subjects that apply these topics to the built environment. The program is open to qualified students with a degree in engineering or in architecture. The latter group may also consider the Master of Science in Architecture Studies Program with a concentration in Building Technology.

The program concentrates on the development of the next generation of technology for the built environment as well as the innovative application of state-of-the-art concepts to building and urban systems. Research topics within the group include integrated architectural and urban design strategies to improve structural performance, construction and fabrication technologies, access to daylight and thermal comfort, resource accounting through material flow analysis and life-cycle assessment, building and urban energy modeling, control design and engineering as well as other technologically-informed design methods. Some of the research is organized through laboratories dedicated to digital structures, urban metabolism, developing countries, and sustainable design.

The SMBT degree is generally completed in two years and requires 66 units of coursework and the completion of an acceptable thesis.

Master of Science in Art, Culture and Technology

ACT is an academic program and research center that explores art broadly and globally in historic and contemporary forms relating it to culture, science, technology, and design. It focuses
on the development of artist-thinkers advancing their critical and production practices. Strong emphasis is placed on critical thinking, knowledge mining, and creative engagement, along with explorations of changing public and private spheres. Participation in faculty research, collaborations within the Institute, connections with visitors, and an ongoing studio seminar provide students with many opportunities to develop and exchange ideas. ACT maintains the Center for Advanced Visual Studies (CAVS) Special Collection, supported by its resources and grant funding, which preserves the legacy of the center and serves as a resource for scholars.

The SMACT degree requires four semesters of on-campus academic work, including 156 units of coursework and the completion of a written thesis. For more information, visit the ACT website (http://act.mit.edu).

**Doctor of Philosophy**

The PhD in Architecture may be pursued in one of the following areas: History and Theory of Architecture/History and Theory of Art; Building Technology; or Design and Computation.

The PhD program in **History, Theory and Criticism of Architecture and Art** emphasizes the study of art, architecture, and urbanism, together with the historical and methodological issues that inform or link conceptual and practical work. The Aga Khan Program for Islamic Architecture is part of this doctoral program.

The doctoral program in **Building Technology** concentrates on the development of the next generation of technology for the built environment as well as the innovative application of state-of-the-art concepts to building and urban systems. Research topics within the group include integrated architectural and urban design strategies to improve structural performance, construction and fabrication technologies, access to daylight and thermal comfort, resource accounting through material flow analysis and life cycle assessment, building and urban energy modeling, control design and engineering as well as other technologically-informed design methods. Some of the research is organized through laboratories dedicated to digital structures, urban metabolism, developing countries, and sustainable design.

The PhD program in **Design and Computation** is broadly conceived around computational ideas and digital technologies as they pertain to the understanding, description, generation, and construction of architectural form. Research topics include the mathematical foundations of shape and shape representation; generative tools for design synthesis; advanced modeling and visualization techniques; rapid prototyping and CAD/CAM technologies for physical fabrication; and the analysis of the design process and its enhancement through supporting technologies and workspaces. The mission of the program is to enrich design from a computational perspective, with clear implications for teaching and practice.

Admission and degree requirements vary somewhat in the specific areas listed above, and may be obtained from the Department of Architecture website or in correspondence with the separate areas. The residency requirement for the PhD is a minimum of two full academic years. Completion of all of the requirements for the PhD—including the dissertation—is usually accomplished in four to six years.

Each student admitted to work in the doctoral program consults closely with one principal professor in his or her area to develop a general plan of study. In all three areas, progress toward the PhD follows a sequence of required subject work, general examinations, and dissertation research, writing, and defense. Students are encouraged to take subjects appropriate to their study plans in other departments at MIT and at Harvard.

**Urban Design Certificate**

The Department of Architecture and the Department of Urban Studies and Planning jointly offer a Certificate in Urban Design. The purpose of the program is to provide the fundamental knowledge and special skills required to design urban and suburban environments. Students in the MArch, SMArchS, MCP, or Master of Science in Urban Studies and Planning programs are eligible for a Certificate in Urban Design if they complete a specific set of subjects drawn from the two departments.

**Faculty and Teaching Staff**

- Andrew M. Scott, BArch
  Professor of Architecture
  Interim Head, Department of Architecture

- Leslie Keith Norford, PhD
  George Macomber Professor in Construction Management
  Professor of Building Technology
  Associate Head, Department of Architecture

**Professors**

- Judith Barry, MA
  Professor of Art, Culture and Technology

- John E. Fernández, MArch
  Professor of Architecture and Building Technology
  (On leave)

- Antón García-Abril, PhD
  Professor of Architecture
  (On leave, fall)

- Leon R. Glicksman, PhD
  Professor Post-Tenure of Building Technology

- Renée Green, BA
  Professor of Art, Culture and Technology
Mark Jarzombek, PhD
Professor of the History and Theory of Architecture
(On leave, spring)

Caroline A. Jones, PhD
Professor of the History of Art

Sheila Kennedy, MArch
Professor of Architecture

Terry W. Knight, PhD
Professor of Design and Computation

John A. Ochsendorf, PhD
Class of 1942 Professor
Professor of Architecture
Professor of Civil and Environmental Engineering
(On leave)

Nasser Rabbat, MArch, PhD
Aga Khan Professor
Professor of the History of Architecture

Christoph Reinhart, PhD
Professor of Building Technology

Adèle Naudé Santos, MArch, MCP, MAUD
Professor of Architecture
Professor of Urban Planning

Hashim Sarkis, PhD
Professor of Architecture
Professor of Urban Planning
Dean, School of Architecture and Planning

Anne Whiston Spirn, PhD
Cecil and Ida Green Distinguished Professor
Professor of Planning
Professor of Landscape Architecture

George N. Stiny, PhD
Professor of Design and Computation

James Wescoat, PhD
Aga Khan Professor
Professor of Urban Studies and Planning

J. Meejin Yoon, MAUD
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Arindam Dutta, PhD
Associate Professor of the History of Architecture

Rania Ghosn, DDes
Class of 1947 Career Development Professor
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Mark Goulthorpe, BArch
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Timothy Hyde, MArch, PhD
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Lauren Jacobi, PhD
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Miho Mazereeuw, MArch, MLA
Associate Professor of Architecture and Urbanism

Ana Miljacki, MArch, PhD
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Caitlin T. Mueller, PhD
Ford International Career Development Professor
Associate Professor of Architecture
Associate Professor of Civil and Environmental Engineering

Takehiko Nagakura, MArch, PhD
Associate Professor of Design and Computation
(On leave, fall)

William O’Brien Jr, MArch
Associate Professor of Architecture
(On leave, fall)

Lawrence Sass, PhD
Associate Professor of Computation and Design

Rafael (Rafi) Segal, PhD
Associate Professor of Architecture and Urbanism

Kristel Smentek, PhD
Associate Professor of the History of Art

Gediminas Urbonas, MFA
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(On leave, fall)

**Assistant Professors**
Brandon Clifford, MArch
Assistant Professor of Architecture

Mariana Ibañez, MArch
Assistant Professor of Architecture

Joel Lamere, MArch
Assistant Professor of Architecture

**Associate Professors**
Azra Aksamija, MArch
Associate Professor of Art, Culture and Technology

Alexander D’Hooghe, MAUD, PhD
Associate Professor of Architecture and Urbanism
Nida Sinnokrot, MFA
Assistant Professor of Art, Culture and Technology

Skylar Tibbits, SMArchS
Cecil and Ida B. Green Career Development Chair
Assistant Professor of Design Research
(On leave, spring)

Professors of the Practice
Yung Ho Chang, MArch
Professor of the Practice of Architecture
(On leave)

Philip G. Freelon, MArch
Professor of the Practice of Architecture
(On leave)

Marc Simmons, MArch
Professor of the Practice of Architecture

Technical Instructors
Christopher B. Dewart, BA
Technical Instructor in Architecture

Research Staff

Research Scientists
Tomas Du Chemin Holderness, PhD
Research Scientist of Architecture

Schendy G. Kernizan, BArch
Research Scientist of Architecture

John Klein, SM
Research Scientist of Architecture

Jared S. Laucks, MS
Research Scientist of Architecture

David Patrick Moses III, MArch
Research Scientist of Architecture

Research Fellows
Shun Kanda, MArch
Research Fellow of Architecture

Professors Emeriti
Julian Beinart, MArch, MCP
Professor Emeritus of Architecture

John de Monchaux, MArch
Professor Emeritus of Architecture

Michael Dennis, BArch
Professor Emeritus of Architecture

Eric J. Dluhosch, MArch, PhD
Professor Emeritus of Building Technology

David Hodes Friedman, PhD
Professor Emeritus of the History of Architecture

N. John Habraken
Professor Emeritus of Architecture

Joan Jonas, MFA
Professor Emerita of Visual Arts

Edward Levine, MA, PhD
Professor Emeritus of Visual Arts

William Lyman Porter, MArch, PhD
Professor Emeritus of Architecture

Maurice K. Smith, BArch
Professor Emeritus of Architecture

Jan Wampler, MArch
Professor Emeritus of Architecture

Krzysztof Wodiczko, MFA
Professor Emeritus of Visual Arts

Waclaw Piotr Zalewski
Professor Emeritus of Structures
The Program in Media Arts and Sciences (MAS) focuses on the invention, study, and creative use of new technologies that change how we express ourselves, how we communicate with each other, how we learn, and how we perceive and interact with the world. The field draws on a number of other disciplines, including computer science, cognitive sciences, communications, design, and the expressive arts. The program offers undergraduate and graduate subjects and a graduate program leading to master's and doctoral degrees. Its academic programs are intimately linked with the research programs of the Media Lab.

Inquiries
Additional information about the programs in Media Arts and Sciences, graduate admissions, research programs, and research assistantships may be obtained from MAS Headquarters (https://www.media.mit.edu/graduate-program/about-media-arts-sciences), Room E15-435, 617-253-5114.

Undergraduate Study
The MAS Alternative First-Year Program (p. 32) emphasizes project-oriented work and connections to current research topics. Students in this program attend mainstream lectures for core first-year subjects but take recitations/tutorials led by Media Lab researchers, take two MAS subjects, and participate in research through UROP positions at the Media Lab. This program is suitable for first-year students who intend to pursue any undergraduate major.

Most MAS undergraduate subjects are project oriented and relate to ongoing research within the Media Lab. Certain graduate subjects are open to advanced undergraduates (see Subjects for details). Undergraduate Research Opportunities Program (UROP) (p. 44) positions at the Media Lab are a major part of the MAS education offerings to undergraduates. First-year students participating in UROP are encouraged to register for MAS.111 Introduction to Doing Research in Media Arts and Sciences.

Graduate Study
Media Arts and Sciences offers a graduate program leading to master's and PhD degrees. Graduate students work closely with a research advisor in an apprenticeship relationship. Students enter the program from a wide variety of backgrounds, including electrical engineering, physics, computer science, cognitive science, mechanical engineering, art and design, and the learning sciences.

For the master's degree, students are required to spend at least four terms in residence (one of which may be a summer term) and to complete a satisfactory research thesis. Students wishing to pursue a PhD degree must demonstrate exemplary progress in the master's program and gain approval from a departmental committee review. Requirements for the PhD degree include successful completion of MAS general exams, and successful completion and defense of a dissertation based on original and significant research within one of the Media Lab's research groups.

Financial Support
The Program in Media Arts and Sciences offers financial assistance to all successful applicants in the form of research assistantships within the Media Lab, which are an important part of the educational program. Research assistants receive academic credit for part of their research activities.

Faculty and Teaching Staff
Tod Machover, MM
Muriel R. Cooper Professor of Interactive Media Design
Academic Head, Media Arts and Sciences Program

Joseph A. Paradiso, PhD
Alexander W. Dreyfoos (1954) Professor in Media Arts and Sciences
Associate Academic Head, Media Arts and Sciences Program

Professors
Neil Gershenfeld, PhD
Professor of Media Arts and Sciences
Hugh M. Herr, PhD
Professor of Media Arts and Sciences
Hiroshi Ishii, PhD
Jerome B. Wiesner Professor
Professor of Media Arts and Sciences
Patricia Maes, MM, PhD
Professor of Media Technology
Nicholas P. Negroponte, MArch
Professor Post-Tenure of Media Arts and Sciences
Alex Pentland, PhD
Toshiba Professor of Media Arts and Sciences
Member, Institute for Data, Systems, and Society
Rosalind W. Picard, ScD
Professor of Media Arts and Sciences
Mitchel Resnick, PhD
LEGO Professor of Learning Research
Associate Professors
Edward S. Boyden III, PhD
Y. Eva Tan Professor in Neurotechnology
Associate Professor of Media Arts and Sciences
Associate Professor of Brain and Cognitive Sciences
Associate Professor of Biological Engineering
Cynthia Lynn Breazeal, PhD
Associate Professor of Media Arts and Sciences
Joseph Jacobson, PhD
Associate Professor of Media Arts and Sciences
Neri Oxman, PhD
Associate Professor of Media Arts and Sciences
Iyad Rahwan, PhD
AT&T Career Development Professor of Media Arts and Sciences
Associate Professor of Media Arts and Sciences
Member, Institute for Data, Systems, and Society
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Deb K. Roy, PhD
Associate Professor of Media Arts and Sciences

Assistant Professors
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Sony Career Development Professor of Media Arts and Sciences
Assistant Professor in Media Arts and Sciences
Canan Dagdeviren, PhD
LG Career Development Professor of Media Arts and Sciences
Assistant Professor of Media Arts and Sciences
Kevin Esvelt, PhD
NEC Career Development Professor of Computer and Communications
Assistant Professor of Media Arts and Sciences
Danielle Wood, PhD
Benesse Corporation Career Development Professor of Media Arts and Sciences
Assistant Professor of Media Arts and Sciences

Professors of the Practice
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Professor of the Practice of Media Arts and Sciences

Associate Professors of the Practice
Ethan Zuckerman, BA
Associate Professor of the Practice of Media Arts and Sciences

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Visiting Professor of Media Arts and Sciences
William D. Hillis, PhD
Visiting Professor of Media Arts and Sciences
Lawrence Lessig, JD
Visiting Professor of Media Arts and Sciences

Visiting Assistant Professors
Karen Ann Brennan, PhD
Visiting Assistant Professor of Media Arts and Sciences

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Lecturer in Media Arts and Sciences
Mark Feldmeier, PhD
Lecturer in Media Arts and Sciences

Research Staff

Senior Research Scientists
Andrew B. Lippman, MS
Senior Research Scientist of Media Arts and Sciences

Professors Emeriti
Barry Lloyd Vercoe, DMA
Professor Emeritus of Media Arts and Sciences
Professor Emeritus of Music
DEPARTMENT OF URBAN STUDIES AND PLANNING

The Department of Urban Studies and Planning (DUSP) offers four degree programs: a Bachelor of Science in Planning; a two-year professional Master in City Planning (MCP); a one-year Master of Science in Urban Studies and Planning (reserved for mid-career students); and a PhD in Urban Studies and Planning. In addition, DUSP has other, nondegree programs and affiliations: the Special Program in Urban and Regional Studies (http://spurs.mit.edu) (for mid-career professionals from developing countries); the Community Innovators Lab; the Center for Advanced Urbanism (http://cau.mit.edu); and the SENSEable City Lab (http://senseable.mit.edu). Once students are admitted and enrolled at MIT, it is possible to apply for certificate programs in urban design (offered jointly with the Department of Architecture) or environmental planning.

City and regional planners in the United States and other parts of the world are involved not only in physical and economic development, but also in management of the environmental, social, and design consequences of development. They engage in a variety of activities aimed at shaping the forms and patterns of human settlements, and at providing people with housing, public services, employment opportunities, and other crucial support systems that comprise a decent living environment. Planning encompasses not just a concern for the structure and experience of the built environment, but also a desire to harness the social, economic, political, and technological forces that give meaning to the everyday lives of men and women in residential, work, and recreational settings. Planners operate at the neighborhood, metropolitan, state, national, or international level, in both the public and the private sectors. Their tasks are the same: to help frame the issues and problems that receive attention; to formulate and implement projects, programs, and policies responsive to individual and group needs; and to work with and for various communities in allocating economic and physical resources most efficiently and most equitably.

Planners are often described as “generalists with a specialty.” The specialties offered at MIT include city design and development; housing, community, and economic development; international development; and environmental policy and planning, as well as cross-cutting opportunities to study urban information systems, multi-regional systems, and mobility systems. These planning specialties can be distinguished by the geographic levels at which decision making takes place—neighborhood, city, regional, state, national, and global. Subspecialties have also been described in terms of the roles that planners are called upon to play, such as manager, designer, regulator, advocate, educator, evaluator, or futurist.

A focus on the development of practice-related skills is central to the department’s mission, particularly for students in the MCP professional degree program. Acquiring these skills and integrating them with classroom knowledge are advanced through the department’s field-based practicum subjects and research, and through internship programs. In fieldwork, students acquire competence by engaging in practice and then bringing field experiences back into the academic setting for reflection and discussion. Students may work with community organizations, government agencies, or private firms under the direction of faculty members involved in field-based projects with outside clients. In some cases, stipends may be available for fieldwork or internship programs. The Department of Urban Studies and Planning is committed to educating planners who can advocate on behalf of underrepresented constituencies.

During the month of January, the department offers a series of “mini-subjects” in specialized fields not covered by the regular curriculum, including both noncredit and for-credit offerings. Specific opportunities for concentration and specialization available to students are detailed in the descriptions of the degree programs that follow.

Undergraduate Study

The Department of Urban Studies and Planning offers a Bachelor of Science in Planning; HASS Minors in Urban Studies and Planning, International Development, and Public Policy; and a variety of HASS concentrations. There is also an accelerated SB/MCP program which allows exceptional students to complete their undergraduate and master’s degree work in five years.

In addition, DUSP also hosts MIT’s Teacher Education Program (TEP), described under Career and Professional Options (p. 49) in the Undergraduate Education section. TEP provides an option for students interested in exploring new ideas in teaching and learning as applied to K-12 schools. Studies in TEP can also lead to licensure in math or science teaching at the high school or middle school levels.

Bachelor of Science in Planning (Course 11)

The Department of Urban Studies and Planning offers an interdisciplinary preprofessional undergraduate major (p. 387) designed to prepare students for careers in both the public and private sectors. The major also provides a foundation for students who are considering graduate work in law, public policy, international development, urban design, management, and planning. The subjects in the major teach students how the tools of economics, policy analysis, political science, and urban design can be used to solve social and environmental problems in the United States and abroad. In addition, students learn the skills and responsibilities of planners who seek to promote effective and equitable social change.

After satisfying the core requirements, students use their electives to pursue a specific track. We suggest one of the following, but will accept self-designed options to better meet a student’s interest:
urban and environmental policy and planning; urban society, history, and politics; or urban and regional public policy. The required laboratory emphasizes urban information systems and offers skills for measurement, representation, and analysis of urban phenomena. In the laboratory subject, students also explore the ways emerging technology can be used to improve government decision making.

Students are encouraged to develop a program that will strengthen their analytic skills, broaden their intellectual perspectives, and test these insights in real-world applications. Students must complete a senior project that synthesizes what they have learned. This project may consist of an analysis of a public policy issue, a report on a problem-solving experience from an internship or other field experience, or a synthesis of research on urban affairs.

**Urban Science and Planning with Computer Science (Course 11-6)**

Urban settlements and technology around the world are rapidly co-evolving as flows of population, finance, and politics are reshaping the very identity of cities and nations globally. We already see rapid and profound change, especially in mega-cities, including pervasive sensing, the growth and availability of continuous data streams, advanced analytics, interactive communications and social networks, and distributed intelligence. Examples of new technologies facilitated by or requiring big data and new informatics concentrated in urban areas include, but are not limited to, autonomous vehicles, sensor-enabled self-management of natural resources, cybersecurity for critical infrastructure biometric identity, the sharing or gig-economy, and continuous public engagement opportunities through social networks and data and visualization.

The Bachelor of Science in Urban Science and Planning with Computer Science (Course 11-6) (p. 486) emphasizes the development of fundamental skills in urban planning and policy, including ethics and justice; statistics, data science, geospatial analysis, and visualization; and computer science, robotics, and machine learning. The Course 11-6 program provides numerous opportunities for field-based problem-solving experience through labs, UROP assignments and client-based courses in which students synthesize and empirically integrate what they are learning about theory and practice at the intersection of computer and urban science. Students also have the opportunity to specialize though the selection of a customized concentration of upper-level electives in data visualization, applied spatial analysis, design, and public policy. Students in the program are full members of both departments and of two schools, Architecture and Planning and Engineering.

For more information, email (duspinfo@mit.edu) or call 617-253-9403.

**Five-Year SB-MCP Option**

Undergraduate Course 11 majors may apply for admission to the department’s Master in City Planning (MCP) program in their junior year. Students accepted into the five-year program receive both the Bachelor of Science and the MCP at the end of five years. Admission is intended for those undergraduates who have demonstrated exceptional performance in the major and show commitment to the field of city planning. Criteria for admission include the following:

- A strong academic record in Course 11 subjects
- Letters of reference from departmental faculty
- Practical experience in planning, which could be gained through internships, practicums, studios, Undergraduate Research Opportunities Program experiences, summer jobs, etc.
- A mature and passionate interest for the field that warrants further study

Students can obtain more information on the five-year program from Sandra Wellford, undergraduate administrator, Room 7-346A, 617-253-9403.

**Minor in Urban Studies and Planning**

The six-subject Minor in Urban Studies and Planning offers students the opportunity to explore issues in urban studies and planning in some depth. Students initially take two Tier I subjects that establish the political, economic, and design contexts for local, urban, and regional decision making. In addition, students choose four Tier II elective subjects, which provide an opportunity to focus on urban and environmental policy issues or to study urban problems and institutions. Students are encouraged to craft a minor that reflects their own particular interests within the general parameters of the minor program requirements and in consultation with the minor advisor.

**Requirements**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.001[J]</td>
<td>Introduction to Urban Design and Development</td>
<td>12</td>
</tr>
</tbody>
</table>

**Electives**

Select four Course 11 elective subjects ¹

| Total Units | 36-48 |

Total Units | 60-72 |

¹ In consultation with the advisor, students can select from recommended concentrations described in the department's course maps or create their own stream tailored to a particular set of urban, policy, or planning concerns.

**Minor in International Development**

The HASS Minor in International Development aims to increase students’ ability to understand, analyze, and tackle problems of global poverty and economic development in the developing world. Challenges include increasing urbanization; the need for industrial growth as well as jobs for an increasing number of educated youth; the crisis of resources and infrastructure; the fragmentation of state capacity and rising violence; ethical and moral issues raised by development planning; the role of appropriate technology and research; and popular discontent. The minor emphasizes problem-
solving, multidisciplinarity, and an understanding of institutions at various levels—from the local to the global—as the keys to solving today’s problems in emerging countries.

The six-subject minor is structured into two tiers. The subjects in the first tier provide a general overview of the history of international development and major theories and debates in the field, and an introduction to the dilemmas of practice. They also introduce the challenges of applying models of interventions across contexts and the importance of understanding local institutional frameworks and political economies across scales and levels of governance.

Subjects in the second tier offer an array of more specialized and advanced subjects to allow students greater depth in specific sectors and international development issues such as public finance, infrastructure and energy, sustainability, the role of technology policy, the form and structure of cities, the politics of urban change and development, the role of law and public policy in development, and the rethinking of development in terms of human rights.

Tier I: Introduction to International Development Theories and Practice
Select two of the following:  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.005</td>
<td>Introduction to International Development</td>
</tr>
<tr>
<td>11.025[J]</td>
<td>D-Lab: Development</td>
</tr>
<tr>
<td>11.140</td>
<td>Urbanization and Development</td>
</tr>
</tbody>
</table>

Tier II: Specialized Topics in International Development
Select four of the following (in consultation with the minor advisor):  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.002[J]</td>
<td>Making Public Policy</td>
</tr>
<tr>
<td>11.027</td>
<td>City to City: Comparing, Researching and Writing about Cities</td>
</tr>
<tr>
<td>11.144</td>
<td>Project Appraisal in Developing Countries</td>
</tr>
<tr>
<td>11.147</td>
<td>Budgeting and Finance for the Public Sector</td>
</tr>
<tr>
<td>11.164[J]</td>
<td>Human Rights at Home and Abroad</td>
</tr>
<tr>
<td>11.165</td>
<td>Urban Energy Systems and Policy</td>
</tr>
<tr>
<td>11.166</td>
<td>Law, Social Movements, and Public Policy: Comparative and International Experience</td>
</tr>
<tr>
<td>EC.715</td>
<td>D-Lab: Water, Sanitation and Hygiene</td>
</tr>
</tbody>
</table>

Additional subjects not listed above may be included in the minor at the discretion of the minor advisor.

Further information can be obtained from Professor Balakrishnan Rajagopal (braj@mit.edu), Room 9-432, 617-253-6315.

Minor in Public Policy
The interdisciplinary HASS Minor in Public Policy (p. 363) is intended to provide a single framework for students interested in the role of public policy in the field of their technical expertise. Because the Course 11 major has a strong public policy element and several subjects are redundant, Course 11 majors are not eligible for the Minor in Public Policy.

HASS Concentrations
DUSP offers clusters of subjects that satisfy the Institute requirement. These three-subject clusters allow students either to develop competence within a specific discipline or to explore a particular policy problem. Possible areas of concentration include: designing the urban environment, environmental policy, urban history, policy analysis and urban problems, legal issues and social change, and education. Sample programs are available online (http://dusp.mit.edu).

The DUSP concentration focusing on education can also lead to Massachusetts licensure in teaching math and science at the middle and high school levels. This requires taking:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.129[J]</td>
<td>Educational Theory and Practice I</td>
<td>12</td>
</tr>
<tr>
<td>11.130[J]</td>
<td>Educational Theory and Practice II</td>
<td>12</td>
</tr>
<tr>
<td>11.131[J]</td>
<td>Educational Theory and Practice III</td>
<td>12</td>
</tr>
<tr>
<td>11.124[J]</td>
<td>Introduction to Education: Looking Forward and Looking Back on Education</td>
<td>12</td>
</tr>
<tr>
<td>11.125[J]</td>
<td>Introduction to Education: Understanding and Evaluating Education</td>
<td>12</td>
</tr>
</tbody>
</table>

More information is available from Eric Klopfer, Room E15-301, 617-253-2025.

Graduate Study
The Department of Urban Studies and Planning offers graduate work leading to the Master in City Planning and the Doctor of Philosophy. In conjunction with the Center for Real Estate, the department also offers a Master of Science in Real Estate Development. These programs are open to students from a variety of backgrounds. Urban studies, city planning, architecture, urban design, environmental planning, political science, civil engineering, economics, sociology, geography, law, management, and public administration all offer suitable preparation. For further information concerning academic programs in the department, application for admission,
and financial aid, contact Graduate Admissions, Room 7-346, 617-253-9403.

**Master in City Planning**

The principal professional degree in the planning field is the Master in City Planning (MCP). The Department of Urban Studies and Planning provides graduate education for men and women who will assume professional roles in public, private, and nonprofit agencies, firms, and international institutions, in the United States and abroad. The department seeks to provide MCP students with the skills and specialized knowledge needed to fill traditional as well as emerging planning roles. The MCP is accredited by the American Planning Association.

The two-year Master in City Planning degree program emphasizes mastery of tools for effective practice and is therefore distinct from undergraduate liberal arts programs in urban affairs or doctoral programs that emphasize advanced research skills. MCP graduates work in a broad array of roles, from "traditional" city planning to economic, social, and environmental planning, as well as urban design. In addition to its basic core requirements, the program offers four areas of specialization: City Design and Development; Environmental Policy and Planning; Housing, Community, and Economic Development; and International Development. MCP students, in their application to the department, select one of these areas of specialization and, when applicable, indicate interest in cross-cutting programs in transportation planning, urban information systems, and regional planning.

Each student’s plan of study in the MCP Program is set forth in a program statement developed jointly by the student and faculty advisor during the student’s first term. Linked to career development goals, the program statement describes the purposes and goals of study, the proposed schedule of subjects, the manner in which competence in a specialization is developed, and an indication of a possible thesis topic.

**Degree Requirements**

Students are expected to take a minimum of 36 credit units each term (at least three subjects, though more frequently four), yielding at least 126 total units, in addition to the thesis.

A collection of subjects and requirements to be taken during the student’s two years in the MCP program constitute a “core experience” viewed as central to the professional program. The core subjects and requirements include the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.201</td>
<td>Gateway: Urban Studies and Planning</td>
<td>12</td>
</tr>
<tr>
<td>11.202</td>
<td>Planning Economics</td>
<td>4</td>
</tr>
<tr>
<td>11.203</td>
<td>Microeconomics</td>
<td>8</td>
</tr>
<tr>
<td>11.205</td>
<td>Introduction to Spatial Analysis</td>
<td>6</td>
</tr>
</tbody>
</table>

An introductory subject in the chosen specialization area, taken in the first term of the first year

At least one core practicum subject, selected from an approved list, during the two-year program

A thesis preparation seminar in the area of specialization, taken during the second or third term of study

1 Students can test out of these subjects.

Students identified as having weaker writing skills are also encouraged to take a writing course.

All students are required to submit a thesis on a topic of their choice. The department encourages MCP students to avoid the traditional perception of the thesis as a “mini-dissertation,” and to think instead of a client-oriented, professional document that bridges academic and professional concerns. While most of the thesis work occurs during the last term of the second year, students are urged to begin the process of defining a thesis topic early in the second year through their participation in a required thesis preparation seminar.

Students in the MCP Program are encouraged to integrate fieldwork and internships with academic coursework. The Department of Urban Studies and Planning provides a variety of individual and group field placements involving varying degrees of faculty participation and supervision. Academic credit is awarded for field experience, although some students choose instead to participate in the work-study financial aid program. The department also sponsors a variety of seminars in which students have an opportunity to reflect on their field experiences.

The City Design and Development (CDD) group engages, researches, and projects the physical planning of cities, regions, and their built and natural environments, at scales and locations that range from urban neighborhoods and city cores to outer suburbs. Graduates work in a variety of private, public, and nonprofit roles as urban designers, planning and design consultants, municipal and regional planners, managers of public agencies, advocates of historic and landscape preservation, housing, and land use regulations, real estate development, and as planners of transportation and mobility systems. CDD is closely associated with faculty and students in the Department of Architecture’s Urbanism field, the Center for Advanced Urbanism, Center for Real Estate, SENSEable City Lab, and Media Lab. Many subjects are cross-listed with these groups. CDD’s diverse educational offerings, ranging from studios to seminars, lectures, and workshops, ensure that every student can develop unique competence and intellectual depth in the field. CDD students may also elect to pursue the Urban Design Certificate, for those who wish to be involved in shaping the physical form and logistical function of cities, or pursue an additional year of study through DUSP’s SM in Advanced Urbanism. Individual faculty within CDD also work in areas that include landscape urbanism; resilient
cities and housing; land use planning and regulation; innovation districts; parametric urbanism; and much more.

The Center for Advanced Urbanism—jointly administered by faculty from the CDD group and the Urbanism group in the Department of Architecture—is a research-based institution dedicated to implementing new collaborative models of design and urban research.

The Environmental Policy and Planning (EPP) group emphasizes the study of how society conserves and manages its natural resources and works to promote sustainable development. Areas of concern include the role of science in environmental policy-making, climate change mitigation and adaptation, sustainable international development, adaptive ecosystem management, environmental justice, global environmental treaty making, environmental regulation, energy efficiency and renewable energy, the role of private corporations in environmental management, the public health impacts of environmental planning, infrastructure planning, and the mediation of environmental disputes. Students investigate the interactions between built and natural systems; the effectiveness of different approaches to environmental planning and policymaking; techniques for describing, modeling, forecasting, and evaluating changes in environmental quality; approaches to environmental policy analysis; strategies for stakeholder involvement in environmental planning; and mechanisms for assessing the choices posed by the environmental impacts of new technology in local, state, national, and international contexts.

The Housing, Community, and Economic Development (HCED) group focuses on the equitable development of communities in the United States, at the neighborhood, city, and regional scales. Its mission is to prepare professionals with the skills and knowledge to be responsible leaders of public, private, and nonprofit sector organizations and networks engaged in equitable development. The group is driven by a deep faculty commitment to expanding opportunity and improving quality of life for historically disadvantaged groups. HCED emphasizes ongoing, empowering partnerships with those affected by change—often those who are organizing to lead local improvement efforts. Many faculty and students also have an interest in global markets and federal and state policy. For decades, the group’s faculty and students have helped shape policy, practice and research in housing, economic, workforce, and comprehensive community development. Increasingly, HCED connects to efforts that promote public health, environmental sustainability, and more inclusive “digital cities” as well. HCED promotes an integrated and dynamic approach to learning, helping prepare students for careers as problem solvers who can perform in varied roles: policy analyst or policy maker, advocate and organizer, mediator, evaluator, program designer, investor and entrepreneur, project developer and manager. At the doctoral level, HCED prepares students not only to produce but also to shape the next generation of creative teaching and scholarship.

The International Development Group (IDG) draws on the experiences of developing and newly industrializing countries throughout the world as the basis for advice about planning at the local, regional, national, and global levels. IDG provides students with an integrated view of the institutional, legal, historical, economic, technological, and sociopolitical factors that have shaped successful planning experiences and how they translate into action. Class content and faculty expertise include economic development at various scales; human rights and rights-based approaches to development, ethical and moral issues raised by development planning, the challenge of planning amidst popular discontent; regional planning (including decentralization); finance and project evaluation; housing, human settlements, and infrastructure services (transportation, telecommunications, water, sanitation, sewerage); institutions of economic growth; law and economic development; industrialization and industrial policies (including privatization); poverty-reducing and employment-increasing interventions including informal sector, nongovernment organizations, and small enterprises; comparative urban and metropolitan politics and policy; property and land rights, comparative property and land use law, collective action, and common property issues (water, forestry, grazing, agriculture); human rights and development; conflict and social dynamics in cities; post-conflict development; and globalization and governance.

Urban Information Systems (UIS) is a cross-cutting group that connects faculty, staff, and students who are interested in the ways information and communication technologies impact urban planning. Research topics include building neighborhood information systems to facilitate public participation in planning; exploring the complex relationships underlying urban spatial structure, land use, transportation, and the environment; modeling urban futures and metropolitan growth scenarios; and experimenting with mobile computing, location-based services, and the community building, planning, and urban design implications of ubiquitous computing. Associated faculty are engaged in many related research projects through the SENSEable City Lab, the Civic Data Design Lab, the Urban Mobility Lab, the Center for Advanced Urbanism, and MIT-wide interdisciplinary research initiatives such as the Future Urban Mobility project in Singapore. Through seminars and related activities, we share experiences and find ways to collaborate on the technical, planning, and social science aspects of making information technology–enabled urban futures more responsive to public and private interests in ways that are transparent and equitable.

Much of UIS’s work involves the development and use of planning-related software and the urban analytics, spatial analysis tools, and systems (such as GIS and distributed geoprocessing) that are increasingly important parts of urban planning methods and metropolitan information infrastructures. However, UIS interests go beyond the development and use of specific technologies and extend to an examination of the ripple effects of computing, communications, and digital spatial information on current
planning practices and on the meaning and value of the impacted communities and planning institutions.

**Simultaneous Master's Degrees in City Planning and Architecture**
Students who have been admitted to either the Department of Urban Studies and Planning or the Department of Architecture can propose a program of joint work in the two fields that will lead to the simultaneous awarding of two degrees. Degree combinations may be MCP/MArch or MCP/SMArchS. A student must apply by the January deadline prior to beginning the last full year of graduate study for the first degree: MCP and SMArchS. SMArchS students must apply during their first year at MIT (by the end of the first term); MArch students must apply during or before their second year. Students are first approved by the Dual Degree Committee and then considered during the spring admissions process. All candidates for simultaneous degrees must meet the requirements of both degrees, but may submit a joint thesis.

**Simultaneous Master's Degrees in City Planning and Transportation**
Students who have been admitted to study for the Master in City Planning or the Master of Science in Transportation may apply to the other program during their first year of study and propose a program of joint work in the two fields that will lead to the simultaneous awarding of two degrees. Details of this program are provided under Interdepartmental Programs in the Civil and Environmental Engineering section.

**Simultaneous Master's Degrees in City Planning and Real Estate Development**
Students who have been admitted to the Master in City Planning Program or the Master of Science in Real Estate Development Program may apply to the other program during their first year of study and propose a program of joint work in the two fields that will lead to the simultaneous awarding of two degrees. Students may submit a joint thesis.

**Master of Science in Urban Studies and Planning**
Under special circumstances, admission may be granted to candidates seeking a one-year Master of Science (SM) degree. The SM is intended for professionals with a number of years of distinguished practice in city planning or related fields who have a clear idea of the courses they want to take at MIT, the thesis they want to write, and the DUSP faculty member with whom they wish to work. That faculty member must be prepared to advise the candidate when at MIT and to submit a letter of recommendation so indicating as part of the candidate’s application. This process means that prior to submitting an application the candidate must contact the appropriate DUSP faculty member to establish such a relationship. The SM does not require the candidate to take the core courses, which are mandatory for MCP candidates. As indicated above, a thesis is required. For further information concerning the SM option, contact Graduate Admissions, Room 7-346, 617-253-9403.

**Doctor of Philosophy**
The PhD is the advanced research degree in urban planning or urban studies. Admission requirements are substantially the same as for the master's degree, but additional emphasis is placed on academic preparation, professional experience, and the fit between the student's research interests and the department's research activities. Nearly all successful applicants have previously completed a master's degree.

The doctoral program emphasizes the development of research competence and the application of research methods to exploring critical planning questions. Students work under the mentorship of a faculty advisor. They may focus their studies on any subfield of planning in which the faculty in the department have expertise.

After successful completion of coursework, students are required to take oral and written qualifying general exams in two fields: an intellectual discipline (city design and development, international development, public policy, urban information systems, regional and urban economics, or urban sociology) and a field to which this discipline is applied and that coincides with the student's research interest and possible dissertation topic. Doctoral candidates are expected to complete the qualifying general examinations before beginning their third year of residence. Upon completing the qualifying general examination and a colloquium about the dissertation proposal, a PhD candidate must write and successfully defend a doctoral dissertation that gives evidence of the capacity to do independent and innovative research.

A minimum of 72 units plus 36 units for the dissertation (a minimum of 108 units) is required for the PhD degree.

Interested and qualified students can undertake joint doctoral programs with the Department of Political Science or the Department of Civil and Environmental Engineering.

**Interdisciplinary Programs**

**Graduate Programs in Transportation**
MIT provides a broad range of opportunities for transportation-related education. Courses and classes span the School of Engineering, the Sloan School of Management, and the School of Architecture and Planning, with many activities covering interdisciplinary topics that prepare students for future industry, government, or academic careers.

A variety of graduate degrees are available to students interested in transportation studies and research, including a Master of Science in Transportation and PhD in Transportation, described under Interdisciplinary Graduate Programs, as well as a nine-month Master of Engineering Transportation program, described in the Master of
Engineering program for the Department of Civil and Environmental Engineering.

**Environmental Planning Certificate**

Students in the MCP and PhD program who complete a prescribed set of subjects are awarded a Certificate in Environmental Planning. For further information contact Takeo Kuwabara (takeok@mit.edu).

**Urban Design Certificate**

Students in the MCP, MArch, or SMArchS programs who complete a specific curriculum of subjects in history and theory, public policy, development, studios and workshops, and a thesis in the field of urban design are awarded a Certificate in Urban Design by the School of Architecture and Planning. For further information contact the Joint Program in City Design and Development office, Room 10-485, 617-253-5115.

**Nondegree Programs**

A limited number of nondegree students are admitted to the department each term. This special student status is especially designed for professionals interested in developing specialized skills, but is also available to others.

The MIT Community Innovators Lab (CoLab) supports faculty and students to work with low-income and excluded people in the United States, Latin America, and the Caribbean, tapping their energy, creativity, and in-depth knowledge of the issues they face to tackle poverty, climate change, and mass urbanization. Launched in 2007, CoLab supports faculty and student collaboration on field-based projects working with departments, laboratories, and centers across the Institute on action research while providing important resources to community leaders.

CoLab offers instruction and tools—practice-based classes, study groups, tutoring, coaching, mentoring, as well as IAP courses in reflective practice, civic engagement, action research, use of social media, storytelling, and visual mapping—to help students embed and apply technical learning in real societal contexts, equipping them with the resources they will need to take leadership roles in an increasingly complex world. Its dense network of innovative practitioners in the US, Latin America, and the Caribbean augment faculty instruction with field-based coaching, helping to train the next generation of practitioners and scholars committed to addressing social exclusion and sustainability—two of the greatest global challenges of our time.

In addition to work in communities, CoLab hosts regular programs that bring nationally recognized leaders to share their work and help inform the Institute’s research agenda. The Mel King Community Fellows Program convenes an annual cohort of advanced practitioners from a range of relevant fields who are grappling with challenges of equitable and sustainable development. CoLab also provides community and industry leaders with private deliberative space in which they can explore emerging issues while allowing students up-close opportunities to participate in collaborative brainstorming sessions. Along with CoLab workshops, CoLab Radio (the center’s blog) and online programming, roundtables, speaker series, and lunchtime talks, these activities enliven and enrich the Institute’s intellectual community by infusing it with a powerful diversity of voices and insights.

CoLab is located in Room 9-419. Further information can be found on the CoLab website (http://colab.mit.edu) and blog (http://colabradio.mit.edu).

The Special Program for Urban and Regional Studies (SPURS) is a one-year program designed for mid-career professionals from developing and newly industrializing countries. SPURS was founded in 1967 as part of the Department of Urban Studies and Planning (DUSP), which has a long-standing commitment to bringing outstanding individuals to MIT to reflect on their professional practice in the field of international development. The program is designed to nurture individuals, often at a turning point in their professional careers, to retool and reflect on their policy-making and planning skills. SPURS Fellows return to their countries with a better understanding of the complex set of relationships among local, regional, and international issues. SPURS has hosted over 676 women and men from more than 117 countries in Latin America, Asia, Africa, the Middle East, and Eastern and Central Europe. SPURS alumni/ae hold senior level positions in both the public and private sectors in their countries.

For further information contact Nimfa de Leon, Room 9-435, 617-253-5915 or visit the SPURS website (http://web.mit.edu/spurs/www).

**Inquiries**

For further information concerning academic programs in the department, application for admission, and financial aid, contact Graduate Admissions, Room 7-346, 617-253-9403.

**Faculty and Teaching Staff**

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Professor of Landscape Architecture and Urban Planning

**Professors**

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Professor of Education

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Professor of Urban Planning

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Hashim Sarkis, PhD
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Professor of Urban Planning

Dean, School of Architecture and Planning

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Professor of Planning
Professor of Landscape Architecture

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David Hsu, PhD
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Associate Professor of Urban and Environmental Planning
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Associate Professor of Anthropology

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Member, Institute for Data, Systems, and Society

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Jinhua Zhao, PhD
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Siqi Zheng, PhD
Samuel Tak Lee Professor
Associate Professor of Real Estate Development and Entrepreneurship

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Spaulding Career Development Professor
Assistant Professor of Urban Planning and Public Health
Jason Jackson, PhD  
Ford Career Development Professor  
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Justin Steil, JD, PhD  
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**Professors of the Practice**  
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Professor of the Practice of Civic Design

Carlo Ratti, PhD  
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Gloria Schuck, PhD  
Lecturer of Real Estate

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Lecturer of Real Estate

Yanni Tsipis, MS  
Lecturer of Real Estate

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Technical Instructor of GIS, Data Visualization and Graphics

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Class of 1922 Professor Emeritus  
Professor Emeritus of Urban Studies and Planning

Ralph Gakenheimer, PhD  
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Frank S. Jones, MBA  
Professor Emeritus of Urban Design

Langley C. Keyes Jr, PhD  
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Professor Emeritus of City and Regional Planning

Melvin H. King, MEd  
Senior Lecturer Emeritus of Urban Studies and Planning

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Frank Levy, PhD
Daniel Rose Professor Emeritus
Professor Emeritus of Urban Economics

Gary Marx, PhD
Professor Emeritus of Sociology

Lisa R. Peattie, PhD
Professor Emerita of Urban Anthropology

Karen R. Polenske, PhD
Professor Emerita of Regional Political Economy and Planning

William C. Wheaton, PhD
Professor Emeritus of Urban Studies and Planning
Professor Emeritus of Economics

Clarence G. Williams, PhD
Adjunct Professor Emeritus of Urban Studies and Planning
SCHOOL OF ENGINEERING

Never have the challenges and opportunities of engineering been more exciting or more critical to the long-term well-being of society than they are today. An engineering education from MIT provides students with exceptional opportunities to define and impact the future.

Technology's enormous influence on society is creating an increasing demand for engineering graduates. Engineers provide important leadership to society through their central role in scientific and technological innovation. By creating, developing, and managing complex technologies and products, engineers contribute directly to the betterment of humanity and to shaping our world. Seeking solutions to the most difficult challenges of our day in the context of physical, economic, human, political, legal, and cultural realities makes engineering a tremendously rewarding endeavor.

The first-year curriculum for all MIT undergraduates includes physics, chemistry, mathematics, biology, and the humanities, arts, and social sciences. An undergraduate student normally becomes affiliated with a particular department or course of study at the beginning of sophomore year and works closely with an advisor from that department or program to shape their course of study. Students who would like to explore an engineering major are encouraged to seek out and get involved with one of the engineering departments during their first year. Every department offers exciting subjects that introduce first-year students to engineering; they also offer First-Year Advising Seminars that bring students together in small groups to discuss their field with department faculty. Undergraduate Research Opportunities Projects (UROPs) (p. 44) are a great way to delve into cutting-edge engineering research.

Once a student chooses an undergraduate major, there are many opportunities for individual initiatives. For example, the New Engineering Education Transformation (NEET) (http://neet.mit.edu) program aims to reimagine and rethink what and how undergraduate engineering students learn by focusing on preparing them to develop the new machines and systems that they will build in the middle of the 21st century. Also, the School's flexible engineering degree programs offer students in several departments the opportunity to satisfy department-based core requirements and declare an additional concentration, which can be broad and interdisciplinary in nature (e.g., energy, health, or the environment), or focused on areas that can be applied to multiple fields (e.g., robotics and controls, computational engineering, or engineering management). Students may also elect to create their own concentrations under supervision from department faculty. In addition, many undergraduates combine their primary major with a second one in another area, such as management, political science, economics, one of the sciences, or another area of engineering. Others organize their programs so they can receive both undergraduate and graduate degrees simultaneously. A series of minor programs from across the Institute is also available.

Pioneering Programs in Engineering Education

Engineering education has been at the core of the Institute's mission since its founding in 1861. MIT created the contemporary model of engineering education grounded in a dynamic, changing base of science. It pioneered the modern model of the research university, with externally sponsored research programs and a matrix of academic departments and research laboratories working across various disciplines. MIT also contributed in significant ways to the creation of entire new fields, for example, chemical engineering, sanitary engineering, naval architecture and marine engineering, and soil mechanics; the Institute also offered the first course in aeronautical engineering. More recently, MIT has created new avenues for students to pursue concentrations in broad, interdisciplinary areas such as energy, medical science and engineering, robotics, computational engineering, or poverty alleviation.

The School of Engineering has distinguished itself as a leader in engineering education, where the teaching of applied, hands-on engineering is of the utmost importance. In 1916, it created one of the first industrial internship programs, now the David H. Koch School of Chemical Engineering Practice. Over the last several decades, the School of Engineering has launched numerous pioneering programs, many in partnership with industry, such as Leaders for Global Operations (1988), System Design and Management (1997), the Deshpande Center for Technological Innovation (2001), the Undergraduate Practice Opportunities Program (2001), the Bernard M. Gordon—MIT Engineering Leadership Program (2008), MITx and edX (2011), SuperUROP (2012), StartMIT (2014), the MIT Sandbox Innovation Fund Program (2016), and the New Engineering Education Transformation program (2017).

The School of Engineering is constantly innovating in engineering education, developing novel pedagogical approaches, designing new subject offerings to strengthen current programs, and creating new disciplines, fields of study, majors, and graduate programs. Today, the School offers more than two dozen exciting engineering degree programs for its undergraduates. For example, there are three interdepartmental degrees offered in conjunction with the Department of Electrical Engineering and Computer Science: Urban Science and Planning with Computer Science (11-6), Computer Science, Economics, and Data Science (6-14), and Computer Science and Molecular Biology (Course 6-7). In addition, the flexible SB in Engineering degree is offered by Mechanical Engineering, Aeronautics and Astronautics, Chemical Engineering, or Civil and Environmental Engineering.

The School of Engineering also offers a range of co-curricular activities designed to enhance students' academic and non-academic experiences at MIT. The MIT Sandbox Innovation Fund Program (http://sandbox.mit.edu) seeks to help students develop
the knowledge, skills, and attitudes to be successful innovators and entrepreneurs by providing up to $25,000 for student-initiated ideas and mentoring from within MIT and from a broad network of committed partners. The Undergraduate Practice Opportunities Program (UPOP) (http://upop.mit.edu) is a program for sophomores that provides opportunities for students to learn first-hand about engineering practice outside the academic context through internships and intensive experiential-learning workshops that emphasize development of professional abilities and attitudes required in engineering work. And SuperUROP (https://superurop.mit.edu), an expanded version of Undergraduate Research Opportunities Program (UROP), was launched in 2012 for juniors and seniors to have the time, training, resources, and guidance necessary for deep scientific and engineering inquiry leading to publication-worthy findings.

The School of Engineering is generally ranked at the top of its fields by third-party rankings and surveys. US News and World Report has placed the School at the top of its engineering rankings every year they have run their survey, as has the QS World University Rankings. The School’s eight academic departments and two institutes are home to 378 faculty members, more than a third of the Institute’s total faculty. Among the most distinguished in the nation, nearly one third of the School’s current and emeritus faculty and research staff have been inducted into the National Academy of Engineering.

Approximately 70 percent of MIT undergraduates with declared majors and half of all graduate students at MIT are enrolled in School of Engineering degree programs.

Interdepartmental Research Programs

Within the School of Engineering, students may develop a program that satisfies their own intellectual and professional objectives. Those interested in an interdepartmental program should study the department descriptions and interdisciplinary program description for opportunities that combine disciplines from MIT’s four other schools with those of the School of Engineering.

While the School’s academic departments provide continuity and stability for the basic engineering disciplines, they increasingly share interests in the way their individual disciplines are expressed and applied. Interdepartmental centers, laboratories, and programs provide opportunities for faculty, students, and research staff to undertake collaborative research and engage in educational programs dealing with these and other interdisciplinary applications of importance to society.

Interdisciplinary centers and laboratories in which School of Engineering faculty play leading roles include the following:

- Center for Advanced Nuclear Energy Systems
- Center for Computational Engineering
- Center for Materials Science and Engineering
- Center for Ocean Engineering
- Center for Transportation and Logistics
- Computer Science and Artificial Intelligence Laboratory
- Deshpande Center for Technological Innovation
- Industrial Performance Center
- Institute for Data, Systems, and Society
- Institute for Medical Engineering and Science
- Koch Institute for Integrative Cancer Research
- Laboratory for Information and Decision Systems
- Laboratory for Manufacturing and Productivity
- Materials Processing Center
- Microsystems Technology Laboratories
- MIT Energy Initiative
- Research Laboratory of Electronics
- Singapore-MIT Alliance
- Sociotechnical Systems Research Center

School of Engineering faculty members also participate in the activities of other research centers and laboratories that are administered outside the School of Engineering. For more information, see the section on Research and Study (p. 88).

Degrees Offered in the School of Engineering

Aeronautics and Astronautics (Course 16)

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<th>Degree</th>
<th>Program</th>
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<tr>
<td>SB</td>
<td>Aerospace Engineering</td>
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<tr>
<td>SB</td>
<td>Engineering</td>
</tr>
<tr>
<td>SM</td>
<td>Aeronautics and Astronautics</td>
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<tr>
<td>SM/MBA</td>
<td>Engineering/Management—dual degree with Leaders for Global Operations Program</td>
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<tr>
<td>Engineer</td>
<td>Aeronautics and Astronautics</td>
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<tr>
<td>PhD, ScD</td>
<td>Aeronautics and Astronautics, and Statistics</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Aerospace Computational Engineering</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Aerospace, Energy, and the Environment</td>
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<tr>
<td>PhD, ScD</td>
<td>Air-Breathing Propulsion</td>
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<tr>
<td>PhD, ScD</td>
<td>Aircraft Systems Engineering</td>
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<td>PhD, ScD</td>
<td>Air Transportation Systems</td>
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<td>PhD, ScD</td>
<td>Autonomous Systems</td>
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<td>PhD, ScD</td>
<td>Communications and Networks</td>
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<td>PhD, ScD</td>
<td>Controls</td>
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<tr>
<td>PhD, ScD</td>
<td>Humans in Aerospace</td>
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<tr>
<td>PhD, ScD</td>
<td>Materials and Structures</td>
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<tr>
<td>PhD, ScD</td>
<td>Oceanographic Engineering (jointly with WHOI)</td>
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<tr>
<td>PhD, ScD</td>
<td>Space Propulsion</td>
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<td>PhD, ScD</td>
<td>Space Systems</td>
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### Biological Engineering (Course 20)

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<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SB</td>
<td>Biological Engineering</td>
</tr>
<tr>
<td>SM</td>
<td>Toxicology</td>
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<tr>
<td>SM/MBA</td>
<td>Engineering/Management—dual degree with Leaders for Global Operations Program ¹</td>
</tr>
<tr>
<td>MEng</td>
<td>Biomedical Engineering</td>
</tr>
<tr>
<td>MEng</td>
<td>Biomedical Engineering</td>
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<tr>
<td>PhD, ScD</td>
<td>Biological Engineering</td>
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### Chemical Engineering (Course 10)

<table>
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<tbody>
<tr>
<td>SB</td>
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<tr>
<td>SM</td>
<td>Chemical Engineering</td>
</tr>
<tr>
<td>SM</td>
<td>Chemical Engineering Practice</td>
</tr>
<tr>
<td>SM/MBA</td>
<td>Engineering/Management—dual degree with Leaders for Global Operations Program ¹</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Chemical Engineering</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Chemical Engineering Practice</td>
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### Civil and Environmental Engineering (Course 1)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SB</td>
<td>General Engineering</td>
</tr>
<tr>
<td>SM</td>
<td>Civil and Environmental Engineering</td>
</tr>
<tr>
<td>SM/MBA</td>
<td>Engineering/Management—dual degree with Leaders for Global Operations Program ¹</td>
</tr>
<tr>
<td>MEng</td>
<td>Civil and Environmental Engineering</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Biological Oceanography (jointly with WHOI)</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Chemical Oceanography (jointly with WHOI)</td>
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<tr>
<td>PhD, ScD</td>
<td>Civil and Environmental Engineering</td>
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<tr>
<td>PhD, ScD</td>
<td>Civil and Environmental Systems</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Civil Engineering</td>
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<tr>
<td>PhD, ScD</td>
<td>Civil Engineering and Computation</td>
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<tr>
<td>PhD, ScD</td>
<td>Coastal Engineering</td>
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<tr>
<td>PhD, ScD</td>
<td>Construction Engineering and Management</td>
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<tr>
<td>PhD, ScD</td>
<td>Environmental Biology</td>
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<tr>
<td>PhD, ScD</td>
<td>Environmental Chemistry</td>
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<td>PhD, ScD</td>
<td>Environmental Engineering</td>
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<td>PhD, ScD</td>
<td>Environmental Engineering and Computation</td>
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<tr>
<td>PhD, ScD</td>
<td>Environmental Fluid Mechanics</td>
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<tr>
<td>PhD, ScD</td>
<td>Geotechnical and Geoenvironmental Engineering</td>
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<tr>
<td>PhD, ScD</td>
<td>Hydrology</td>
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<tr>
<td>PhD, ScD</td>
<td>Information Technology</td>
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<tr>
<td>PhD, ScD</td>
<td>Oceanographic Engineering (jointly with WHOI)</td>
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<tr>
<td>PhD, ScD</td>
<td>Structures and Materials</td>
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<tr>
<td>PhD, ScD</td>
<td>Transportation</td>
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<td>Civil Engineer</td>
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### Computation for Design and Optimization

<table>
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<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SM</td>
<td>Computation for Design and Optimization ¹</td>
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### Computational and Systems Biology (CSB)

<table>
<thead>
<tr>
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<th>Program</th>
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</thead>
<tbody>
<tr>
<td>PhD</td>
<td>Computational and Systems Biology      ¹</td>
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### Computational Science and Engineering

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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</thead>
<tbody>
<tr>
<td>PhD, ScD</td>
<td>Computational Science and Engineering ¹</td>
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### Computer Science and Molecular Biology (Course 6-7)

<table>
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<tr>
<th>Degree</th>
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<tbody>
<tr>
<td>SM</td>
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### Computer Science, Economics, and Data Science (Course 6-14)

<table>
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<tbody>
<tr>
<td>SB</td>
<td>Computer Science, Economics, and Data Science ¹</td>
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### Data, Systems, and Society

<table>
<thead>
<tr>
<th>Degree</th>
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<tbody>
<tr>
<td>SM</td>
<td>Technology and Policy</td>
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<tr>
<td>PhD, ScD</td>
<td>Social and Engineering Systems</td>
</tr>
<tr>
<td>PhD</td>
<td>Social and Engineering Systems and Statistics</td>
</tr>
<tr>
<td>PhD</td>
<td>Aeronautics and Astronautics and Statistics</td>
</tr>
<tr>
<td>PhD</td>
<td>Economics and Statistics</td>
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<tr>
<td>PhD</td>
<td>Mathematics and Statistics</td>
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<tr>
<td>PhD</td>
<td>Political Science and Statistics</td>
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<td>PhD</td>
<td>Social and Engineering Systems and Statistics</td>
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### Design and Management (Integrated Design and Management & System Design and Management)

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<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SM</td>
<td>Engineering and Management             ¹</td>
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### Electrical Engineering and Computer Science (Course 6)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SB</td>
<td>Computer Science and Engineering</td>
</tr>
<tr>
<td>SB</td>
<td>Electrical Engineering and Computer Science</td>
</tr>
<tr>
<td>SB</td>
<td>Electrical Science and Engineering</td>
</tr>
<tr>
<td>SM</td>
<td>Electrical Engineering and Computer Science</td>
</tr>
<tr>
<td>SM/MBA</td>
<td>Engineering/Management—dual degree with Leaders for Global Operations Program ¹</td>
</tr>
<tr>
<td>MEng</td>
<td>Electrical Engineering and Computer Science</td>
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</table>
### Electrical Engineer
- PhD, ScD in Computer Science
- PhD, ScD in Electrical Engineering
- PhD, ScD in Electrical Engineering and Computer Science

### Health Sciences and Technology (HST)

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<th>Program</th>
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<tbody>
<tr>
<td>SM</td>
<td>Health Sciences and Technology</td>
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<tr>
<td>MD</td>
<td>Medical Sciences (degree from Harvard Medical School)</td>
</tr>
<tr>
<td>ScD, PhD</td>
<td>Health Sciences and Technology</td>
</tr>
<tr>
<td>ScD, PhD</td>
<td>Health Sciences and Technology—Bioastronautics</td>
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<tr>
<td>ScD, PhD</td>
<td>Health Sciences and Technology—Bioinformatics and Integrative Genomics</td>
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<tr>
<td>ScD, PhD</td>
<td>Health Sciences and Technology—Medical Engineering and Medical Physics</td>
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### Materials Science and Engineering (Course 3)

<table>
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<tr>
<th>Degree</th>
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<tbody>
<tr>
<td>SB</td>
<td>Archaeology and Materials</td>
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<tr>
<td>SB</td>
<td>Materials Science and Engineering</td>
</tr>
<tr>
<td>SM</td>
<td>Materials Science and Engineering</td>
</tr>
<tr>
<td>Materials Engineer</td>
<td>PhD, ScD in Archaeological Materials</td>
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<tr>
<td>Materials Engineer</td>
<td>PhD, ScD in Materials Science and Engineering</td>
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### Mechanical Engineering (Course 2)

<table>
<thead>
<tr>
<th>Degree</th>
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<tbody>
<tr>
<td>SB</td>
<td>Engineering</td>
</tr>
<tr>
<td>SB</td>
<td>Mechanical and Ocean Engineering</td>
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<tr>
<td>SB</td>
<td>Mechanical Engineering</td>
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<tr>
<td>SM</td>
<td>Mechanical Engineering</td>
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<tr>
<td>SM</td>
<td>Naval Architecture and Marine Engineering</td>
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<tr>
<td>SM</td>
<td>Ocean Engineering</td>
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<tr>
<td>SM</td>
<td>Oceanographic Engineering (jointly with WHOI)</td>
</tr>
<tr>
<td>SM/MBA</td>
<td>Engineering/Management—dual degree with Leaders for Global Operations Program 1</td>
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<td>PhD, ScD in Mechanical Engineering</td>
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<tr>
<td>Mechanical Engineer</td>
<td>PhD, ScD in Naval Architecture and Marine Engineering</td>
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<tr>
<td>Mechanical Engineer</td>
<td>PhD, ScD in Ocean Engineering</td>
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### Nuclear Science and Engineering (Course 22)

<table>
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<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SB</td>
<td>Nuclear Science and Engineering</td>
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<td>SM</td>
<td>Nuclear Science and Engineering</td>
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<td>Nuclear Engineer</td>
<td>PhD, ScD in Nuclear Science and Engineering</td>
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### Polymers and Soft Matter

<table>
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<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>PhD, ScD</td>
<td>Polymers and Soft Matter 1</td>
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### Statistics and AeroAstro

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>PhD</td>
<td>Aeronautics and Astronautics and Statistics 1</td>
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### Supply Chain Management

<table>
<thead>
<tr>
<th>Degree</th>
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<tbody>
<tr>
<td>MSc</td>
<td>Supply Chain Management 1</td>
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<td>MEng</td>
<td>Supply Chain Management 1</td>
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### Transportation

<table>
<thead>
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<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SM</td>
<td>Transportation 1</td>
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<td>PhD, ScD</td>
<td>Transportation 1</td>
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### Urban Science and Planning with Computer Science (Course 11-6)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Urban Science and Planning with Computer Science 1</td>
</tr>
</tbody>
</table>

### Notes

Many departments make it possible for a graduate student to pursue a simultaneous master’s degree.

Several departments also offer undesignated degrees, which lead to the Bachelor of Science without departmental designation. The curricula for these programs offer students opportunities to pursue broader programs of study than can be accommodated within a four-year departmental program.

1. **See Interdisciplinary Programs (p. 337).**
Admissions

The selection process at MIT is holistic and student centered: each application is evaluated within its unique context. Selection is based on outstanding academic achievement as well as a strong match between the applicant and the Institute.

Undergraduate applicants do not apply to a particular school, department or program and, although the application asks about a preferred field of study, most admitted undergraduates do not declare a major until the second semester of their first year. Admissions information for regular, transfer, and non-degree applicants is provided in the section on Undergraduate Education (p. 31).

Applicants for graduate study apply directly to the particular department or program of interest. See the individual department and program descriptions for specific requirements.

Office of the Dean

Anantha P. Chandrakasan, PhD
Vannevar Bush Professor in Electrical Engineering
Dean, School of Engineering

Anette E. Hosoi, PhD
Neil and Jane Pappalardo Professor
Professor of Mechanical Engineering
Professor of Mathematics
Associate Dean, School of Engineering

Michael J. Cima, PhD
David H. Koch Professor in Engineering
Professor of Materials Science and Engineering
Associate Dean for Innovation, School of Engineering

Eileen Ng-Ghavidel, MBA
Assistant Dean for Finance and Administration

Catherine Kim
Assistant Dean for Human Resources and Administration

Chad Galts, MA
Director of Communications

Mary Ellen Sinkus
Administrative Officer

School Professors

Nicholas A. Ashford, JD, PhD
Professor of Technology and Policy
Member, Institute for Data, Systems, and Society

Timothy Berners-Lee
3Com Founders Professor of Engineering
The Department of Aeronautics and Astronautics (AeroAstro) students, faculty, and staff share a passion for air and space vehicles, the technologies that enable them, and the missions they fulfill.

Aerospace is an intellectually challenging, economically important, and exciting field. AeroAstro’s mission is to prepare engineers for success and leadership in the conception, design, implementation, and operation of aerospace and related engineering systems. This is achieved through commitment to educational excellence and to the creation of critical aerospace vehicle and information engineering technologies, and the engineering of complex high-performance systems.

AeroAstro, which traces its roots to 1914 (even earlier if you count MIT’s 1896 wind tunnel), is the oldest program of its kind in the United States. The department maintains a tradition of strong scholarship and solving complex challenges. The campus community comprises people whose careers have included astronaut, Air Force secretary, NASA deputy administrator and chief technologist, Air Force chief scientist, aerospace executives, and corporate founders. AeroAstro alumni/ae are entrepreneurs who start their own businesses, policy-makers shaping the direction of future research and development, educators sharing a passion for learning, and researchers pushing technology’s boundaries.

Working closely with student, alumni/ae, industry, government, and academic stakeholders, AeroAstro created a landmark educational initiative for its degree programs, an education model that has spread to more than 100 universities worldwide. This undergraduate engineering education model motivates students to master a deep working knowledge of the technical fundamentals while providing the skills, knowledge, and attitude necessary to lead in the creation and operation of products, processes, and systems.

Graduates with an aerospace engineering degree find careers in commercial and military aircraft and spacecraft engineering, space exploration, air- and space-based telecommunication, autonomous vehicle and system design, teaching, research, military service, and related technology-intensive fields such as transportation, information, and the environment. The comprehensive technical education, with its strong emphasis on understanding complex systems, is also excellent preparation for careers in business, law, medicine, and public service.

AeroAstro supports labs and centers across campus. Three of particular note are the Learning Laboratory for Complex Systems, Building 31 (Sloan Laboratories), and the Wright Brothers Wind Tunnel.

- The Learning Laboratory for Complex Systems’ Arthur Gelb Laboratory features an extensive machine shop, composites fabrication facility, electronics design lab, and team project areas. Connected to the Gelb Lab is the expansive Gerhard Neumann Hangar, which includes a small wind tunnel, and a workspace for large-scale student projects, such as aircraft, rockets, and autonomous vehicles of all descriptions. The adjacent Robert C. Seams Jr. Laboratory is a community gathering area with meeting and discussion rooms.

- From 1938 until the spring of 2018, the Wright Brothers Wind Tunnel played a key role in the development of aerospace, civil engineering, and architectural systems. In late 2017, it was announced that the tunnel would be dismantled at the end of the spring 2018 term and a new state-of-the-art Wright Brothers Wind Tunnel constructed in its place. This will be the largest and most advanced academic wind tunnel in the US and is expected to be operational in the fall of 2019. All AeroAstro students will be provided the opportunity to perform research in the tunnel.

- Building 31 (Sloan Laboratories) is the new crown jewel of AeroAstro facilities. Reopened in the fall of 2017, fresh from a $52 million renovation, a highlight of Building 31 is the Kresa Center for Autonomous Systems’ massive high-bay facility for testing of aerial robotic systems. Another Building 31 feature is extensive lab and workshop space for Beaver Works, the joint MIT-Lincoln Laboratory center where undergraduates design and build projects for real-world customers.

In looking toward future challenges and opportunities in the aerospace field, the department has identified six strategic thrusts to strengthen and evolve: vehicle design, information sciences, computation, human–system collaboration, atmosphere and space sciences, and complex systems. These are built upon and connected by four strategic thrusts: air transportation, autonomous systems, small satellites, and education. By striving for excellence in the underlying core disciplines and emphasizing the collaborative problem solving required for tackling the complex, multidisciplinary problems that characterize this industry, AeroAstro is positioned to respond to these and future opportunities.

**Sectors of Instruction**

The department’s faculty are organized into three sectors of instruction. Typically, a faculty member teaches both undergraduate and graduate subjects in one or more of the sectors.

**Information Sector**

Most of the aerospace systems of the future will either revolve around or critically depend upon information technology, and all will exploit information technology to an increasing extent. The missions of many aerospace systems are fundamentally centered on gathering, processing, and transmitting information. Examples where information technology is central include communication satellites, surveillance and reconnaissance aircraft and satellites, planetary rovers, global positioning satellites, the air transportation system, and integrated defense systems. Other aerospace systems also must rely on information technology-intensive subsystems.
to provide important on-board functions, including navigation, autonomous or semi-autonomous guidance and control, cooperative action (including formation flight), and health monitoring systems. Furthermore, almost every aircraft or satellite is one system within a larger system, and information plays a central role in the interoperability of these subsystems.

Faculty members in the Information Sector teach and perform research on a broad range of areas, including guidance, navigation, control, autonomy, communication, networks, and real-time mission-critical software and hardware. In many instances, the functions provided by aerospace information systems are critical to life or mission success. The complex nature of an aerospace system can either be simplified by the use of information technologies or can become significantly more complicated through the misuse of information technologies. Hence, safety, fault-tolerance, verification, and validation are significant areas of inquiry. Ongoing research in this sector includes autonomy and robotics, command and control of multiple unmanned/autonomous vehicles, space and airborne communication systems and networks, and software development methods for flight and mission-critical systems, investigation of air traffic management, and design of robust and adaptive control algorithms.

The Information Sector has strong linkages to the department’s Aerospace Systems Sector, particularly on issues related to how humans interact with aerospace vehicles. Other common interests include the safety aspects of large, mission-critical software systems, the design and operation of ground and air transportation systems, and the design and operation of satellite systems. The sector also has linkages with the Vehicles Technology Sector through a common interest in research on unmanned aerial vehicles. Moreover, the sector has strong links to the Department of Electrical Engineering and Computer Science and the Institute for Data, Systems, and Society through joint teaching and collaborative research in communication, networks, control, robotic systems, optimization, numerical techniques, and algorithms.

Aerospace Systems Sector
The Aerospace Systems sector is responsible for instruction and research in systems engineering, a discipline that denotes the methodologies used in the architecting, design, manufacture, and operation of the highly complex and demanding systems in the field of aeronautics and astronautics. The sector consists of faculty members with research specialties in this area, as well as faculty affiliates who contribute to the full disciplinary strength of the department.

The systems approach considers all factors important to the performance, economic viability, manufacture, acceptability, and operation of engineering systems—technical, social, environmental, production, financial, and safety aspects—and attempts to find optimal or best-value trade-offs among them while considering risk and uncertainty. The systems engineer must deal simultaneously with these factors, whether the objective is the transport of passengers in commercial aircraft, orbital communications, or the exploration of space, among others.

The Aerospace Systems sector addresses traditional vehicle design issues integrated with other issues, including environmental impact, how humans interact with aerospace vehicles, and information-related aspects. Safety, fault-tolerance, verification, and validation are also significant areas of inquiry. Ongoing research in the sector includes investigation of air traffic management, distributed satellite systems, environmental impact of aerospace systems, enterprise architecture, integrated design of space-based optical systems, micro-gravity research into human physiology, and software development methods for flight and mission-critical systems.

Students interested in systems engineering should develop a strong background in some of the disciplines that support systems analysis, such as probability, statistics, optimization, operations research, manufacturing, and economics. Research labs associated with the activities of this sector include the Man Vehicle Laboratory, Space Systems Laboratory, Lean Advancement Initiative, International Center in Air Transportation, Laboratory for Aviation and the Environment, and the Operations Research Center. Many of the department faculty in this sector are also associated with the Institute for Data, Systems, and Society.

Vehicle Technologies Sector
The design of an aerospace vehicle requires not only depth in a number of disciplines, but also the ability to integrate and optimize across these disciplines so the result is greater than the sum of the individual parts. For the former, the vehicle sector faculty represent, in both research and teaching, a broad suite of disciplines ranging across the fields of computation, fluid mechanics, propulsion, materials, and structures. For the latter, there is strong interest in, and many successful examples of, collaborations that bring these different disciplines together to solve important problems beyond the reach of a single faculty member.

The research footprint of the sector spans from fundamental engineering science to design techniques to the rigorous engineering of complex vehicle components and systems. One specific embodiment of such “intellectual vertical integration” has been the development of a first-principles conceptual design procedure for advanced aircraft. There is also substantive research engagement with industry, both in sponsorship of projects and through collaboration.

Topics of current interest include aviation and ground transportation climate and air quality impacts; computational design and simulation of fluid, material, and structural systems, including computational aerodynamics and, more broadly, numerical methods, optimization, and uncertainty quantification for large-scale engineering systems; composite materials and structures, including nano-engineered composites; simulation of the dynamic deformation and failure response of materials, with application to concepts and material for force protection, physics of plasma,
and electromagnetics, studied in the foundation of electrical science. Knowledge of materials science and mechanical behavior; dynamics and vibration; fluid mechanics and heat transfer; and structural design and analysis are fundamental to the design and construction of airframes and engines. Topics within these disciplines include fluid mechanics, aerodynamics, heat and mass transfer, computational mechanics, flight vehicle aerodynamics, solid mechanics, structural design and analysis, the study of engineering materials, structural dynamics, and propulsion and energy conversion from both fluid/thermal (gas turbines and rockets) and electrical devices.

Professional area subjects in the four areas of Estimation and Control, Computer Systems, Communications Systems, and Humans and Automation are in the broad disciplinary area of information, opportunities for formal and practical (hands-on) learning in these areas are integrated into the departmental subjects through examples set by the faculty, subject content, and the ability for substantive engagement in the CDIO process in the department’s Learning Laboratory for Complex Systems.

The curriculum (p. 389) includes the General Institute Requirements (p. 36) and the departmental program. The departmental program includes a fall-spring-fall sequence of subjects called Unified Engineering, subjects in dynamics and principles of automatic control, a statistics and probability subject, a subject in computers and programming, professional area subjects, an experimental projects laboratory, and a capstone design subject. The program also includes subject 18.03 Differential Equations.

Unified Engineering is usually taken in the sophomore year, 16.09 Statistics and Probability in the spring of the sophomore year, and the subjects 16.06 Principles of Automatic Control and 16.07 Dynamics in the first term of the junior year. 6.00 Introduction to Computer Science and Programming can be taken at any time, starting in the first year of undergraduate study, but the fall term of the sophomore year is recommended.

The professional area subjects offer a more complete and in-depth treatment of the materials introduced in the core courses. Students must take four subjects (48 units) from among the professional area subjects, with subjects in at least three areas. Students may choose to complete an option in Aerospace Information Technology by taking at least 36 of the 48 required units from a designated group of subjects specified in the degree chart (p. 389).

Professional area subjects in the four areas of Fluid Mechanics, Materials and Structures, Propulsion, and Computational Tools represent the advanced aerospace disciplines encompassing the design and construction of airframes and engines. Topics within these disciplines include fluid mechanics, aerodynamics, heat and mass transfer, computational mechanics, flight vehicle aerodynamics, solid mechanics, structural design and analysis, the study of engineering materials, structural dynamics, and propulsion and energy conversion from both fluid/thermal (gas turbines and rockets) and electrical devices.

Professional area subjects in the four areas of Estimation and Control, Computer Systems, Communications Systems, and Humans and Automation are in the broad disciplinary area of information,
which plays a dominant role in modern aerospace systems. Topics within these disciplines include feedback, control, estimation, control of flight vehicles, software engineering, human systems engineering, aerospace communications and digital systems, fundamentals of robotics, the way in which humans interact with the vehicle through manual control and supervisory control of telerobotic processes (e.g., modern cockpit systems and human centered automation), and how planning and real-time decisions are made by machines.

The capstone subjects serve to integrate the various disciplines and emphasize the CDIO context of the AeroAstro curriculum. They also satisfy the Communication Requirement (p. 38) as Communication-Intensive in the Major (CI-M) subjects. The vehicle and system design subjects require student teams to apply their undergraduate knowledge to the design of an aircraft or spacecraft system. One of these two subjects is required and is typically taken in the second term of the junior year or in the senior year. (The completion of at least two professional area or concentration subjects is the prerequisite for capstone subjects 16.82 and 16.83[J].) The rest of the capstone requirement is satisfied by one of four 12–18 unit subjects or subject sequences, as outlined in the Course 16 degree chart; these sequences satisfy the Institute Laboratory Requirement. In 16.82[J] and 16.83[J] students build and operate the vehicles or systems developed in 16.82 and 16.83[J]. In 16.621/16.622, students conceive, design, and execute an original experimental research project in collaboration with a partner and a faculty advisor. In 16.405[J], students specify and design a small-scale yet complex robot capable of real-time interaction with the natural world.

To take full advantage of the General Institute Requirements (p. 36) and required electives, the department recommends the following:

- 3.091 Introduction to Solid-State Chemistry for the chemistry requirement;
- the ecology option of the biology requirement;
- a subject in economics (e.g., 14.01 Principles of Microeconomics) as part of the HASS Requirement;
- and elective subjects such as 16.00 Introduction to Aerospace and Design, a mathematics subject (e.g., 18.06 Linear Algebra, 18.075 Methods for Scientists and Engineers, or 18.085 Computational Science and Engineering I), and additional professional area subjects in the departmental program. Please consult the department’s Academic Programs Office (Room 33-202) for additional elective options.

**Bachelor of Science in Engineering as Recommended by the Department of Aeronautics and Astronautics (Course 16-ENG)**

Course 16-ENG is an engineering degree program designed to offer flexibility within the context of aerospace engineering and is a complement to our Course 16 aerospace engineering degree program. The program leads to the Bachelor of Science in Engineering as recommended by the Department of Aeronautics and Astronautics (p. 406). The 16-ENG degree is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org). Depending on their interests, Course 16-ENG students can develop a deeper level of understanding and skill in a field of engineering that is relevant to multiple disciplinary areas (e.g., robotics and control, computational engineering, mechanics, or engineering management), or a greater understanding and skill in an interdisciplinary area (e.g., energy, environment and sustainability, or transportation). This is accomplished first through a rigorous foundation within core aerospace engineering disciplines, followed by a six-subject concentration tailored to the student’s interests, and completed with hands-on aerospace engineering lab and capstone design subjects.

The core of the 16-ENG degree is very similar to the core of the 16 degree. A significant part of the 16-ENG curriculum consists of electives (72 units) chosen by the student to provide in-depth study of a field of the student’s choosing. A wide variety of concentrations are possible in which well-selected academic subjects complement a foundation in aerospace engineering and General Institute Requirements. Potential concentrations include aerospace software engineering, autonomous systems, communications, computation and sustainability, computational engineering, embedded systems and networks, energy, engineering management, environment, space exploration, and transportation. AeroAstro faculty have developed specific recommendations in these areas; details are available from the AeroAstro Academic Programs Office (Room 33-202) and on the departmental website. However, concentrations are not limited to those listed above. Students can design and propose technically oriented concentrations that reflect their own needs and those of society.

The student’s overall program must contain a total of at least one and one-half years of engineering content (144 units) appropriate to his or her field of study. The required core, lab, and capstone subjects include 102 units of engineering topics. Thus, concentrations must include at least 42 more units of engineering topics. In addition, each concentration must include 12 units of mathematics or science.

The culmination of the 16-ENG degree program is our aerospace laboratory and capstone subject sequences. The capstone subjects serve to integrate the various disciplines and emphasize the CDIO context of our engineering curriculum. They also satisfy the Communication Requirement as CI-M subjects. The laboratory and capstone options in the 16-ENG degree are identical to those in the Course 16 degree program (see the description of this program for additional details on the laboratory and capstone sequences).

**Double Major**

Students may pursue two majors under the Double Major Program (p. 34). In particular, some students may wish to combine a professional education in aeronautics and astronautics with a liberal education that links the development and practice of science and engineering to their social, economic, historical, and cultural contexts. For them, the Department of Aeronautics and Astronautics and the Program in Science, Technology, and Society offer a double major program (p. 278) that combines majors in both fields.
Other Undergraduate Opportunities

Undergraduate Research Opportunities Program
To take full advantage of the unique research environment of MIT, undergraduates, including first-year students, are encouraged to become involved in the research activities of the department through the Undergraduate Research Opportunities Program (UROP) (p. 44). Many of the faculty actively seek undergraduates to become a part of their research teams. Visit research centers’ websites to learn more about available research opportunities. For more information, contact Marie Stuppard (mas@mit.edu) in the AeroAstro Academic Programs Office, Room 33-202, 617-253-2279.

Advanced Undergraduate Research Opportunities Program
Juniors and seniors in Course 16 may participate in an advanced undergraduate research program, SuperUROP (https://superurop.mit.edu), which was launched as a collaborative effort between the Department of Electrical Engineering and Computer Science (EECS) and the Undergraduate Research Opportunities Program (UROP) (p. 44). More information is available online or by contacting Joyce Light (jlight@mit.edu), AeroAstro Headquarters, Room 33-207, 617-253-8408.

Undergraduate Practice Opportunities Program
The Undergraduate Practice Opportunities Program (UPOP) (http://urop.mit.edu) is a program sponsored by the School of Engineering and administered through the Office of the Dean of Engineering. Open to all School of Engineering sophomores, this program provides students an opportunity to develop engineering and business skills while working in industry, nonprofit organizations, or government agencies. UPOP consists of three parts: an intensive one-week engineering practice workshop offered during IAP, 10–12 weeks of summer employment, and a written report and oral presentation in the fall. Students are paid during their periods of residence at the participating companies and also receive academic credit in the program. There are no obligations on either side regarding further employment.

Summer Internship Program
The Summer Internship Program provides undergraduates in the department the opportunity to apply the skills they are learning in the classroom in paid professional positions with employers throughout the United States. During recruitment periods, representatives from firms in the aerospace industry will visit the department and offer information sessions and technical talks specifically geared to Course 16 students. Often, student résumés are collected and interviews conducted for summer internships as well as long-term employment. Employers wishing to offer an information session or seeking candidates for openings in their company may contact Marie Stuppard (mas@mit.edu), 617-253-2279.

Students are also encouraged to take advantage of other career resources available through Career Advising and Professional Development or through the MIT International Science and Technology Initiatives (MISTI). AeroAstro students can apply to participate in the Imperial College London-MIT Summer Research Exchange Program.

Career Advising and Professional Development coordinates several annual career fairs and offers workshops on how to navigate these fairs, as well as critique on résumé writing and cover letters.

Year Abroad Program
Through the MIT Global Education Office, students can apply to study abroad in the junior year. In particular, the department participates in the University of Pretoria-MIT Exchange program. In any year-abroad experience, students enroll in the academic cycle of the host institution and take courses in the local language. They plan their course of study in advance; this includes securing credit commitments in exchange for satisfactory performance abroad. A grade average of B or better is normally required of participating AeroAstro students.

For more information, contact Marie Stuppard (mas@mit.edu). Also refer to Undergraduate Education (p. 46) for more details on the exchange programs.

Massachusetts Space Grant Consortium
MIT leads the NASA-supported Massachusetts Space Grant Consortium (MASGC) in partnership with Boston University, Bridgewater State University, Harvard University, Framingham State University, Mount Holyoke College, Northeastern University, Olin College of Engineering, Roxbury Community College, Tufts University, University of Massachusetts (Amherst, Dartmouth, and Lowell), Wellesley College, Williams College, Worcester State University, Worcester Polytechnic Institute, Boston Museum of Science, the Christa McAuliffe Center, the Maria Mitchell Observatory, and the Five College Astronomy Department. The program has the principal objective of stimulating and supporting student interest, especially that of women and underrepresented minorities, in space engineering and science at all educational levels, primary through graduate. The program offers a number of activities to this end, including sponsorship of undergraduate research projects, support for student travel to present conference papers, a January internship at the Kennedy Space Center, an annual public lecture by a distinguished member of the aerospace community, and summer workshops for pre-college teachers.

An important function of the program is coordinating placement of students in summer positions at NASA centers for summer academies and research opportunities. MASGC also participates in a number of public outreach and education policy initiatives in Massachusetts to increase public awareness and inform legislators about the importance of science, technology, engineering, and math education in the state.
For more information, contact the program coordinator of the Massachusetts Space Grant Consortium, Helen Halaris (halaris@mit.edu), 617-258-5546.

Inquiries
For additional information concerning academic and undergraduate research programs in the department, suggested four-year undergraduate programs, and interdisciplinary programs, contact Marie Stuppard (mas@mit.edu), 617-253-2279.

Graduate Study
Graduate study in the Department of Aeronautics and Astronautics includes graduate-level subjects in Course 16 and others at MIT, and research work culminating in a thesis. Degrees are awarded at the master’s and doctoral levels. The range of subject matter is described under Sectors of Instruction (p. 147). Departmental research centers’ websites offer information on research interests. Detailed information may be obtained from the Department Academic Programs Office or from individual faculty members.

Admission Requirements
In addition to the general requirements for admission to the Graduate School, applicants to the Department of Aeronautics and Astronautics should have a strong undergraduate background in the fundamentals of engineering and mathematics as described in the Undergraduate Study section.

International students whose language of instruction has not been English in their primary and secondary schooling must pass the Test of English as a Foreign Language (TOEFL) with a minimum score of 100 out of 120, or the International English Language Testing System (IELTS) with a minimum score of 7 out of 9 to be considered for admission to this department. TOEFL waivers are not accepted. No other exams fulfill this requirement.

All applicants to the graduate program in Aeronautics and Astronautics also must submit the Graduate Record Examination (GRE) test results.

New graduate students are normally admitted as candidates for the degree of Master of Science. Admission to the doctoral program is offered to students who have been accepted for graduate study through a two-step process:

1. Passing performance on the field exam (FE). The standard for passing the FE is the demonstration of superior intellectual ability through skillful use of concepts, including synthesis of multiple concepts, in foundational, graduate-level material in a field of aerospace engineering.
2. Granting of admission to the doctoral program through a faculty review consisting of an examination of the student's achievements, including an assessment of the quality of past research work and evaluation of the student's academic record in light of the performance on the FE.

The FE examination is offered once each year, during the January Independent Activities Period. Students who wish to be considered for the doctoral program must take the FE before the fourth term following initial registration in the graduate program.

The Department of Aeronautics and Astronautics requires that all entering graduate students demonstrate satisfactory English writing ability by taking the Graduate Writing Examination offered by the Comparative Media Studies/Writing Program. The examination is usually administered in July, and all entering candidates must take the examination electronically at that time. Students with deficient skills must complete remedial training specifically designed to fulfill their individual needs. The remedial training prescribed by the CMS/Writing Program must be completed by the end of the first Independent Activities Period following initial registration in the graduate program or, in some cases, in the spring term of the first year of the program.

All incoming graduate students whose native language is not English are required to take the Department of Humanities English Evaluation Test (EET) offered at the start of each regular term. This test is a proficiency examination designed to indicate areas where deficiencies may still exist and recommend specific language subjects available at MIT.

Degree Requirements
All entering students are provided with additional information concerning degree requirements, including lists of recommended subjects, thesis advising, research and teaching assistantships, and course and thesis registration.

Degrees Offered

Master of Science in Aeronautics and Astronautics
The Master of Science (SM) degree is a one- to two-year graduate program with a beginning research or design experience represented by the SM thesis. This degree prepares the graduate for an advanced position in the aerospace field, and provides a solid foundation for future doctoral study.

The general requirements for the Master of Science degree are cited in the section on General Degree Requirements (p. 61) for graduate students. The specific departmental requirements include at least 66 graduate subject units, typically in subjects relevant to the candidate’s area of technical interest. Of the 66 units, at least 21 units must be in departmental subjects. To be credited toward the degree, graduate subjects must carry a grade of B or better. In addition, a 24-unit thesis is required beyond the 66 units of coursework. Full-time students normally must be in residence one full academic year. Special students admitted to the SM program in this department must enroll in and satisfactorily complete at least two graduate subjects while in residence (i.e., after being
admitted as a degree candidate) regardless of the number of subjects completed before admission to the program. Students holding research assistantships typically require a longer period of residence.

In addition, the department's SM program requires one graduate-level mathematics subject. The requirement is satisfied only by graduate-level subjects on the list approved by the department graduate committee. The specific choice of math subjects is arranged individually by each student in consultation with their faculty advisor.

**Doctor of Philosophy and Doctor of Science**

AeroAstro offers doctoral degrees (PhD and ScD) that emphasize in-depth study, with a significant research project in a focused area. The admission process for the department's doctoral program is described previously in this section under Admission Requirements. The doctoral degree is awarded after completion of an individual course of study, submission and defense of a thesis proposal, and submission and defense of a thesis embodying an original research contribution.

The general requirements for this degree are given in the section on General Degree Requirements (p. 61). A detailed description of the program requirements are outlined in a booklet titled The Doctoral Program (http://mit.edu/aeroastro/academics/grad/forms/New_Doctoral_Booklet.pdf). After successful admission to the doctoral program, the doctoral candidate selects a field of study and research in consultation with the thesis supervisor and forms a doctoral thesis committee, which assists in the formulation of the candidate's research and study programs and monitors his or her progress. Demonstrated competence for original research at the forefront of aerospace engineering is the final and main criterion for granting the doctoral degree. The candidate's thesis serves in part to demonstrate such competence and, upon completion, is defended orally in a presentation to the faculty of the department, who may then recommend that the degree be awarded.

**Interdisciplinary Programs**

The department participates in several interdisciplinary fields at the graduate level, which are of special importance for aeronautics and astronautics in both research and the curriculum.

**Aeronautics, Astronautics, and Statistics**

The Interdisciplinary Doctoral Program in Statistics provides training in statistics, including classical statistics and probability as well as computation and data analysis, to students who wish to integrate these valuable skills into their primary academic program. The program is administered jointly by the departments of Aeronautics and Astronautics, Economics, Mathematics, and Political Science, and the Statistics and Data Science Center within the Institute for Data, Systems, and Society. It is open to current doctoral students in participating departments, who may apply to enroll in the program at any time after the end of their first year. For more information, see the full program description (p. 376) under Interdisciplinary Graduate Programs.

**Air Transportation**

For students interested in a career in flight transportation, a program is available that incorporates a broader graduate education in disciplines such as economics, management, and operations research than is normally pursued by candidates for degrees in engineering. Graduate research emphasizes one of the four areas of flight transportation: airport planning and design, air traffic control, air transportation systems analysis, and airline economics and management, with subjects selected appropriately from those available in the departments of Aeronautics and Astronautics, Civil and Environmental Engineering, Economics, and the interdepartmental Master of Science in Transportation (MST) program. Doctoral students may pursue a PhD with specialization in air transportation in the Department of Aeronautics and Astronautics or in the interdepartmental PhD program in transportation or in the PhD program of the Operations Research Center (see the section on Graduate Programs in Operations Research under Research and Study).

**Biomedical Engineering**

The department offers opportunities for students interested in biomedical instrumentation and physiological control systems where the disciplines involved in aeronautics and astronautics are applied to biology and medicine. Graduate study combining aerospace engineering with biomedical engineering may be pursued through the Bioastronautics program offered as part of the Medical Engineering and Medical Physics PhD program in the Institute for Medical Engineering and Science (IMES) via the Harvard-MIT Program in Health Sciences and Technology (HST).

Students wishing to pursue a degree through HST must apply to that graduate program. At the master's degree level, students in the department may specialize in biomedical engineering research, emphasizing space life sciences and life support, instrumentation and control, or in human factors engineering and in instrumentation and statistics. Most biomedical engineering research in the Department of Aeronautics and Astronautics is conducted in the Man Vehicle Laboratory.

**Computation for Design and Optimization**

The Computation for Design and Optimization (CDO) (http://computationalengineering.mit.edu/education) program offers a master's degree to students interested in the analysis and application of computational approaches to designing and operating engineered systems. The curriculum is designed with a common core serving all engineering disciplines and an elective component focusing on specific applications. Current MIT graduate students may pursue a CDO master's degree in conjunction with a department-based master's or PhD program. For more information,
see the full program description (p. 368) under Interdisciplinary Graduate Programs.

Computational Science and Engineering
The Computational Science and Engineering (CSE) (http://computation-engineering.mit.edu/education) program allows students to specialize at the doctoral level in a computation-related field of their choice through focused coursework and a doctoral thesis through a number of participating host departments. The CSE program is administered jointly by the Center for Computational Engineering (CCE) and the host departments, with the emphasis of thesis research activities being the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science. For more information, see the full program description (p. 370) under Interdisciplinary Graduate Programs.

Joint Program with the Woods Hole Oceanographic Institution
The Joint Program with the Woods Hole Oceanographic Institution (WHOI) (http://mit.whoi.edu) is intended for students whose primary career objective is oceanography or oceanographic engineering. Students divide their academic and research efforts between the campuses of MIT and WHOI. Joint Program students are assigned an MIT faculty member as academic advisor; thesis research may be supervised by MIT or WHOI faculty. While in residence at MIT, students follow a program similar to that of other students in their home department. The program is described in more detail under Interdisciplinary Graduate Programs (p. 372).

Leaders for Global Operations
The 24-month Leaders for Global Operations (LGO) (http://lgo.mit.edu) program combines graduate degrees in engineering and management for those with previous postgraduate work experience and strong undergraduate degrees in a technical field. During the two-year program, students complete a six-month internship at one of LGO’s partner companies, where they conduct research that forms the basis of a dual-degree thesis. Students finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of seven engineering programs, some of which have optional or required LGO tracks. After graduation, alumni take on leadership roles at top global manufacturing and operations companies.

System Design and Management
The System Design and Management (SDM) (http://sdm.mit.edu) program is a partnership among industry, government, and the university for educating technically grounded leaders of 21st-century enterprises. Jointly sponsored by the School of Engineering and the Sloan School of Management, it is MIT’s first degree program to be offered with a distance learning option in addition to a full-time in-residence option.

Technology and Policy
The Master of Science in Technology and Policy is an engineering research degree with a strong focus on the role of technology in policy analysis and formulation. The Technology and Policy Program (TPP) (http://tpp.mit.edu) curriculum provides a solid grounding in technology and policy by combining advanced subjects in the student’s chosen technical field with courses in economics, politics, quantitative methods, and social science. Many students combine TPP’s curriculum with complementary subjects to obtain dual degrees in TPP and either a specialized branch of engineering or an applied social science such as political science or urban studies and planning. For additional information, see the program description under the Institute for Data, Systems, and Society (p. 181).

Financial Support
Financial assistance for graduate study may be in the form of fellowships or research or teaching assistantships. Both fellowship students and research assistants work with a faculty supervisor on a specific research assignment of interest, which generally leads to a thesis. Teaching assistants are appointed to work on specific subjects of instruction.

A special relationship exists between the department and the Charles Stark Draper Laboratory. This relationship affords fellowship opportunities for SM and PhD candidates who perform their research as an integral part of ongoing projects at Draper. Faculty from the department maintain close working relationships with researchers at Draper, and thesis research at Draper performed by Draper fellows can be structured to fulfill MIT residency requirements. Further information on Draper can be found in the section on Research and Study.

Inquiries
For additional information concerning admissions, financial aid and assistantships, and academic, research, and interdisciplinary programs in the department, contact Beth Marois (bethamar@mit.edu), Room 33-202, 617-253-0043.

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DEPARTMENT OF BIOLOGICAL ENGINEERING

The mission of the Department of Biological Engineering (BE) is to educate next-generation leaders and to generate and translate new knowledge in a new bioscience-based engineering discipline fusing engineering analysis and synthesis approaches with modern molecular-to-genomic biology. Combining quantitative, physical, and integrative principles with advances in mechanistic molecular and cellular bioscience, biological engineering increases understanding of how biological systems function as both physical and chemical mechanisms; how they respond when perturbed by factors such as medical therapeutics, environmental agents, and genetic variation; and how to manipulate and construct them toward beneficial use. Through this understanding, new technologies can be created to improve human health in a variety of medical applications, and biology-based paradigms can be generated to address many of the diverse challenges facing society across a broad spectrum, including energy, the environment, nutrition, and manufacturing.

The department’s premise is that the science of biology is as important to the development of technology and society in the 21st century as physics and chemistry were in the 20th century, and that an increasing ability to measure, model, and manipulate properties of biological systems at the molecular, cellular, and multicellular levels will continue to shape this development. A new generation of engineers and scientists is learning to address problems through their ability to measure, model, and rationally manipulate the technological and environmental factors affecting biological systems. They are applying not only engineering principles to the analytical understanding of how biological systems operate, especially when impacted by genetic, chemical, physical, infectious, or other interventions; but also a synthetic design perspective to creating biology-based technologies for medical diagnostics, therapeutics, and prosthetics, as well as for applications in diverse industries beyond human health care.

Undergraduate Study

Bachelor of Science in Biological Engineering (Course 20)
The Department of Biological Engineering (BE) (http://be.mit.edu) offers an undergraduate curriculum emphasizing quantitative, engineering-based analysis, design, and synthesis in the study of modern biology from the molecular to the systems level. Completion of the curriculum leads to the Bachelor of Science in Biological Engineering and prepares students for careers in diverse fields ranging from the pharmaceutical and biotechnology industries to materials, devices, ecology, and public health. Graduates of the program will be prepared to enter positions in basic research or project-oriented product development, as well as graduate school or further professional study.

The required core curriculum includes a strong foundation in biological and biochemical sciences, which are integrated with quantitative analysis and engineering principles throughout the entire core. Students who wish to pursue the Bachelor of Science in Biological Engineering (p. 392) are encouraged to complete the Biology General Institute Requirement during their first year and may delay completion of Physics II until the fall term of sophomore year if necessary. The optional subject Introduction to Biological Engineering Design, offered during the spring term of the first year, provides a framework for understanding the Biological Engineering SB program.

Students are encouraged to take the sophomore fall-term subject 20.110 Thermodynamics of Biomolecular Systems. This subject also fulfills an SB degree requirement in Biology. Students are also encouraged to take Organic Chemistry I and Differential Equations during their sophomore year in order to prepare for the introductory biological engineering laboratory subject that provides context for the lecture subjects and a strong foundation for subsequent undergraduate research in biological engineering through Undergraduate Research Opportunities Program projects or summer internships.

The advanced subjects required in the junior and senior years introduce additional engineering skills through lecture and laboratory subjects and culminate in a senior design project. These advanced subjects maintain the theme of molecular to systems-level analysis, design, and synthesis based on a strong integration with biology fundamentals. They also include a variety of restricted electives that allow students to develop expertise in one of six thematic areas: systems biology, synthetic biology, biophysics, pharmacology/toxicology, cell and tissue engineering, and microbial systems. Many of these advanced subjects are jointly taught with other departments in the School of Engineering or School of Science and may fulfill degree requirements in other programs.

Minor in Biomedical Engineering
An interdepartmental Minor in Biomedical Engineering (p. 354) is available to all undergraduate students outside the BE (Course 20) major. See Interdisciplinary Programs (p. 354) for detailed information.

Minor in Toxicology and Environmental Health
The Department of Biological Engineering offers an undergraduate Minor in Toxicology and Environmental Health. The goal of this program is to meet the growing demand for undergraduates to acquire the intellectual tools needed to understand and assess the impact of new products and processes on human health, and to provide a perspective on the risks of human exposure to synthetic and natural chemicals, physical agents, and microorganisms.

Given the importance of environmental education at MIT, the program is designed to be accessible to any MIT undergraduate. The program consists of three required didactic core subjects and one laboratory subject, as well as one restricted elective. The
prerequisites for the core subjects are 5.111 / 5.112 Principles of Chemical Science or 3.091 Introduction to Solid-State Chemistry plus Introductory Biology (7.012 / 7.013 / 7.014 / 7.015 / 7.016).

Core Subjects

<table>
<thead>
<tr>
<th>Subject ID</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.102</td>
<td>Metakaryotic Stem Cells in Carcinogenesis: Origins and Cures</td>
<td>12</td>
</tr>
<tr>
<td>20.104[J]</td>
<td>Environmental Cancer Risks, Prevention, and Therapy</td>
<td>12</td>
</tr>
<tr>
<td>20.106[J]</td>
<td>Systems Microbiology</td>
<td>12</td>
</tr>
</tbody>
</table>

Laboratory Core

Select one of the following: 12-18

- 5.310 Laboratory Chemistry
- 7.02[J] Introduction to Experimental Biology and Communication
- 20.109 Laboratory Fundamentals in Biological Engineering

Restricted Electives

Select one of the following: 12

- 1.080A Environmental Chemistry I
- & 1.080B and Environmental Chemistry II
- 1.089 Environmental Microbiology
- 5.07[J] Biological Chemistry I
- 7.05 General Biochemistry
- 7.06 Cell Biology
- 7.28 Molecular Biology
- 20.URG Undergraduate Research Opportunities
- 22.01 Introduction to Nuclear Engineering and Ionizing Radiation

Total Units 60-66

Inquiries

For further information on the undergraduate programs, see the Biological Engineering website (http://be.mit.edu) or contact the BE Academic Office (be-acad@mit.edu), Room 16-127.

Graduate Study

Master of Engineering in Biomedical Engineering

The Master of Engineering in Biomedical Engineering (MEBE) program is a five-year program leading to a bachelor's degree in a science or engineering discipline along with a Master of Engineering in Biomedical Engineering. The program emphasizes the fusion of engineering with modern molecular-to-genomic biology, as in our SB and PhD degree programs. Admission to the MEBE program is open only to MIT undergraduate students, and requires candidates to demonstrate adequate quantitative and engineering credentials through their undergraduate coursework.

In addition to satisfying the requirements of their departmental program, candidates also are expected to complete the following:

<table>
<thead>
<tr>
<th>Subject ID</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03</td>
<td>Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>5.12</td>
<td>Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.07[J]</td>
<td>Biological Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>or 7.05</td>
<td>General Biochemistry</td>
<td></td>
</tr>
</tbody>
</table>

Select one of the following: 12

- 2.005 Thermal-Fluids Engineering I
- 6.002 Circuits and Electronics

Select two of the following: 24

- 1.010 Introduction to Probability and Statistics in Engineering
- 2.086 Numerical Computation for Mechanical Engineers
- 3.016 Computational Methods for Materials Scientists and Engineers
- 6.041A Introduction to Probability I
- & 6.041B and Introduction to Probability II
- 18.05 Introduction to Probability and Statistics

Applications to the MEBE program are accepted from students in any of the departments in the School of Engineering or School of Science. Students interested in applying to the MEBE program should submit a standard MIT graduate application by the end of their junior year; they are informed of the decision by the end of that summer.

Additional information on application procedures, objectives, and program requirements can be obtained by contacting the BE Academic Office (be-acad@mit.edu), Room 16-127.

Program Requirements

In addition to thesis credits, at least 66 units of coursework are required. At least 42 of these subject units must be from graduate subjects. The remaining units may be satisfied, in some cases, with advanced undergraduate subjects that are not requirements in MIT’s undergraduate curriculum. Of the 66 units, a minimum distribution in each of three categories is specified below.

Bioengineering Core

Select two of the following: 24

- 20.410[J] Molecular, Cellular, and Tissue Biomechanics
- 20.420[J] Principles of Molecular Bioengineering

Biomedical Engineering Electives

...
Select 24 units from a selection of graduate subjects from various departments in the School of Engineering, including HST.  

Bioscience Elective
Select one biological science subject in addition to organic chemistry and biochemistry. This must be a laboratory subject if one was not taken as part of the student’s undergraduate curriculum

Total Units 66

2 A list of suggested subjects is available from the BE Academic Office (be-acad@mit.edu), Room 16-267.

Thesis
The student is required to complete a thesis that must be approved by the program director. The thesis is an original work of research, design, or development. If the supervisor is not a member of the Department of Biological Engineering, a reader who belongs to the BE faculty must also approve and sign the thesis. The student submits a thesis proposal by the end of the fourth year.

Doctoral Program in Biological Engineering
The Department of Biological Engineering offers a PhD program and, in certain cases, an SM degree. Graduate students in the Department of Biological Engineering can carry out their research as part of a number of multi-investigator, multidisciplinary research centers at MIT, including the Center for Biomedical Engineering, the Center for Environmental Health Sciences (p. 91), the Division of Comparative Medicine (p. 97), and the Synthetic Biology Engineering Research Center (http://www.synberc.org). These opportunities include collaboration with faculty in the Schools of Engineering (p. 142) and Science (p. 298), the Koch Institute for Integrative Cancer Research (p. 101), the Whitehead Institute for Biomedical Research (p. 114), and the Broad Institute (p. 89), along with the Harvard University School of Medicine, Harvard University School of Dental Medicine, Harvard School of Public Health, and Boston University School of Medicine.

The Biological Engineering graduate program educates students to use engineering principles in the analysis and manipulation of biological systems, allowing them to solve problems across a spectrum of important applications. The curriculum is inherently interdisciplinary in that it brings together engineering and biology as fundamentally as possible and cuts across the boundaries of the traditional engineering disciplines.

The written part of the doctoral qualifying examinations—focused on the core curriculum—is taken after the second term. The student selects a research advisor, typically by the start of the spring term in the first year, and begins research before the end of that year. The oral part of the doctoral qualifying examinations, which focuses on the student’s area of research, is taken prior to December 1 of the third year. A total of approximately five years in residence is needed to complete the doctoral thesis and other degree requirements.

Students admitted to the Biological Engineering graduate program typically have a bachelor’s or master’s degree in science or engineering. Foundational coursework in biochemistry and molecular cell biology is required, either prior to admission or during the first year of graduate study. Students who have not taken biochemistry previously should take 7.05 General Biochemistry or 5.07[J] Biological Chemistry I, and those who have not taken cell biology previously should take 7.06 Cell Biology, prior to taking the core classes. During their first year, students pursue a unified core curriculum in which engineering approaches are used to analyze biological systems and technologies over a wide range of length and time scales. The subjects in the unified core bring central engineering principles to bear on the operation of biological systems from molecular to cell to tissue/organ/device systems levels. These are then supplemented by electives in the biological sciences and engineering to enhance breadth and depth.

<table>
<thead>
<tr>
<th>Core</th>
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<tbody>
<tr>
<td>20.420[J] Principles of Molecular Bioengineering</td>
<td>12</td>
</tr>
<tr>
<td>20.440 Analysis of Biological Networks (Electives)</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electives</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>One graduate subject in biological science offered by the Department of Biology</td>
<td></td>
</tr>
<tr>
<td>One graduate subject from a restricted set of Biological Engineering offerings beyond the core subjects</td>
<td></td>
</tr>
<tr>
<td>One graduate subject in Biological Engineering</td>
<td></td>
</tr>
<tr>
<td>One additional graduate engineering or science subject</td>
<td></td>
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</tbody>
</table>

Faculty members associated with the program possess a wide range of research interests. Areas in which students may specialize include systems and synthetic biology; biological and physiological transport phenomena; biological imaging and functional measurement; biomolecular engineering; cell and tissue engineering; computational modeling of biological and physiological systems; bioinformatics; design, discovery, and delivery of molecular therapeutics; molecular, cell, and tissue biomechanics; development of in vitro models of the immune system and lymphoid tissue; development of molecular methods for direct measurement of mutations in humans; metabolism of foreign compounds; genetic toxicology; the molecular aspects and dosimetry of interactions between mutagens and carcinogens with nucleic acids and proteins; molecular mechanisms of DNA damage and repair; design and mechanisms of action of chemotherapeutic agents; environmental carcinogenesis and epidemiology; molecular mechanisms of carcinogenesis; cell physiology; extracellular regulation and signal transduction; molecular and pathologic...
interactions between infectious microbial agents and carcinogens; and new tools for genomics, proteomics, and glycomics.

**Interdisciplinary Programs**

**Leaders for Global Operations**
The 24-month Leaders for Global Operations (LGO) ([http://lgo.mit.edu](http://lgo.mit.edu)) program combines graduate degrees in engineering and management for those with previous postgraduate work experience and strong undergraduate degrees in a technical field. During the two-year program, students complete a six-month internship at one of LGO’s partner companies, where they conduct research that forms the basis of a dual-degree thesis. Students finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of seven engineering programs, some of which have optional or required LGO tracks. After graduation, alumni take on leadership roles at top global manufacturing and operations companies.

**Polymers and Soft Matter**
The Program in Polymers and Soft Matter (PPSM) ([http://polymerscience.mit.edu](http://polymerscience.mit.edu)) offers students from participating departments an interdisciplinary core curriculum in polymer science and engineering, exposure to the broader polymer community through seminars, contact with visitors from industry and academia, and interdepartmental collaboration while working towards a PhD or ScD degree.

Research opportunities include functional polymers, controlled drug delivery, nanostructured polymers, polymers at interfaces, biomaterials, molecular modeling, polymer synthesis, biomimetic materials, polymer mechanics and rheology, self-assembly, and polymers in energy. The program is described in more detail under Interdisciplinary Graduate Programs (p. 376).

**Inquiries**
For further information on the graduate programs, see the Biological Engineering website ([http://be.mit.edu](http://be.mit.edu)) or contact the BE Academic Office (be-acad@mit.edu), Room 16-267, 617-253-1712.

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Gerald N. Wogan, PhD
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Professor Emeritus of Chemistry
DEPARTMENT OF CHEMICAL ENGINEERING

Chemical engineering encompasses the translation of molecular information into discovery of new products and processes. It involves molecular transformations—chemical, physical, and biological—with multi-scale description from the submolecular to the macroscopic, and the analysis and synthesis of such systems. The chemical engineer is well prepared for a rewarding career in a strikingly diverse array of industries and professional arenas. Whether these industries are at the cutting edge—e.g., nanotechnology or biotechnology—or traditional, they depend on chemical engineers to make their products and processes a reality. The effectiveness of chemical engineers in such a broad range of areas begins with foundational knowledge in chemistry, biology, physics, and mathematics. From this foundation, chemical engineers develop core expertise in engineering thermodynamics, transport processes, and chemical kinetics, creating a powerful and widely applicable combination of molecular knowledge and engineering problem solving. To cope with complex, real-world problems, chemical engineers develop strong synthetic and analytic skills. Through creative application of these chemical engineering principles, chemical engineers create innovative solutions to important industrial and societal problems in areas such as development of clean energy sources, advancement of life sciences, production of pharmaceuticals, sustainable systems and responsible environmental stewardship, and discovery and production of new materials.

The Department of Chemical Engineering at MIT offers four undergraduate programs. Course 10 leads to the Bachelor of Science in Chemical Engineering through a curriculum that prepares the graduate for a wide range of career pursuits. Course 10-B leads to the Bachelor of Science in Chemical-Biological Engineering, which includes the basic engineering core from the Course 10 degree and adds material in basic and applied biology. Course 10-ENG leads to the Bachelor of Science in Engineering, a more flexible curriculum that supplements a chemical engineering foundation with an area of technical specialization. Course 10-C leads to the Bachelor of Science without specification; this non-accredited degree requires fewer chemical engineering subjects. Undergraduates have access to graduate-level subjects in their upper-level years. Undergraduate students are also encouraged to participate in research through the Undergraduate Research Opportunities Program (UROP) (http://web.mit.edu/urop).

The department offers a broad selection of graduate subjects and research topics leading to advanced degrees in chemical engineering. Multidisciplinary approaches are highly valued, leading to strong ties with other MIT departments. In addition, the department maintains alliances, arrangements, and connections with institutions and industries worldwide. Areas for specialization include, but are not limited to: biochemical engineering, biomedical engineering, biotechnology, chemical catalysis, chemical process development, environmental engineering, fuels and energy, polymer chemistry, surface and colloid chemistry, systems engineering, and transport processes. Additional information may be found under Graduate Education (p. 60) and on the department’s website (http://web.mit.edu/cheme).

The School of Chemical Engineering Practice, leading to five-year bachelor's and master's degrees, involves one term of work under the direction of an Institute staff member resident at Practice School sites. This program provides students with a unique opportunity to apply basic professional principles to the solution of practical industrial problems.

Undergraduate Study

The undergraduate curriculum in chemical engineering provides basic studies in physics, biology, and mathematics, advanced subjects in chemistry or biology, and a strong core of chemical engineering. The four-year undergraduate programs provide students with the fundamentals of the discipline and allow some room for focus in subdisciplines or subjects that strengthen their preparation for advanced work.

In addition to science and engineering, students take an integrated sequence of subjects in the humanities and social sciences. Specific subject selection allows students to meet individual areas of interest. The curriculum provides a sound preparation for jobs in industry or government, and for graduate work in chemical engineering.

Chemical engineering also provides excellent preparation for careers in medicine and related fields of health science and technology. The department's strong emphasis on chemistry and biology provides excellent preparation for medical school. Students interested in medical school work with their faculty and premedical advisor to create the best program. A minor in biomedical engineering is also available.

Bachelor of Science in Chemical Engineering (Course 10)

This degree (p. 394) is intended for the student who seeks a broad education in the application of chemical engineering to a variety of specific areas, including energy and the environment, nanotechnology, polymers and colloids, surface science, catalysis and reaction engineering, systems and process design, and biotechnology. The degree requirements include the core chemical engineering subjects with a chemistry emphasis, and the opportunity to add subjects in any of these application areas.

Course 10 is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org) as a chemical engineering degree.
Bachelor of Science in Chemical-Biological Engineering (Course 10-B)

This degree (p. 393) is intended for the student who is specifically interested in the application of chemical engineering in the areas of biochemical and biomedical technologies. The degree requirements include core chemical engineering subjects and additional subjects in biological sciences and applied biology. This degree is excellent preparation for students also considering the biomedical engineering minor or medical school.

Course 10-B is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org) as a chemical and biological engineering degree.

Students who decide early to major in either Course 10 or Course 10-B are encouraged to take subjects such as 5.111/5.112 Principles of Chemical Science, 5.12 Organic Chemistry I, and 7.01x Introductory Biology in their first year. Then 5.60 Thermodynamics and Kinetics, 18.03 Differential Equations, 10.10 Introduction to Chemical Engineering, 10.213 Chemical and Biological Engineering Thermodynamics, and 10.301 Fluid Mechanics may be taken in the sophomore year. The student is then well positioned for more in-depth and specialized subjects in the third and fourth years.

Some students may wish to defer choice of a major field or exercise maximum freedom during the first two years. If the Restricted Electives in Science and Technology (REST) Requirement subjects chosen in the second year include 18.03 Differential Equations and two subjects in the fields of fluid mechanics, thermodynamics, chemistry, biology, or chemical engineering, students can generally complete the requirements for a degree in chemical engineering in two more years. Students are advised to discuss their proposed program with a Course 10 faculty advisor as soon as they become interested in a degree in chemical engineering. Faculty advisors are assigned to students as soon as they declare their major and then work with the students through graduation. Further information may be obtained from Dr. Barry S. Johnston.

Additional information is available on the Chemical Engineering Department website (http://web.mit.edu/cheme). Undergraduates are encouraged to take part in the research activities of the department through the Undergraduate Research Opportunities Program (UROP) (http://web.mit.edu/urop).

Bachelor of Science (Course 10-C)

The curriculum (p. 396) for students in Course 10-C involves basic subjects in chemistry and chemical engineering. Instead of continuing in depth in these areas, students can add breadth by study in another field, such as another engineering discipline, biology, biomedical engineering, economics, or management. Course 10-C is attractive to students who wish to specialize in an area such as those cited above while simultaneously gaining a broad exposure to the chemical engineering approach to solving problems.

Students planning to follow this curriculum should discuss their interests with their faculty advisor in the department at the time they decide to enter the Course 10-C program, and submit to Dr. Barry S. Johnston in the department’s Undergraduate Office a statement of goals and a coherent program of subjects no later than spring term of junior year. Please direct questions about this program to Dr. Johnston.

Bachelor of Science in Engineering as Recommended by the Department of Chemical Engineering (Course 10-ENG)

The 10-ENG degree program (p. 407) is designed to offer flexibility within the context of chemical engineering while ensuring significant engineering content, and is a complement to our chemical engineering degree programs 10 and 10-B. The degree is designed to enable students to pursue a deeper level of understanding in a specific interdisciplinary field that is relevant to the chemical engineering core discipline. The degree requirements include all of the core chemical engineering coursework, plus a chosen set of three foundational concept subjects and four subjects with engineering content that make up a comprehensive concentration specific to the interdisciplinary area selected by the student. The concentrations have been selected by the Department of Chemical Engineering to represent new and developing cross-disciplinary areas that benefit from a strong foundation in engineering within the chemical engineering context. Details of the concentrations are available from the Chemical Engineering Student Office and the department’s website (https://cheme.mit.edu/academics/undergraduate-students/undergraduate-programs/course-10-eng).

The foundational concept component of the flexible engineering degree consist of basic science and engineering subjects that help lay the groundwork for the chosen concentration. Three subjects must be selected from a list of potential topics. One of the foundational concept subjects must be a chemical engineering CI-M subject, and one must be a laboratory subject that satisfies the Institute Laboratory Requirement. The subjects should be selected with the assistance of a 10-ENG degree advisor from the Chemical Engineering Department so as to be consistent with the degree requirements of the program and the General Institute Requirements. Several of these subjects can satisfy the program’s CI-M requirement.

The flexible engineering concentration consists of four subjects that are selected by the student from a suggested subject list provided for each 10-ENG concentration; the student also may propose subjects that fit the theme of the chosen concentration. These lists are included in the concentration descriptions provided on the department’s website and at the Chemical Engineering Student Office. Students work with their 10-ENG advisors to propose a 10-ENG degree program, which must then be approved by the Chemical Engineering Undergraduate Committee.

The flexible engineering degree major capstone experience consists of 12 units and/or a senior-level project. Alternatively, the student may choose to complete a senior thesis in a topic area relevant to
the concentration. Senior-level projects or senior thesis projects are specifically designed to integrate engineering principles into specific applications or problems and are not standard UROP projects; such projects require the preliminary approval of the department’s undergraduate officer.

Course 10-ENG is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org) as an engineering degree.

Five-Year Programs and Joint Programs
In addition to offering separate programs leading to the Bachelor of Science and Master of Science in Chemical Engineering, the department offers a program leading to the simultaneous award of both degrees at the end of five years. A detailed description of this program is available from the Graduate Student Office. Students in the five-year program normally enroll in the School of Chemical Engineering Practice.

For chemical engineering students interested in nuclear applications, the Department of Chemical Engineering and the Department of Nuclear Engineering offer a five-year program leading to the joint Bachelor of Science in Chemical Engineering and Master of Science in Nuclear Engineering. Such programs are approved on an individual basis between the registration officers of the two departments.

Inquiries
Additional information concerning undergraduate academic and research programs may be obtained by writing to Dr. Barry S. Johnston (bsjohnst@mit.edu), undergraduate officer, Department of Chemical Engineering, Room 66-368, 617-258-7141, fax 617-258-0546. For information regarding admissions and financial aid, contact the Admissions Office, Room 3-108, 617-253-4791.

Graduate Study
Graduate study provides both rigorous training in the fundamental core discipline of chemical engineering and the opportunity to focus on specific subdisciplines. In addition to completing the four core subject requirements in thermodynamics, reaction engineering, numerical methods, and transport phenomena, students select a research advisor and area for specialization, some of which are discussed below.

Thermodynamics and Molecular Computation. Thermodynamics is a cornerstone of chemical engineering. Processes as diverse as chemical production, bioreaction, creation of advanced materials, protein separation, and environmental treatment are governed by thermodynamics. The classical concepts of equilibrium, reversibility, energy, and entropy are basic to the analysis and design of these processes. The extension of classical thermodynamics to molecular scales by use of statistical mechanics has made molecular simulation an increasingly valuable tool for the chemical engineer.

Prediction of macroscopic behavior from molecular computations is becoming ever more feasible. This venerable field continues to yield fruitful areas of inquiry.

Opportunities in the department for graduate study in this field include predicting properties of materials and polymers from molecular structure, applying quantum mechanics to catalyst design, supercritical fluid processing, the behavior of complex fluids with environmental and biomedical applications, phase equilibrium with simple and complex molecular species, immunology, protein stabilization, nucleation and crystallization of polymer and pharmaceuticals, and many other areas of classical and statistical thermodynamics.

Transport Processes. A fluid deforming and flowing as forces are imposed on it, its temperature varying as heat is transferred through it, the interdiffusion of its distinct molecular species—these are examples of the processes of transport. These transport processes govern the rates at which velocity, temperature, and composition vary in a fluid; chemical engineers study transport to be able to describe, predict, and manage these changes. Research includes experimental testing and analytical and computational modeling; its applications range among an enormous variety of mechanical, chemical, and biological processes.

Current work includes the study of polymer molecular theory and polymer processing, transport and separations in magnetotheoreological fluids, membrane separations, diffusion in complex fluids, defect formation and evolution in near-crystalline materials, microfluidics, fluid instability, transport in living tissue, numerical solution of field equations, and many other areas of transport phenomena.

Catalysis and Chemical Reaction Engineering. A simple chemical reaction—the rearrangement of electrons and bonding partners—occurs between two small molecules. From understanding the kinetics of the reaction, and the equilibrium extent to which it can proceed, come applications: the network of reactions during combustion, the chain reactions that form polymers, the multiple steps in the synthesis of a complex pharmaceutical molecule, the specialized reactions of proteins and metabolism. Chemical kinetics is the chemical engineer’s tool for understanding chemical change.

A catalyst influences the reaction rate. Catalysts are sought for increasing production, improving the reaction conditions, and emphasizing a desired product among several possibilities. The challenge is to design the catalyst, to increase its effectiveness and stability, and to create methods to manufacture it.

A chemical reactor should produce a desired product reliably, safely, and economically. In designing a reactor, the chemical engineer must consider how the chemical kinetics, often modified by catalysis, interacts with the transport phenomena in flowing materials. New microreactor designs are expanding the concept of
what a reactor may do, how reactions may be conducted, and what is required to scale a process from laboratory to production.

Research is being conducted in the department at the forefront of catalyst design, complex chemical synthesis, bioreactor design, surface- and gas-phase chemistry, miniaturization of reactors, mathematical modeling of chemical reaction networks, and many other areas of chemical reaction engineering. Applications include the manufacturing of chemicals, refining of fuels for transportation and power, and microreactors for highly reactive or potentially hazardous materials.

Polymers. Wondrous materials found in nature and now synthesized in enormous quantity and variety, polymers find an ever-increasing use in manufactured products. Polymers are versatile because their properties are so wide-ranging, as is evident even in the conceptually simple polymers made from a single molecular species. The versatility becomes more profound in the copolymers made from multiple precursors, and the polymers compounded with filler materials. Research in polymers encompasses the chemical reactions of their formation, methods of processing them into products, means of modifying their physical properties, and the relationship between the properties and the underlying molecular-and solid-phase structure.

Graduate research opportunities in the department include studies of polymerization kinetics, non-Newtonian rheology, polymer thin films and interfaces, block copolymers, liquid crystalline polymers, nanocomposites and nanofibers, self-assembly and patterning, and many other areas of polymer science and engineering. In addition to a program in graduate study in polymers within the department, the interdiscipliary Program in Polymers and Soft Matter (PPSM) provides a community for researchers in the polymer field and offers a program of study that focuses on the interdisciplinary nature of polymer science and engineering.

Materials. The inorganic compounds found in nature are the basis for new materials made by modifying molecular composition (such as purifying silicon and doping it with selected impurities) and structure (such as control of pore and grain size). These materials have electronic, mechanical, and optical properties that support a variety of novel technologies. Other materials are applied as coatings—thin films that create a functional surface. Still other materials have biological applications, such as diagnostic sensors that are compatible with living tissue, barriers that control the release of pharmaceutical molecules, and scaffolds for tissue repair. A new generation of biomaterials is being derived from biological molecules. Research in materials is wide-ranging and highly interdisciplinary, both fundamental and applied. In the department, materials research includes studies in plasma etching, thin-film chemical vapor deposition, crystal growth, nano-crystalline structure, molecular simulation, scaffolds for bone and soft tissue regeneration, biocompatible polymers, and many other areas of materials engineering.

Surfaces and Nanostructures. In many arrangements of matter, the interfaces between phases—more than their bulk compositions—are critical to the material structure and behavior. The surfaces of solids offer a platform for functional coating; coatings may be deposited from vapor, applied as a volatile liquid, or assembled from solution onto the solid, in a pattern determined by the molecular properties. This self-assembly tendency may be exploited to arrange desired patterns that have operational properties. Interfacial effects are also responsible for stable dispersions of immiscible phases, leading to fluids with complex microstructure. Other structured fluids arise from large molecules whose orientation in the solvent is constrained by molecular size and properties. In solids, tight control of pore size, grain size, chemical composition, and crystal structure offer a striking range of catalytic, mechanical, and electromagnetic properties. The understanding of gas-solid kinetics is crucial to the study of heterogeneous catalysis and integrated circuit fabrication. Structure is the basis for function, and by manipulating tiny length scales, the resulting nanostructure makes available new capabilities, and thus new technologies and products. Graduate study in surfaces and nanostructures may include studies of colloids, emulsions, surfactants, and other structured fluids with biological, medical, or environmental applications. It also encompasses thin films, liquid crystals, sol-gel processing, control of pharmaceutical morphology, nanostructured materials, carbon nanotubes, surface chemistry, surface patterning, and many other areas of nanotechnology and surface science.

Biological Engineering. Chemical engineering thermodynamics, transport, and chemical kinetics, so useful for manufacturing processes, are fruitful tools for exploring biological systems as well. Biological engineering research may be directed at molecular-level processes, the cell, tissues, the organism, and large-scale manufacturing in biotech processes. It may be applied to producing specialized proteins, genetic modification of cells, transport of nutrients and wastes in tissue, therapeutic methods of drug delivery, tissue repair and generation, purification of product molecules, and control strategies for complex bioproduction plants. Its methods include analytical chemistry and biochemistry techniques, bioinformatic processing of data, and computational solution of chemical reaction and transport models. Biological engineering is an extraordinarily rich area for chemical engineers, and its consequences—theroretical, medical, commercial—will be far-reaching.

Opportunities in the department for graduate study in biological engineering include manipulation and purification of proteins and other biomolecules, research into metabolic processes, tissue regeneration, gene regulation, bioprocesses, bioinformatics, drug delivery, and biomaterials, to name a few. Both experimental and computational methods are used, including statistical mechanics and systems theory. Chemical engineering faculty are also involved in the Center for Biomedical Engineering, created to enhance interdisciplinary research and education at the intersection of engineering, molecular and cell biology, and medicine. The Novartis-
MIT Center for Continuous Manufacturing, another center of research activity involving chemical engineers, promises to revolutionize the chemical processing of pharmaceuticals.

**Energy and Environmental Engineering.** Making energy available to society requires finding and producing a range of fuels, improving the efficiency of energy use under the ultimate limits imposed by thermodynamics, and reducing the effects of these processes on the environment. The widespread use of fossil fuels increases the amount of carbon dioxide in the atmosphere, leading to concerns about global warming. Other sustainability indicators also suggest that we now need to transform our energy system to a more efficient, lower-carbon future. This transformation provides many opportunities for chemical engineers to evaluate and explore other energy supply options such as renewable energy from solar, biomass, and geothermal resources, unconventional fuels from heavy oils, tar sands, natural gas hydrates, and oil shales. Developing technologies for transporting and storing thermal and electrical energy over a range of scales are also of interest.

Further environmental distress can result from manufacturing processes and society’s use of the manufactured products. The traditional response of treating process wastes is still useful, but there is growing emphasis on designing new processes to produce less waste. This might be done by improving catalysts to decrease unwanted by-products, finding alternatives to volatile solvents, and developing more effective separation processes. Chemical engineers are at work in these areas, and in developing alternative energy sources and assessing the effects of pollutants on human health.

In the department, students will find expertise in combustion, chemical reaction networks, renewable energy and upgrading of nonconventional fuels, carbon dioxide capture and sequestration, water purification and catalytic treatment of pollutants, global air pollution modeling, design of novel energy conversion processes, energy supply chains, and many other areas of energy and environmental engineering. Faculty in the department are actively involved in the MIT Energy Initiative.

**Systems Design and Simulation.** From early in the development of chemical engineering, processes were represented as combinations of unit operations. This concept was useful in analyzing processes, as well as providing a library of building blocks for creating new processes. Process and product design are imaginative activities, an artful blend of intuition and analysis. Design is aided by mathematical tools that simulate the behavior of the process or product and seek optimum performance. Effective use of simulation and optimization tools allows unexpected pathways to be explored, dangerous operating regions to be identified, and transient and accident conditions to be tested. Process and product systems engineering brings it all together, placing the technical features of a process or product in the context of operations, economics, and business. The end result is improved economy, reliability, and safety. Methodologies for process and product modeling and simulation, computer-aided engineering, operations research, optimization theory and algorithms, process and product design strategy, treatment of uncertainty, multiscale systems engineering, and many other areas of systems engineering are being developed in the Department of Chemical Engineering. Such research leads to new prototypes for process systems, design of new molecules with desired properties, and processes with better operability, control, safety, and environmental performance.

**School of Chemical Engineering Practice**

Since 1916, the David H. Koch School of Chemical Engineering Practice has been a major feature of the graduate education in the department. In this unique program, students receive intensive instruction to broaden their education in the technical aspects of the profession, and also in communication skills and human relations, which are frequently decisive factors in the success of an engineering enterprise. The Practice School program stresses problem solving in an engineering internship format, where students undertake projects at industrial sites under the direct supervision of resident MIT faculty. Credit is granted for participation in the Practice School in lieu of preparing a master’s thesis.

The operation of the Practice School is similar to that of a small consulting company. The resident staff work closely with the technical personnel of the host companies in identifying project assignments with significant educational merit, and with solutions that make important contributions to the operation of the company.

During Practice School, students work on three or four different projects. Groups and designated group leaders change from one project to another, giving every individual an opportunity to be a group leader at least once.

Students in the Practice School program are required to demonstrate proficiency, or take one graduate subject, in each of the following areas: thermodynamics, heat and mass transfer, applied process chemistry, kinetics and reactor design, systems engineering, and applied mathematics.

**Master of Science in Chemical Engineering**

Programs for the Master of Science in Chemical Engineering usually are arranged as a continuation of undergraduate professional training, but at a greater level of depth and maturity. The general requirements for a master’s program are given in the section on Graduate Education (p. 60). To complete the requirement of at least 66 graduate subject units, together with an acceptable thesis, generally takes four terms.

**Master of Science in Chemical Engineering Practice**

The unit requirements for the Master of Science in Chemical Engineering Practice (Course 10-A) are the same as those for the Master of Science in Chemical Engineering, except that 48 units of Practice School experience replace the master’s thesis.

In some cases, Bachelor of Science graduates of this department can meet the requirements for the Master of Science in Chemical Engineering.
Engineering Practice (Course 10-A) in two terms. Beginning in September following graduation, students complete the required coursework at the Institute. The spring semester is spent at the Practice School field stations. Careful planning of the senior year schedule is important.

For students who have graduated in chemical engineering from other institutions, the usual program of study for the Master of Science in Chemical Engineering Practice involves two terms at the Institute followed by field station work in the Practice School. Graduates in chemistry from other institutions normally require an additional term.

**Doctor of Science or Doctor of Philosophy**

Doctoral candidates are required to pass a written general examination early in their program of study. Given in January and May, the written examination is usually taken at the end of the first term in residence as a graduate student. There is also an oral general examination, which consists of the presentation of a thesis proposal to a faculty committee; this is normally done during the second year of residence. Completing a master's degree is not a prerequisite for entering the doctoral program or obtaining a doctoral degree.

The requirements for the doctoral degree include a program of advanced study, a minor program, a biology requirement, and a thesis. The program of advanced study and research is normally carried out in one of the fields of chemical engineering under the supervision of one or more faculty members in the Department of Chemical Engineering. A thesis committee of selected faculty monitors the doctoral program of each candidate.

**Doctor of Philosophy in Chemical Engineering Practice**

This degree program provides educational experience that combines advanced work in manufacturing, independent research, and management. The program is built on the outstanding research programs within the department, the unique resources of the David H. Koch School of Chemical Engineering Practice, and the world-class resources of the Sloan School of Management. Students are prepared for a rapid launch into positions of leadership in industry and provided with a foundation for completion of an MBA degree.

The program consists of three major parts: the first year is devoted to coursework and the Practice School, the two middle years are devoted to research, and the final year is completed in the Sloan School of Management. In addition, an integrative project combines the research and management portions of the program.

Students in the PhD in Chemical Engineering Practice (PhDCEP) program must pass the department’s written and oral examinations. The progress of their research is monitored by a faculty committee, and the final thesis document is defended in a public forum. The normal completion time should be four calendar years for the PhDCEP program.

**Interdisciplinary Programs**

**Computational Science and Engineering**

The Computational Science and Engineering (CSE) ([http://computationalengineering.mit.edu/education](http://computationalengineering.mit.edu/education)) program allows students to specialize at the doctoral level in a computation-related field of their choice through focused coursework and a doctoral thesis through a number of participating host departments. The CSE program is administered jointly by the Center for Computational Engineering (CCE) and the host departments, with the emphasis of thesis research activities being the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science. For more information, see the full program description (p. 370) under Interdisciplinary Graduate Programs.

**Leaders for Global Operations**

The 24-month Leaders for Global Operations (LGO) ([http://lgo.mit.edu](http://lgo.mit.edu)) program combines graduate degrees in engineering and management for those with previous postgraduate work experience and strong undergraduate degrees in a technical field. During the two-year program, students complete a six-month internship at one of LGO’s partner companies, where they conduct research that forms the basis of a dual-degree thesis. Students finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of seven engineering programs, some of which have optional or required LGO tracks. After graduation, alumni take on leadership roles at top global manufacturing and operations companies.

**Microbiology**

The MIT Microbiology Graduate PhD Program (p. 374) is an interdepartmental, interdisciplinary program that provides students broad exposure to underlying elements of modern microbiological research and engineering, and depth in specific areas of microbiology during the student’s thesis work. MIT has a long-standing tradition of excellence in microbiological research; currently, more than 50 faculty from different departments study or use microbes in significant ways in their research. The program integrates educational resources across the participating departments to build connections among faculty with shared interests from different units and to build an educational community for training students in the study of microbial systems. Students apply to the Microbiology program and conduct research in the labs of faculty in one of the participating departments: Biology; Biological Engineering; Chemical Engineering; Chemistry; Civil and Environmental Engineering; Earth, Atmospheric and Planetary Sciences; Electrical Engineering and Computer Science; Materials Sciences and Engineering; and Physics. Graduates of this program will be prepared to enter a range of fields in microbial science and engineering, and will have excellent career options in academic, industrial, and government settings.
Polymers and Soft Matter
The Program in Polymers and Soft Matter (PPSM) (http://polymerscience.mit.edu) offers students from participating departments an interdisciplinary core curriculum in polymer science and engineering, exposure to the broader polymer community through seminars, contact with visitors from industry and academia, and interdepartmental collaboration while working towards a PhD or ScD degree.

Research opportunities include functional polymers, controlled drug delivery, nanostructured polymers, polymers at interfaces, biomaterials, molecular modeling, polymer synthesis, biomimetic materials, polymer mechanics and rheology, self-assembly, and polymers in energy. The program is described in more detail under Interdisciplinary Graduate Programs (p. 376).

Financial Support
The department has a wide variety of financial support options for graduate students, including teaching and research assistantships, fellowships, and loans. Information about financial assistance may be obtained by writing to the Graduate Student Office, but consideration for awards cannot be given before admissions decisions have been made.

Inquiries
For additional information concerning graduate programs, admissions, financial aid, and assistantships, contact the Graduate Student Office (chemegrad@mit.edu), Department of Chemical Engineering, Room 66-366, 617-253-4579.

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DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

The Department of Civil and Environmental Engineering (CEE) seeks to understand the world, invent, and innovate with creative design. To address some of the greatest challenges of our time, the department uses approaches that range from basic scientific principles to complex engineering design, at scales from the nano to the global. Emphasizing the use of quantitative approaches, CEE features two vibrant centers of gravity: environment (what exists as natural systems) and infrastructure (what is created by human activity). The department is organized into two laboratories around these focus areas: the Parsons Laboratory for Environmental Science and Engineering (https://cee.mit.edu/research/#Parsons) and the Pierce Laboratory for Infrastructure Science and Engineering (https://cee.mit.edu/research/#Pierce), which emphasizes materials and systems. CEE consists of people from a broad range of academic disciplines who work together to contribute to exciting intellectual networks across the department and MIT, solving tomorrow’s problems to build a better future through discovery and innovation.

An education in civil and environmental engineering provides an excellent foundation to solve the world’s greatest challenges in areas such as sustainability, environment, or energy. It prepares students for careers in fields as diverse as engineering design, education, law, medicine, and public health, as well as for graduate study in engineering and science. Graduates teach and carry out research in universities, work for large firms, start their own businesses, and hold leadership positions in government and nonprofit organizations. The department’s undergraduate program provides a solid background in science and engineering fundamentals while emphasizing hands-on design and research projects that provide real-world context. Students focus on the use of large data, computation, probability, and data analysis, and learn how to combine theory, experiments, and modeling to understand and solve complex science and engineering problems.

Course 1-ENG is the undergraduate degree program offered by The Department of Civil and Environmental Engineering. 1-ENG leads to a Bachelor of Science in General Engineering, and has a flexible curriculum that supplements a civil and environmental engineering foundation with an area of core coursework in a field of specialization, introducing exciting opportunities for disciplinary or multidisciplinary focus. This program is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org) as an engineering degree.

The department also offers graduate degrees within the broadly defined areas of environmental science and engineering (which includes environmental chemistry, environmental fluid mechanics, environmental microbiology, and hydrology and hydroclimatology), mechanics of materials and structures, geotechnical engineering and geomechanics, and transportation. The depth and breadth of coursework and research required differ for each degree program.

The department’s graduate degrees are as follows: Master of Engineering (MEng), Master of Science in Transportation (MST), Master of Science (SM), Civil Engineer, Environmental Engineer, Doctor of Philosophy (PhD), and Doctor of Science (ScD).

Undergraduate Study

The Department of Civil and Environmental Engineering offers an undergraduate program, Course 1-ENG, leading to the Bachelor of Science in General Engineering.

Undergraduates are encouraged to participate in the research activities of the department and in many cases obtain degree credit for such work. In general, students are encouraged to plan their programs for the third and fourth years so they dovetail with possible graduate study, including the department’s Master of Engineering degree. This is readily accomplished by those students who embark on the departmental program in their second year. Under certain circumstances, students are permitted to work toward receiving simultaneous undergraduate and graduate degrees.

Bachelor of Science in General Engineering (Course 1-ENG)

The degree is designed to prepare students to make an impact in solving the world’s greatest challenges. The program (p. 410) offers possibilities to select tracks of study for in-depth exploration of particular areas, or to focus on cross-cutting, multidisciplinary studies within and outside the department in emerging areas of civil and environmental engineering, broadly defined. Refer to the website (http://cee.mit.edu/undergraduate) for further details on sample educational tracks and educational opportunities.

The undergraduate program provides significant flexibility through a track structure that is consistent with the diverse nature of our disciplinary groups and responsive to students’ interests in new educational offerings. The program is built around a solid foundation in mathematics, big data, sensing, and computing, and is complemented by laboratory subjects on data analysis. It includes a capstone subject that provides ample opportunities for students to solve complex problems. The program enables students to design individualized programs to meet particular educational objectives. For example, students interested in careers in fields such as sustainability, environmental science and engineering, microbiology, sustainable materials, geochemistry, energy resources, structural/architectural engineering, oceanography, or environmental law can design programs that provide both depth and breadth.

The main component of the program is a small set of General Department Requirements (GDRs) consisting of subjects that focus on mathematics, computation, probability and statistics, and data analysis, plus a capstone. Students select one of three core options, each consisting of subjects that build a solid background
in one of three areas: environment, mechanics and materials, or systems. Their selections of a core and a consistent set of four or five restricted elective subjects, in consultation with a CEE faculty advisor, define their track of undergraduate study. Restricted electives may be selected from subjects within or outside the Department of Civil and Environmental Engineering.

To satisfy the CI-M component of the Communication Requirement, students must take two of the department's CI-M subjects (1.013 Senior Civil and Environmental Engineering Design and either 1.011 Project Evaluation and Management or 1.092 Traveling Research Environmental eXperience (TREX): Fieldwork Analysis and Communication) 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. Any outside CI-M must fit into the coherent program of electives approved by the student's academic advisor and must be approved by the undergraduate officer. The remaining part of the program consists of unrestricted electives, bringing the total number of required units beyond the General Institute Requirements to 180.

Minor in Civil and Environmental Systems
The Minor in Civil and Environmental Systems consists of the following subjects:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
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<tbody>
<tr>
<td>1.020</td>
<td>Engineering Sustainability: Analysis and Design</td>
<td>12</td>
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<tr>
<td>1.022</td>
<td>Introduction to Network Models</td>
<td>12</td>
</tr>
<tr>
<td>1.041</td>
<td>Transportation Systems Modeling</td>
<td>12</td>
</tr>
<tr>
<td>1.075</td>
<td>Water Resource Systems</td>
<td>12</td>
</tr>
<tr>
<td>1.101</td>
<td>Introduction to Civil and Environmental Engineering Design I</td>
<td>6</td>
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<tr>
<td>1.102</td>
<td>Introduction to Civil and Environmental Engineering Design II</td>
<td>6</td>
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<tr>
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Minor in Civil Engineering
The Minor in Civil Engineering consists of the following subjects:

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<th>Subject Code</th>
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<tr>
<td>1.035</td>
<td>Multiscale Characterization of Materials</td>
<td>12</td>
</tr>
<tr>
<td>1.036</td>
<td>Structural Mechanics and Design</td>
<td>12</td>
</tr>
<tr>
<td>1.050</td>
<td>Solid Mechanics</td>
<td>12</td>
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<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>1.101</td>
<td>Introduction to Civil and Environmental Engineering Design I</td>
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<tr>
<td>1.102</td>
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<td>Total Units</td>
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<td>60</td>
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</table>

Minor in Environmental Engineering Science
The Minor in Environmental Engineering Science consists of the following subjects:

<table>
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<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
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<tbody>
<tr>
<td>1.018A(J)</td>
<td>Fundamentals of Ecology I</td>
<td>6</td>
</tr>
<tr>
<td>1.060A</td>
<td>Fluid Mechanics I</td>
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<td>1.061A</td>
<td>Transport Processes in the Environment I</td>
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<tr>
<td>1.070A(J)</td>
<td>Introduction to Hydrology and Water Resources</td>
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<tr>
<td>1.080A</td>
<td>Environmental Chemistry I</td>
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<td>1.089A</td>
<td>Environmental Microbiology I</td>
<td>6</td>
</tr>
<tr>
<td>1.091</td>
<td>Traveling Research Environmental eXperience (TREX): Fieldwork Analysis and Communication</td>
<td>3</td>
</tr>
<tr>
<td>1.092</td>
<td>Traveling Research Environmental eXperience (TREX): Fieldwork Analysis and Communication</td>
<td>9</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>
<tr>
<td>Total Units</td>
<td></td>
<td>60</td>
</tr>
</tbody>
</table>

Substitution of equivalent subjects offered by other departments is allowed, with permission of the minor advisor. However, at least three full 12-unit subjects must be Course 1 subjects.

For a general description of the minor program, see Undergraduate Education (p. 35).

Other Undergraduate Opportunities

Undergraduate Practice Opportunities Program
The Undergraduate Practice Opportunities Program (UPOP) is a full-year co-curricular professional development program sponsored by the School of Engineering that prepares sophomores for success in the workplace. UPOP is open to all sophomores, regardless of major. Over the course of the program, students receive classroom instruction and personalized coaching focused on advancing both short- and long-term professional goals, with support provided in finding and securing a summer internship. UPOP students participate in professional development workshops and one-to-one coaching during both fall and spring semesters. Students also attend a one-week course over IAP focusing on foundational decision making, team dynamics and development, and communication—essential tools for workplace success. Experiential modules are taught by MIT faculty and coached by MIT alumni mentor-instructors, providing students with an opportunity to practice professional skills with highly experienced industry professionals. UPOP’s two-unit curriculum also serves as the foundation of the Bernard M. Gordon-MIT Engineering Leadership (GEL) Program. Contact the Undergraduate Practice Opportunities Program (upop@mit.edu),
Room 12-193, 617-253-0077, or Leo McGonagle, executive director, for further information.

Research Opportunities

Students wishing to work closely with a member of the faculty on research may obtain permission to register for thesis, or to enroll in 1.999 Undergraduate Studies in Civil and Environmental Engineering. In addition, numerous possibilities exist in the Undergraduate Research Opportunities Program (UROP) (p. 44), and several UROP traineeships are awarded to undergraduates by the department each spring.

Graduate Study

Graduate students in the Department of Civil and Environmental Engineering (CEE) participate in research with renowned faculty and get hands-on experience solving some of the world’s largest problems in the domains of infrastructure and environment, and related areas of interest. Education takes place inside and outside the classroom, and there are numerous opportunities to learn not only about civil and environmental engineering in an interdisciplinary research environment but also to network with peers. CEE grants the following advanced degrees: Master of Engineering in Civil and Environmental Engineering, Master of Science in Transportation, Master of Science, Civil Engineer, Environmental Engineer, Doctor of Science, and Doctor of Philosophy. The Institute's general requirements for these degrees are described under Graduate Education (p. 60). Detailed information on the departmental requirements for each degree may be obtained on the website (http://cee.mit.edu).

Admission Requirements

CEE seeks a diverse group of applicants from a range of academic disciplines who will work together to contribute to exciting intellectual networks across the department and Institute. All applicants are required to submit scores from the GRE General Test. Applicants whose first language is not English are required to submit scores from either the International English Language Testing System (IELTS), the preferred exam, or the Test of English as a Foreign Language (TOEFL). More information about individual graduate programs can be obtained from the website (http://cee.mit.edu) or by email (cee-admissions@mit.edu).

Master of Engineering

The Master of Engineering (MEng) (http://cee.mit.edu/master-of-engineering) degree program is a professional-oriented graduate program that consists of high-level, fast-paced coursework and significant engagement with applied engineering projects that prepare graduates for a professional career path or further graduate studies at MIT or elsewhere. This nine-month program, with opportunities for individualized tracks of study in CEE, prepares students to address significant challenges in the domains of civil and environmental engineering. The degree requirements include 66 units of graduate-level subjects, 48 units of which must be departmental subjects. Students are also required to complete an original thesis.

Students in the Environmental Engineering Science track pursue classes and research in their areas of interest, including hydrology, environmental chemistry, ecology, and environmental fluid mechanics.

Students in the Structural Mechanics and Design track pursue classes and research in areas including structural engineering mechanics, computational design and optimization, and collaborative workflows at the interface of engineering and architecture.

For current MIT students, the program is a natural extension of the Institute’s four-year Bachelor of Science degree, providing them an opportunity to gain practical experience and preparing them for emerging fields in today’s job market.

Master of Science in Civil and Environmental Engineering

The Master of Science is a two-year research-focused degree that culminates with a thesis. This degree prepares graduates for an advanced position in the field, and provides a foundation for doctoral studies. The degree requirements include 66 units of subject units, 34 of which must be departmental subjects. The student is also required to complete a research thesis comprised of original work.

Doctoral Degrees

The Doctor of Philosophy (PhD) or Doctor of Science (ScD) in Civil and Environmental Engineering offers in-depth study in all areas represented by the department’s faculty. The Civil and Environmental Engineering doctoral program educates students to find solutions based on scientific research and implement them to make real-world contributions. The curriculum and doctoral degree program applies basic scientific principles to complex engineering design at scales from the nano to the global.

Student research is characterized by the following traits:

- Applies theoretical, numerical, experimental, and field work to cutting-edge research projects
- Considers a range of scientific and engineering issues and investigates solutions
- Emphasizes fundamental understanding of, and innovative approaches to, engineering problems by considering a vast range of scales from the nano to the macro

The doctoral program includes a three-subject core area of study that reflects key knowledge in the student’s chosen field. The three subjects are selected from an approved list of four to five subjects within a specific subdiscipline of CEE. The remainder of the doctoral program consists of seven graduate subjects that complement the core, including one “breadth” class. (Subjects taken in pursuit of
the SM can be counted towards these requirements.) The doctoral degree is granted upon completion of the required subjects, submission and defense of a thesis proposal, and submission and defense of a thesis embodying an original research contribution. A detailed description of the doctoral program requirements can be found here (https://cee.mit.edu/resources).

Financial Assistance
The research of the department is an integral part of the graduate program. All doctoral students receive appointments as research or teaching assistants, as do the majority of our SM and MST students. Most of these appointments fully cover tuition, individual health insurance, and reasonable living expenses in the Boston area.

Applicants are encouraged to apply for traineeships and fellowships offered nationally by the National Science Foundation, NASA, DOE, and other governmental agencies that traditionally support students in the department. For an extensive list of such opportunities, visit the Office of Graduate Education website (http://odge.mit.edu/finances/fellowships).

Interdisciplinary Programs
Through its interdisciplinary programs, the Department of Civil and Environmental Engineering brings together the science, technology, systems, and management skills necessary to deal with the important engineering problems of the future.

Computational Science and Engineering
The Computational Science and Engineering (CSE) (http://computationalengineering.mit.edu/education) program allows students to specialize at the doctoral level in a computation-related field of their choice through focused coursework and a doctoral thesis through a number of participating host departments. The CSE program is administered jointly by the Center for Computational Engineering (CCE) and the host departments, with the emphasis of thesis research activities being the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science. For more information, see the full program description (p. 370) under Interdisciplinary Graduate Programs.

Graduate Programs in Transportation
MIT provides a broad range of opportunities for transportation-related education. Courses and classes span the School of Engineering, the Sloan School of Management, and the School of Architecture and Planning, with many activities covering interdisciplinary topics that prepare students for future industry, government, or academic careers.

A variety of graduate degrees are available to students interested in transportation studies and research, including a Master of Science in Transportation and PhD in Transportation, described under Interdisciplinary Graduate Programs (p. 377).

Leaders for Global Operations
The 24-month Leaders for Global Operations (LGO) (http://lgo.mit.edu) program combines graduate degrees in engineering and management for those with previous postgraduate work experience and strong undergraduate degrees in a technical field. During the two-year program, students complete a six-month internship at one of LGO’s partner companies, where they conduct research that forms the basis of a dual-degree thesis. Students finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of seven engineering programs, some of which have optional or required LGO tracks. After graduation, alumni take on leadership roles at top global manufacturing and operations companies.

Joint Program with the Woods Hole Oceanographic Institution
The Joint Program with the Woods Hole Oceanographic Institution (WHOI) (http://mit.whoi.edu) is intended for students whose primary career objective is oceanography or oceanographic engineering. Students divide their academic and research efforts between the campuses of MIT and WHOI. Joint Program students are assigned an MIT faculty member as academic advisor; thesis research may be supervised by MIT or WHOI faculty. While in residence at MIT, students follow a program similar to that of other students in their home department. The program is described in more detail under Interdisciplinary Graduate Programs (p. 372).

Inquiries
Detailed information about the academic policies and programs of the department (http://cee.mit.edu) may be obtained by writing (cee-apo@mit.edu) to or visiting the Academic Programs Office, Room 1-290, 617-253-9723.

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The mission of the Institute for Data, Systems, and Society (IDSS) (http://idss.mit.edu) is to advance education and research in state-of-the-art, analytical methods in information and decision systems; statistics and data science; and the social sciences, and to apply these methods to address complex societal challenges in a diverse set of areas such as energy systems, finance, healthcare, social networks, and urban science. Its mission also includes the creation of an MIT-wide focal point for advancing research and educational programs related to statistics and data science.

Technology advances in areas such as smart sensors, big data, communications, computing, and social networking are rapidly scaling the size and complexity of interconnected systems and networks and, at the same time, are generating massive data that can lead to new insights and understanding. Research at IDSS will aim to understand and analyze data from across these systems, which present unique and substantial challenges due to scale, complexity, and the difficulties of extracting clear, actionable insights.

Our ability to understand data and develop models across complex, interconnected systems is at the core of our ability to uncover new insights and solutions.

Spanning all five schools at MIT, IDSS embraces the collision and synthesis of ideas and methods from analytical disciplines including statistics, data science, information theory and inference, systems and control theory, optimization, economics, human and social behavior, and network science. These disciplines are relevant both for understanding complex systems and for presenting design principles and architectures that allow for the systems’ quantification and management. IDSS seeks to integrate these areas, fostering new collaborations, introducing new paradigms and abstractions, and utilizing the power of data to address societal challenges.

Undergraduate Study

Minor in Statistics and Data Science

The Minor in Statistics and Data Science (p. 364) provides students with a working knowledge base in statistics, probability, and computation, along with an ability to perform data analysis. For a description of the minor, see Interdisciplinary Programs (p. 338).

Graduate Study

IDSS provides educational programs anchored in the following intellectual pillars: statistics, information and decision sciences, and human and institutional behavior.

IDSS’s academic programs embrace the collision and synthesis of ideas and methods from analytical disciplines, including statistics, stochastic modeling, information theory and inference, systems and control theory, optimization, economics, human and social behavior, and network science. Each of these fields in isolation is an insufficient basis for a deep understanding of complex interactions and systems. However, the intersections of these disciplines provide new tools and perspectives for understanding complex systems, addressing overarching challenges (including sustainability and systemic risk), and presenting design principles and architectures that enable those systems’ quantification, management, and regulation.

Inquiries about IDSS academic programs may directed to the Academic Office (idss_academic_office@mit.edu).

Admission Requirements for Graduate Study

Application forms for all programs are available online (http://web.mit.edu/admissions/graduate). Applicants whose first language is not English must offer evidence of written and oral proficiency in English by registering (http://www.ielts.org) for the International English Language Testing System (IELTS) exam, academic format, and achieving a score of 7.5 or better. Information about the Graduate Record Examinations (GRE) can be obtained through the website (http://www.ets.org/gre). Applicants should refer to the details of each program concerning specific requirements for admission.

Master of Science in Technology and Policy

The Technology and Policy Program (TPP) (http://tpp.mit.edu) educates students seeking leadership roles in the constructive development and use of technology—an area that is not well served by the traditional education of technical or social science specialists. TPP focuses on meeting the need for leaders who are engineers and scientists—people with not only strong technical foundations but also the skills and abilities to deal cogently and effectively with the economic, political, and administrative dimensions of the technological challenges of the 21st century.

The Master of Science in Technology and Policy is an engineering research degree with a focus on the increasingly central role of technology in the framing, formulation, and resolution of policy problems. Many students combine TPP’s curriculum with complementary subjects to obtain dual degrees in TPP and either a specialized branch of engineering or an applied social science, such as political science or urban studies and planning.

TPP’s coursework provides a solid grounding in technology and policy by combining advanced subjects in the student’s chosen technical field with courses in economics, politics, modern quantitative methods, and social science. All students must complete a satisfactory research thesis that has a substantial technology and policy component. In order to prepare students for effective professional practice, TPP stresses leadership and communication. It also encourages students to participate in TPP’s
summer internship program, which places students in government and industry in the US and around the world.

The TPP curriculum consists of three blocks of subjects and a research thesis. The first block is a required integrative subject in technology and policy and a subject in applied quantitative methods. The second block focuses on training in formal frameworks for policy development and consists of subjects in microeconomics, political economy, and one restricted elective in microeconomics, social science methods, law, or statistics. The third block comprises a minimum of three coherent electives that fulfill professional and research objectives. The research thesis is the culmination of scholarship integrating technology and policy.

Completion of the academic and research requirements of the TPP typically takes four terms.

The TPP curriculum normally begins in September; applications are due by December 15. All applicants should have a strong basis in engineering or science, and must take the GRE. Strong candidates for the program typically score in the top 10 percent of all three GRE areas: verbal, quantitative, and analytic writing. TPP seeks applicants having relevant work or research experience as well as the ability to demonstrate evidence of leadership and initiative in their professional or other activities.

Contact the TPP program office (tpp@mit.edu), Room E17-373, 617-258-7295, for additional information.

Doctor of Philosophy in Social and Engineering Systems

The Doctor of Philosophy in Social and Engineering Systems (SES) (http://idss.mit.edu/academics/ses_doc) is focused on addressing concrete and societally significant problems by combining methods from engineering and the social sciences. A student's doctoral program includes coursework that prepares them for advanced, rigorous, and original research leading to a doctoral thesis. Both coursework and research must include breadth and depth in engineering and quantitative methods, as well as in the social sciences, and in a particular application domain.

Student research in SES is characterized by the following traits:

- It is driven by problems of societal interest, in areas such as energy, finance, health care, social networks, urban science, as well as in policy-related topics.
- It is application domain driven.
- It involves quantitative methods. The program is focused on problems that can be addressed through mathematical modeling and data analysis.
- It relies on real-world data. Research is expected to analyze data from the application domain of interest, and draw upon the training provided in statistics, etc., through the program's coursework.

- It engages societal aspects of the problem. The research incorporates theories and tools from the social sciences.

The program's subject requirements follow. Waivers for some of the requirements are possible in special circumstances.

**Core**

Select three of the following:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.251J</td>
<td>Introduction to Mathematical Programming</td>
</tr>
<tr>
<td>6.436J</td>
<td>Fundamentals of Probability</td>
</tr>
<tr>
<td>14.121</td>
<td>Microeconomic Theory I</td>
</tr>
<tr>
<td>&amp; 14.122</td>
<td>Microeconomic Theory II</td>
</tr>
<tr>
<td>21A.809</td>
<td>Designing Empirical Research in the Social Sciences</td>
</tr>
</tbody>
</table>

**Information Systems and Decision Science**

Five subjects in the areas of probabilistic modeling, statistics, optimization, or systems/control theory, including:

- One subject that involves the statistical processing of data
- One subject of substantial mathematical content
- Two subjects belonging to a sequence that provides increasing depth on a particular topic

**Social Science**

Four subjects that create a coherent and rigorous program of study in the social sciences, providing necessary background for research, including:

- Three subjects comprising a coherent collection that builds depth in a particular social science focus area

**Problem Domain**

Two subjects in the application domain of the student's research

1. Criteria defined by the graduate program committee.
2. Subjects used to satisfy the core can be counted toward this requirement. However, the remaining subjects should be at a more-advanced level.
3. One subject may be satisfied by an internship or independent study in which the student is evaluated on their performance of hands-on work in a particular domain.
4. One subject may also be counted toward the social science requirement.

The program begins in September and applications are due by December 15 of the preceding year.

Further information about SES is available on the program website (http://idss.mit.edu/academics/ses_doc) or by contacting the IDSS Academic Office (idss_academic_office@mit.edu), Room E17-375, or 617-253-1182.
Research Centers

Research in IDSS addresses overarching challenges, including the modeling and prediction of system behavior and performance; systems design and architecture; and issues including social welfare, monetization, and regulation, as well as sustainability and resilience, cascades and contagion phenomena, and systemic risk.

IDSS will sustain this research agenda by fostering and prioritizing several types of strong connections, including:

• A community of experts, at MIT and elsewhere, with demonstrated success performing impactful, multidisciplinary research in these domains.
• A close connection between research and domain expertise, to enable a contextually-informed understanding of the challenges and opportunities in complex systems.
• Educational and research methodologies, not considered in isolation, but instead anchored in one or several of the cross-disciplinary fields of statistics, information and decision sciences, the science of interconnections, as well as the study of social and institutional behavior.

Laboratory for Information and Decision Systems

The Laboratory for Information and Decision Systems (LIDS) (http:// lids.mit.edu) is an interdepartmental laboratory devoted to research and education in systems, networks, and control, staffed by faculty, research scientists, and graduate students from many departments and centers across MIT. The mission of LIDS is to develop and apply rigorous approaches and tools for system modeling, analysis, design, and optimization. It encompasses the development of novel analytical methodologies, as well as the adaptation and application of advanced methods to specific contexts and application domains. LIDS research addresses physical and man-made systems, their dynamics, and the associated information processing. Some of the lab’s core research areas are: statistical inference and machine learning; optimization; systems theory, control, and autonomy; and networks.

For further information, see the Research and Study (p. 102) section.

Sociotechnical Systems Research Center

The Sociotechnical Systems Research Center (SSRC) (http:// ssrc.mit.edu) is an interdisciplinary research center that focuses on the study of high-impact, complex, sociotechnical systems that shape our world.

SSRC brings together faculty, researchers, students, and staff from across MIT to study and seek solutions to complex societal challenges that span healthcare, energy, infrastructure networks, the environment, and international development.

For further information on SSRC and its programs, see the Research and Study (p. 114) section.

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DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Electrical engineers and computer scientists are everywhere—in industry and research areas as diverse as computer and communication networks, electronic circuits and systems, lasers and photonics, semiconductor and solid-state devices, nanoelectronics, biomedical engineering, computational biology, artificial intelligence, robotics, design and manufacturing, control and optimization, computer algorithms, games and graphics, software engineering, computer architecture, cryptography and computer security, power and energy systems, financial analysis, and many more. The infrastructure and fabric of the information age, including technologies such as the internet and the web, search engines, cell phones, high-definition television, and magnetic resonance imaging, are largely the result of innovations in electrical engineering and computer science. The Department of Electrical Engineering and Computer Science (EECS) (http://www-eecs.mit.edu) at MIT and its graduates have been at the forefront of a great many of these advances. Current work in the department holds promise of continuing this record of innovation and leadership, in both research and education, across the full spectrum of departmental activity.

The career paths and opportunities for EECS graduates cover a wide range and continue to grow: fundamental technologies, devices, and systems based on electrical engineering and computer science are pervasive and essential to improving the lives of people around the world and managing the environments they live in. The basis for the success of EECS graduates is a deep education in engineering principles, built on mathematical, computational, physical, and life sciences, and exercised with practical applications and project experiences in a wide range of areas. Our graduates have also demonstrated over the years that EECS provides a strong foundation for those whose work and careers develop in areas quite removed from their origins in engineering.

Undergraduate students in the department take two core subjects that introduce electrical engineering and computer science, and then systematically build up broad foundations and depth in selected intellectual theme areas that match their individual interests. Laboratory subjects, independent projects, and research provide engagement with principles and techniques of analysis, design, and experimentation in a variety of fields. The department also offers a range of programs that enable students to gain experience in industrial settings, ranging from collaborative industrial projects done on campus to term-long experiences at partner companies.

Graduate study in the department moves students toward mastery of areas of individual interest, through coursework and significant research, often defined in interdisciplinary areas that take advantage of the tremendous range of faculty expertise in the department and, more broadly, across MIT.

Undergraduate Study

For MIT undergraduates, the Department of Electrical Engineering and Computer Science offers several programs leading to the Bachelor of Science:

- The 6-1 program (p. 403) leads to the Bachelor of Science in Electrical Science and Engineering. It is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org).
- The 6-2 program (p. 399) leads to the Bachelor of Science in Electrical Engineering and Computer Science and is for those whose interests cross this traditional boundary. It is accredited by both the Engineering and Computing Accreditation Commissions of ABET (http://www.abet.org).
- The 6-3 program (p. 397) leads to the Bachelor of Science in Computer Science and Engineering. It is accredited by both the Engineering and Computing Accreditation Commissions of ABET (http://www.abet.org).
- The 6-7 program (p. 482), offered jointly by the Department of Electrical Engineering and Computer Science and the Department of Biology (Course 7), is for students specializing in computer science and molecular biology. A detailed description of this degree program and its requirements can be found in the section on Interdisciplinary Programs (p. 338).
- The 6-14 program (p. 484), offered jointly by the Department of Electrical Engineering and Computer Science and the Department of Economics (Course 14), is for students specializing in computer science, economics, and data science. A detailed description of this degree program and its requirements can be found in the section on Interdisciplinary Programs (p. 339).
- The 11-6 program (p. 486), offered jointly by the Department of Electrical Engineering and Computer Science and the Department of Urban Studies and Planning (Course 11), is for students specializing in urban science and planning with computer science. A detailed description of this degree program and its requirements can be found in the section on Interdisciplinary Programs (p. 348).

The bachelor’s programs in 6-1, 6-2, and 6-3 build on the General Institute Requirements in science and the humanities, and are structured to provide early, hands-on engagement with ideas, activities, and learning that allow students to experience the range and power of electrical engineering and computer science in an integrated way. The required introductory core subject (one of 6.01, 6.02, 6.03, and 6.08) involves substantial work in the laboratory. This subject is complemented by a mathematics subject, and followed by a choice of three foundation courses from a set of subjects that provide the basis for subsequent specialization.
Students define their specialization by selecting three to four header subjects, two advanced undergraduate subjects, and one to two EECS elective subjects from an extensive set of possibilities. The flexibility in these choices permits students considerable latitude in shaping their program to match diverse interests, while ensuring depth and mastery in a few selected areas.

The joint bachelor’s programs in 6-7 provides an interdepartmental curriculum involving rigorous training in both molecular biology and computer science. Students begin with introductory courses in math, chemistry, programming, and lab skills. Students then build on these skills with five courses in algorithms and biology, which lead to a choice of electives in biology, with a particular focus on computational biology.

The joint bachelor’s program in 6-14 is designed to equip students with a foundational knowledge of economic analysis, computing, optimization, and data science, as well as hands-on experience with empirical analysis of economic data. Students take eight subjects that provide a mathematical, computational, and algorithmic basis for the major. From there, students take two subjects in data science, two in intermediate economics, and three elective subjects from data science and economics theory.

All students in 6-1, 6-2, 6-3, or 6-7 may also apply for one of the Master of Engineering programs offered by the department, which require an additional year of study for the simultaneous award of both degrees.

Minor in Computer Science
The department offers a minor in Computer Science; the requirements are as follows:

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6.00</strong></td>
<td>Introduction to Computer Science and Programming</td>
</tr>
<tr>
<td><strong>6.0001</strong> &amp; <strong>6.0002</strong></td>
<td>Introduction to Computer Science Programming in Python and Introduction to Computational Thinking and Data Science</td>
</tr>
<tr>
<td><strong>6.042[J]</strong></td>
<td>Mathematics for Computer Science</td>
</tr>
<tr>
<td><strong>6.006</strong></td>
<td>Introduction to Algorithms</td>
</tr>
<tr>
<td><strong>6.009</strong></td>
<td>Fundamentals of Programming</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electives</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Select two subjects from the following lists, one of which must be from the Advanced Level list:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Basic Level</strong></td>
<td></td>
</tr>
<tr>
<td><strong>6.004</strong></td>
<td>Computation Structures</td>
</tr>
<tr>
<td><strong>6.008</strong></td>
<td>Introduction to Inference</td>
</tr>
<tr>
<td><strong>6.034</strong></td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td><strong>Advanced Level</strong></td>
<td></td>
</tr>
<tr>
<td><strong>6.031</strong></td>
<td>Elements of Software Construction</td>
</tr>
</tbody>
</table>

| 6.033 | Computer Systems Engineering |
| 6.036 | Introduction to Machine Learning |
| 6.045[J] | Automata, Computability, and Complexity |
| 6.046[J] | Design and Analysis of Algorithms |
| 6.170 | Software Studio |

Total Units 72-75
A minimum of four subjects (48 units) taken for the Computer Science Minor cannot also count toward a major or another minor.

Inquiries
Additional information about the department’s undergraduate programs may be obtained from the EECS Undergraduate Office (ug@eecs.mit.edu), Room 38-476, 617-253-7329.

Graduate Study

Master of Engineering
The Department of Electrical Engineering and Computer Science permits qualified MIT undergraduate students to apply for one of three Master of Engineering (MEng) programs. These programs consist of an additional, fifth year of study beyond one of the Bachelor of Science programs offered by the department.

Recipients of a Master of Engineering degree normally receive a Bachelor of Science degree simultaneously. No thesis is explicitly required for the Bachelor of Science degree. However, every program must include a major project experience at an advanced level, culminating in written and oral reports.

The Master of Engineering degree also requires completion of 24 units of thesis credit under 6.THM Master of Engineering Program Thesis. While a student may register for more than this number of thesis units, only 24 units count toward the degree requirement. Adjustments to the department requirements are made on an individual basis when it is clear that a student would be better served by a variation in the requirements because of their strong prior background.

Programs leading to the five-year Master of Engineering degree or to the four-year Bachelor of Science degrees can easily be arranged to be identical through the junior year. At the end of the junior year, students with strong academic records may apply to continue through the five-year master’s program. Admission to the Master of Engineering program is open only to undergraduate students who have completed their junior year in the Department of Electrical Engineering and Computer Science at MIT. Students with other preparation seeking a master’s level experience in EECS at MIT should see the Master of Science program described later in this section.
A student in the Master of Engineering program must be registered as a graduate student for at least one regular (non-summer) term. To remain in the program and to receive the Master of Engineering degree, students will be expected to maintain strong academic records.

Three MEng Programs are available:

- The Master of Engineering in Electrical Engineering and Computer Science (6-P) program is intended to provide the depth of knowledge and the skills needed for advanced graduate study and for professional work, as well as the breadth and perspective essential for engineering leadership in an increasingly complex technological world.
- The 6-A Master of Engineering Thesis Program with Industry combines the Master of Engineering academic program with periods of industrial practice at affiliated companies. An undergraduate wishing to pursue this degree should initially register for one of the department’s three bachelor’s programs.
- The Department of Electrical Engineering and Computer Science jointly offers a Master of Engineering in Computer Science and Molecular Biology (6-7P) with the Department of Biology (Course 6-7P). This program is modeled on the 6-P program, but provides additional depth in computational biology through coursework and a substantial thesis.

Master of Engineering in Electrical Engineering and Computer Science (Course 6-P)

Through a seamless, five-year course of study, the Master of Engineering in Electrical Engineering and Computer Science (6-P) (p. 402) program leads directly to the simultaneous awarding of the Master of Engineering and one of the three bachelor's degrees offered by the department. The 6-P program is intended to provide the skills and depth of knowledge in a selected field of concentration needed for advanced graduate study and for professional work, as well as the breadth and perspective essential for engineering leadership in an increasingly complex technological world. The student selects 42 units from a list of subjects approved by the Graduate Office; these subjects, considered along with the two advanced undergraduate subjects from the bachelor’s program, must include at least 36 units in an area of concentration. A further 24 units of electives are chosen from a restricted departmental list of mathematics, science, and engineering subjects.

Master of Engineering Thesis Program with Industry (Course 6-A)

The 6-A Master of Engineering Thesis Program with Industry (http://vi-a.mit.edu) enables students to combine classroom studies with practical experience in industry through a series of supervised work assignments at one of the companies or laboratories participating in the program, culminating with a Master of Engineering thesis performed at a 6-A member company. Collectively, the participating companies provide a wide spectrum of assignments in the various fields of electrical engineering and computer science, as well as an exposure to the kinds of activities in which engineers are currently engaged. Since a continuing liaison between the companies and faculty of the department is maintained, students receive assignments of progressive responsibility and sophistication that are usually more professionally rewarding than typical summer jobs.

The 6-A program is primarily designed to work in conjunction with the department’s five-year Master of Engineering degree program. Internship students generally complete three assignments with their cooperating company—usually two summers and one regular term. While on 6-A assignment, students receive pay from the participating company as well as academic credit for their work. During their graduate year, 6-A students generally receive a 6-A fellowship or a research or teaching assistantship to help pay for the graduate year.

The department conducts a fall recruitment during which juniors who wish to work toward an industry-based Master of Engineering thesis may apply for admission to the 6-A program. Acceptance of a student into the program cannot be guaranteed, as openings are limited. At the end of their junior year, most 6-A students can apply for admission to 6-PA, which is the 6-A version of the department’s five-year 6-P Master of Engineering degree program. 6-PA students do their Master of Engineering thesis at their participating company’s facilities. They can apply up to 24 units of work-assignment credit toward their Master of Engineering degree. The first 6-A assignment may be used for the advanced undergraduate project that is required for award of a bachelor’s degree, by including a written report and obtaining approval by a faculty member.

At the conclusion of their program, 6-A students are not obliged to accept employment with the company, nor is the company obliged to offer such employment.

Additional information about the program is available at the 6-A Office, Room 38-409E, 617-253-4644.

Master of Engineering in Computer Science and Molecular Biology (Course 6-7P)

The Departments of Biology and Electrical Engineering and Computer Science jointly offer a Master of Engineering in Computer Science and Molecular Biology (6-7P) (p. 489). A detailed description of the program requirements may be found under the section on Interdisciplinary Programs (p. 370).

Predoctoral and Doctoral Programs

The programs of education offered by the Department of Electrical Engineering and Computer Science at the doctoral and predoctoral level have three aspects. First, a variety of classroom subjects in physics, mathematics, and fundamental fields of electrical engineering and computer science is provided to permit students to develop strong scientific backgrounds. Second, more specialized classroom and laboratory subjects and a wide variety of colloquia and seminars introduce the student to the problems of current interest in many fields of research, and to the techniques that may
be useful in attacking them. Third, each student conducts research under the direct supervision of a member of the faculty and reports the results in a thesis.

Three advanced degree programs are offered in addition to the Master of Engineering program described above. A well-prepared student with a bachelor's degree in an appropriate field from some school other than MIT (or from another department at MIT) normally requires about one and one-half to two years to complete the formal studies and the required thesis research in the Master of Science degree program. (Students who have been undergraduates in Electrical Engineering and Computer Science at MIT and who seek opportunities for further study must complete the Master of Engineering rather than the Master of Science degree program.) With an additional year of study and research beyond the master's level, a student in the doctoral or predoctoral program can complete the requirements for the degree of Electrical Engineer or Engineer in Computer Science. The doctoral program usually takes about four to five years beyond the master's level.

There are no fixed programs of study for these doctoral and predoctoral degrees. Each student plans a program in consultation with a faculty advisor. As the program moves toward thesis research, it usually centers in one of a number of areas, each characterized by an active research program. Areas of specialization in the department that have active research programs and related graduate subjects include communications, control, signal processing, and optimization; computer science; artificial intelligence, robotics, computer vision, and graphics; electronics, computers, systems, and networks; electromagnetics and electrodynamics; optics, photonics, and quantum electronics; energy conversion devices and systems; power engineering and power electronics; materials and devices; VLSI system design and technology; nanoelectronics; bioelectrical engineering; and computational biology.

In addition to graduate subjects in electrical engineering and computer science, many students find it profitable to study subjects in other departments such as Biology, Brain and Cognitive Sciences, Economics, Linguistics and Philosophy, Management, Mathematics, and Physics.

The informal seminar is an important mechanism for bringing together members of the various research groups. Numerous seminars meet every week. In these, graduate students, faculty, and visitors report their research in an atmosphere of free discussion and criticism. These open seminars are excellent places to learn about the various research activities in the department.

Research activities in electrical engineering and computer science are carried on by students and faculty in laboratories of extraordinary range and strength, including the Laboratory for Information and Decision Systems, Research Laboratory of Electronics, Computer Science and Artificial Intelligence Laboratory, Laboratory for Energy and the Environment (see MIT Energy Initiative), Kavli Institute for Astrophysics and Space Research, Lincoln Laboratory, Materials Research Laboratory, MIT Media Lab, Francis Bitter Magnet Laboratory, Operations Research Center, Plasma Science and Fusion Center, and the Microsystems Technology Laboratories. Descriptions of many of these laboratories may be found under the section on Research and Study (p. 88).

Because the backgrounds of applicants to the department's doctoral and predoctoral programs are extremely varied, both as to field (electrical engineering, computer science, physics, mathematics, biomedical engineering, etc.) and as to level of previous degree (bachelor's or master's), no specific admissions requirements are listed. All applicants for any of these advanced programs will be evaluated in terms of their potential for successful completion of the department's doctoral program. Superior achievement in relevant technical fields is considered particularly important.

Master of Science in Electrical Engineering and Computer Science

The general requirements for the degree of Master of Science are listed under Graduate Education (p. 61). The department requires that the 66-unit program consist of at least four subjects from a list of approved subjects by the Graduate Office which must include a minimum of 42 units of advanced graduate subjects. In addition, a 24-unit thesis is required beyond the 66 units. Students working full-time for the Master of Science degree may take as many as four classroom subjects per term. The subjects are wholly elective and are not restricted to those given by the department. The program of study must be well balanced, emphasizing one or more of the theoretical or experimental aspects of electrical engineering or computer science.

Electrical Engineer or Engineer in Computer Science

The general requirements for an engineer's degree are given under the section on Graduate Education (p. 61). These degrees are open to those able students in the doctoral or predoctoral program who seek more extensive training and research experiences than are possible within the master's program. Admission to the engineer's program depends upon a superior academic record and outstanding progress on a thesis. The course of studies consists of at least 162 units, 90 of which must be from a list of subjects approved by the Graduate Office, and the thesis requirements for a master's degree.

Doctor of Philosophy or Doctor of Science

The general requirements for the degree of Doctor of Philosophy or Doctor of Science are given under the section on Graduate Education (p. 61). Doctoral candidates are expected to participate fully in the educational program of the department and to perform thesis work that is a significant contribution to knowledge. As preparation, MIT students in the Master of Engineering in Electrical Engineering and Computer Science program will be expected to complete that program. Students who have received a bachelor's degree outside the department, but who have not completed a master's degree program, will normally be expected to complete the requirements for the Master of Science degree described earlier, including a thesis.
Students who have completed a master’s degree elsewhere without a significant research component will be required to register for and carry out a research accomplishment equivalent to a master’s thesis before being allowed to proceed in the doctoral program.

Details of how students in the department fulfill the requirements for the doctoral program are spelled out in an internal memorandum. The department does not have a foreign language requirement, but does require an approved minor program.

Graduate students enrolled in the department may participate in the research centers described in the Research and Study (p. 88) section, such as the Operations Research Center.

Financial Support

Master of Engineering Degree Students
Students in the fifth year of study toward the Master of Engineering degree are commonly supported by a graduate teaching or research assistantship. In the 6-A Master of Engineering Thesis Program with Industry, students are supported by paid company internships. Students supported by full-time research or teaching assistantships may register for no more than two regular classes totaling at most 27 units. They receive additional academic units for their participation in the teaching or research program. Support through an assistantship may extend the period required to complete the Master of Engineering program by an additional term or two. Support is granted competitively to graduate students and may not be available for all of those admitted to the Master of Engineering program. The MEng degree is normally completed by students taking a full load of regular subjects in two graduate terms. Students receiving assistantships commonly require a third term and may petition to continue for a fourth graduate term.

Master of Science, Engineer, and Doctoral Degree Students
Studies toward an advanced degree can be supported by personal funds, by an award such as the National Science Foundation Fellowship (which the student brings to MIT), by a fellowship or traineeship awarded by MIT, or by a graduate assistantship. Assistantships require participation in research or teaching in the department or in one of the associated laboratories. Full-time assistants may register for no more than two scheduled classroom or laboratory subjects during the term, but may receive additional academic credit for their participation in the teaching or research program.

Inquiries
Additional information concerning graduate academic and research programs, admissions, financial aid, and assistantships may be obtained from the Electrical Engineering and Computer Science Graduate Office, Room 38-444, 617-253-4605, or visit the website (http://www-eecs.mit.edu).

Interdisciplinary Programs

Computation for Design and Optimization
The Computation for Design and Optimization (CDO) (http://computationalengineering.mit.edu/education) program offers a master’s degree to students interested in the analysis and application of computational approaches to designing and operating engineered systems. The curriculum is designed with a common core serving all engineering disciplines and an elective component focusing on specific applications. Current MIT graduate students may pursue a CDO master’s degree in conjunction with a department-based master’s or PhD program. For more information, see the full program description (p. 368) under Interdisciplinary Graduate Programs.

Joint Program with the Woods Hole Oceanographic Institution
The Joint Program with the Woods Hole Oceanographic Institution (WHOI) (http://mit.whoi.edu) is intended for students whose primary career objective is oceanography or oceanographic engineering. Students divide their academic and research efforts between the campuses of MIT and WHOI. Joint Program students are assigned an MIT faculty member as academic advisor; thesis research may be supervised by MIT or WHOI faculty. While in residence at MIT, students follow a program similar to that of other students in their home department. The program is described in more detail under Interdisciplinary Graduate Programs (p. 372).

Leaders for Global Operations
The 24-month Leaders for Global Operations (LGO) (http://lgo.mit.edu) program combines graduate degrees in engineering and management for those with previous postgraduate work experience and strong undergraduate degrees in a technical field. During the two-year program, students complete a six-month internship at one of LGO’s partner companies, where they conduct research that forms the basis of a dual-degree thesis. Students finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of seven engineering programs, some of which have optional or required LGO tracks. After graduation, alumni take on leadership roles at top global manufacturing and operations companies.

System Design and Management
The System Design and Management (SDM) (http://sdm.mit.edu) program is a partnership among industry, government, and the university for educating technically grounded leaders of 21st-century enterprises. Jointly sponsored by the School of Engineering and the Sloan School of Management, it is MIT’s first degree program to be offered with a distance learning option in addition to a full-time in-residence option.

Technology and Policy
The Master of Science in Technology and Policy is an engineering research degree with a strong focus on the role of technology in policy analysis and formulation. The Technology and Policy Program
(TPP) (http://tpp.mit.edu) curriculum provides a solid grounding in technology and policy by combining advanced subjects in the student's chosen technical field with courses in economics, politics, quantitative methods, and social science. Many students combine TPP's curriculum with complementary subjects to obtain dual degrees in TPP and either a specialized branch of engineering or an applied social science such as political science or urban studies and planning. For additional information, see the program description under the Institute for Data, Systems, and Society (p. 181).

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HARVARD-MIT HEALTH SCIENCES AND TECHNOLOGY PROGRAM

Founded in 1970, the Harvard-MIT Health Sciences and Technology (HST) Program is one of the oldest and largest biomedical engineering and physician-scientist training programs in the United States and the longest-standing collaboration between Harvard and MIT. Since 2012, HST has been housed in the Institute for Medical Engineering and Science (IMES) (p. 98).

HST’s unique interdisciplinary educational program brings engineering as well as the physical and biological sciences from the scientist’s bench to the patient’s bedside. Conversely, it brings clinical insight from the patient’s bedside to the laboratory bench. In this way, HST students are trained to have deep understanding of engineering, physical sciences, and the biological sciences, complemented with hands-on experience in the clinic or in industry; and they become conversant with the underlying quantitative and molecular aspects of medicine and biomedical science. Within HST, approximately 300 graduate students work with eminent faculty members from the MIT and Harvard communities.

In addition to its outstanding record of accomplishment for research in human health care, HST educational programs are distinguished by three key elements:

- A strong quantitative orientation
- Required hands-on experience in a clinical setting
- A focused interdisciplinary research project

HST currently offers degrees in two multidisciplinary areas of graduate study:

- Medical Sciences MD Program
- Medical Engineering and Medical Physics Doctoral Program

Doctoral Programs

Medical Sciences

HST’s Medical Sciences Program leads to the MD degree from Harvard Medical School. It is oriented toward students with a strong interest and background in quantitative science, especially in the biological, physical, engineering, and chemical sciences. The subjects in human biology developed for this curriculum represent the joint efforts of life scientists, physicians, physical scientists, and engineers from the faculties of Harvard and MIT.

Because HST is committed to educating physicians who have a deep understanding of the scientific basis of medicine and who are well equipped for an interdisciplinary research career, HST encourages students in the MD curriculum to devote time to research and requires a thesis for completion of the degree. Many MD students desire even more research training than is possible during the standard four-year MD curriculum. For such students, one option is to pursue a formal PhD program in addition to an MD program. Another option expands the MD program to five or more years in order to include a major research training component.

Details on the Medical Sciences Program and application forms may be obtained from Harvard Medical School Admissions (https://meded.hms.harvard.edu/admissions).

For further information, candidates can contact HST’s MD Admissions Coordinator (hstadmissions@hms.harvard.edu).

Medical Engineering and Medical Physics

The Medical Engineering and Medical Physics (MEMP) Program is a five-to-seven-year program that leads to the PhD in Medical Engineering and Medical Physics awarded by MIT or by the Harvard Faculty of Arts and Sciences. The program trains students as engineers or physical scientists who also have extensive knowledge of the medical sciences. By understanding engineering and physical science applications, as well as their clinical implications, graduates of this program are well positioned to define new questions and formulate novel approaches in biomedical research.

The HST MEMP PhD program has a unique two-pronged curriculum that combines a traditional graduate education in engineering or physical sciences with extensive training in medicine. Each student selects one of 11 technical concentration areas and completes a set of advanced technical classes in the selected discipline. In addition, MEMP students take medical school classes together with HST MD students and then spend 12 weeks full-time in clinical experiences where they learn to take a medical history, perform physical exams, and round on patients in the hospital. MEMP graduates are biomedical engineers and scientists who possess a deep understanding of the clinical environment; they are well positioned to define new questions and formulate novel approaches to unmet needs in human health.

The program’s academic curriculum includes multiple components that prepare students to be medical innovators who will advance human health. First, HST provides MEMP students with a thorough graduate education in a classical discipline of engineering or physical science. Each student selects a concentration area, such as biological engineering, mechanical engineering, chemistry and chemical engineering, materials science, electrical engineering, computer science, physics, aeronautics and astronautics, brain and cognitive science, or nuclear science and engineering, and completes substantial coursework in this discipline.

Students then become conversant in the biological sciences through preclinical coursework followed by a series of clinical experiences. Courses such as pathology and pathophysiology are taken together with HST MD students. Then students engage in immersive clinical experiences where they acquire a hands-on understanding of clinical care, medical decision-making, and the role of technology in medical practice. Through these experiences, students become...
fluent in the language and culture of medicine and gain a firsthand understanding of the opportunities for, and constraints on, applying scientific and technological innovations in health care.

Two seminar classes help students integrate science and engineering with medicine and develop professional skills. A two-stage qualifying examination ensures that each student is proficient in his or her chosen concentration area, can integrate information from diverse sources into a coherent research proposal, and is able to defend that research proposal in an oral presentation.

Finally, MEMP students investigate important problems at the interfaces of science, technology, and clinical medicine through individualized research projects that prepare them to undertake independent research. MEMP students have the opportunity to perform thesis research in laboratories at MIT, Harvard, and the Harvard affiliated teaching hospitals.

Neuroimaging and bioastronautics are areas of specialization within MEMP for which HST offers specially designed training programs. MEMP candidates may choose to apply through MIT, Harvard, or both. Those applying to MEMP through MIT should submit a single application. Those applying to MEMP through Harvard must also apply to the School of Engineering and Applied Sciences or the Biophysics Program. Additional information about applying to MEMP is available on the MEMP website (http://hst.mit.edu/academics/memp/admissions).

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DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Materials science and engineering studies the ways in which atoms and molecules can be built into solid materials and how the structural arrangement of the atoms in a material governs its properties. The department's research and academic programs address all classes of materials, used in every domain of human endeavor, including energy, sustainability, nanotechnology, healthcare, information technology, and all types of manufacturing. The discipline is unique for its balance of basic science (examining the relationships and connections between materials' processing, structure, and properties) and applied engineering (because all advanced technologies depend on materials). Faculty and student research projects in the Department of Materials Science and Engineering (DMSE) range from the purely scientific to specific applications and goals. The department draws on perspectives from chemistry, physics, biology, electronics, and design.

Recent achievements in materials have depended as much on advances in materials engineering as they have on materials science. When developing engineering processes for preparation and production of materials and when designing materials for specific applications, the materials engineer must understand fundamental concepts such as thermodynamics, heat and mass transfer, and chemical kinetics, and must also have a proper concern for economic, social, and environmental factors. Today's materials scientists and engineers address some of the key challenges facing humanity, including energy, sustainability, nanotechnology, healthcare, information technology, and all types of manufacturing. A large number of DMSE alumni are faculty of leading universities.

The department has modern undergraduate materials teaching laboratories containing a wide variety of materials processing and characterization equipment. The Undergraduate Teaching Laboratory on the Infinite Corridor includes facilities for biomaterials research, chemical synthesis, and physical and electronic properties measurement. The Laboratory for Advanced Materials contains characterization equipment for scanning acoustical microscopy, near-field and scanning laser confocal microscopes, and low-temperature multiprobe. Other departmental facilities include those for preparation and characterization of thin films, ceramics and glasses, metallic and nonmetallic crystals, biomaterials, and polymers. Materials are characterized by optical, electron (TEM, SEM), and scanning probe (AFM, STM) microscopy, and there is equipment for a wide range of electrical, optical, magnetic, and mechanical property measurements. DMSE faculty, students, and staff will be among the key users of the new MIT.nano building, a state-of-the-art facility for materials research set to open during the 2018–2019 academic year.

Undergraduate Study

The Department of Materials Science and Engineering (DMSE) offers several undergraduate degree programs:

- Course 3, leading to the Bachelor of Science in Materials Science and Engineering, is taken by the majority of undergraduates in the department and is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org).
- Course 3-A, leading to the Bachelor of Science without specification, provides students greater flexibility in designing their own self-guided program. The New Engineering Education Transformation (NEET) program (https://neet.mit.edu/team-and-contact/faq/advanced-materials-machines-faq) offers a thread in Advanced Materials Machines that meets the 3-A requirements.
- Course 3-C leads to a Bachelor of Science in Archaeology and Materials.

The department also offers research and educational specialization in a large number of industrially and scientifically important areas leading to master's and doctoral degrees.

Bachelor of Science in Materials Science and Engineering (Course 3)

The undergraduate program (p. 412) serves the needs of students who intend to pursue employment in materials-related industries immediately upon graduation, as well as those who will do graduate work in the engineering or science of materials. The program is
Some students may be attracted to the many opportunities available to them as co-supervisors during the students’ assignments. Students earn a thesis matching each student’s capabilities and arranged by concurrently with academic work through cooperative work in industry. This option provides students with industrial experience during their sophomore year and allows them to write either a senior thesis or reports based on industrial internships. This provides an opportunity for original research work beyond that which occurs elsewhere in the program.

The required subjects can be completed in the sophomore and junior years within a schedule that allows students to take a HASS subject each term and a range of elective junior and senior subjects. Departmental advisors assist students in selecting elective subjects. While the program should satisfy the academic needs of most students, petitions for variations or substitutions may be approved by the departmental Undergraduate Committee; students should contact their advisor for guidance in such cases.

Participation in laboratory work by undergraduates is an integral part of the curriculum. The departmental core subjects include extensive laboratory exercises, which investigate materials properties, structure, and processing and are complementary to the lecture subjects. The junior-year core includes a capstone laboratory subject, 3.042 Materials Project Laboratory, that emphasizes design, materials processing, teamwork, communication skills, and project management. Undergraduate students also have access to extensive research facilities as part of UROP in the Undergraduate Archaeology and Materials Laboratory. Students develop oral and written communication skills by reporting data and analysis in a variety of ways.

Students may substitute industrial internship reports (12 units of Industrial Practice, 3.930/3.931 Internship Program) for the senior thesis (3.THU Undergraduate Thesis). Students select this option during their sophomore year, and take 3.930 in the summer after the sophomore year and 3.931 in the summer following the junior year. This option provides students with industrial experience concurrently with academic work through cooperative work assignments matched to each student’s capabilities and arranged by the department. A company representative and a faculty advisor act as co-supervisors during the students’ assignments. Students earn a salary during their work periods and also receive academic credit.

Bachelor of Science (Course 3-A)

Some students may be attracted to the many opportunities available in the materials discipline but also have special interests that are not satisfied by the Course 3 program. For instance, some students may wish to take more biology and chemistry subjects in preparation for medical school or more management subjects prior to entering an MBA or law program. In these cases, the 3-A program may be of value as a more flexible curriculum in which a larger number of elective choices is available.

The curriculum requirements (p. 414) for Course 3-A are similar to but more flexible than those for Course 3.

A student considering the 3-A program (including NEET) should contact the department Academic Office, who will counsel them more fully on the academic considerations involved. The student will prepare a complete plan of study which must be approved by the departmental Undergraduate Committee. This approval must be obtained no later than the beginning of the student’s junior year. The student is then expected to adhere to this plan unless circumstances require a change, in which case a petition for a modified program must be submitted to the Undergraduate Committee. The department does not seek ABET accreditation for the 3-A program.

The NEET option allows students to pursue a project-centered academic program across multiple departments and disciplines.

Bachelor of Science in Archaeology and Materials as Recommended by the Department of Materials Science and Engineering (Course 3-C)

Students who have a specific interest in archaeology and archaeological science may choose Course 3-C. The 3-C program (p. 391) is designed to afford students broad exposure to fields that contribute fundamental theoretical and methodological approaches to the study of ancient and historic societies. The primary fields include anthropological archaeology, geology, and materials science and engineering. The program enriches knowledge of past and present-day nonindustrial societies by making the natural and engineering sciences part of the archaeological tool kit.

The program’s special focus is on understanding prehistoric culture through study of the structure and properties of materials associated with human activities. Investigating peoples’ interactions with materials, the objects that such interactions produced, and the related environmental settings leads to a fuller analysis of the physical, social, cultural, and ideological world in which people function. These are the goals of anthropological archaeology, goals that are reached, in part, through science and engineering perspectives.

Participation in laboratory work by undergraduates is an integral part of the curriculum. The program requires that all students take a materials laboratory subject. Many of the archaeology subjects are designed with a laboratory component; such subjects meet in the Undergraduate Archaeology and Materials Laboratory. Undergraduate students also have access to the extensive CMRAE facilities for research in archaeological materials as part of UROP.
and thesis projects. Such projects may include archaeological fieldwork during IAP or the summer months.

The HASS Concentration in Archaeology and Archaeological Science provides concentrators with a basic knowledge of the field of archaeology, the systematic study of the human past. Students pursuing the SB in 3-C may not also concentrate in this area. The archaeology and archaeological science concentration consists of four subjects:

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.986 The Human Past: Introduction to Archaeology</td>
<td>12</td>
</tr>
<tr>
<td>3.985[J] Archaeological Science</td>
<td>9</td>
</tr>
<tr>
<td>Select two other HASS electives from among the following:</td>
<td>18-21</td>
</tr>
<tr>
<td>3.094 Materials in Human Experience</td>
<td></td>
</tr>
<tr>
<td>3.982 The Ancient Andean World</td>
<td></td>
</tr>
<tr>
<td>3.983 Ancient Mesoamerican Civilization</td>
<td></td>
</tr>
<tr>
<td>3.987 Human Evolution: Data from Palaeontology, Archaeology, and Materials Science</td>
<td></td>
</tr>
<tr>
<td>3.993 Archaeology of the Middle East</td>
<td></td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>39-42</strong></td>
</tr>
</tbody>
</table>

The department does not seek ABET accreditation for the 3-C program. Students may contact Dr. Max Price (maxprice@mit.edu) for more information.

**Minor in Materials Science and Engineering**

The Minor in Materials Science and Engineering consists of six undergraduate subjects totaling at least 72 units from the list of Required Subjects and Restricted Electives in the departmental program, with at least one of these taken from the list of Restricted Electives. (See Course 3 degree chart (p. 412) for a list of subjects.) With the approval of the minor advisor, students may substitute one subject taken outside the department for one of the Course 3 subjects, provided that the coverage of the substituted subject is similar to one of those in the departmental program.

The department’s minor advisor, Professor Juejun Hu, will ensure that individual minor programs form a coherent group of subjects. Because of the breadth of the undergraduate program in the department and the variety of possibilities for specialization, the minor program is flexible in its composition. Examples of minor programs in materials science and engineering can be obtained from the department. Other suitable programs may be composed through consultation between the student, the minor advisor, and the Undergraduate Committee.

**Minor in Archaeology and Materials**

The Minor in Archaeology and Materials (3-C) consists of six undergraduate subjects as described below.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.012 Fundamentals of Materials Science and Engineering</td>
<td>15</td>
</tr>
<tr>
<td>3.014 Materials Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>3.022 Microstructural Evolution in Materials</td>
<td>12</td>
</tr>
<tr>
<td>3.985[J] Archaeological Science (HASS-S)</td>
<td>9</td>
</tr>
<tr>
<td>3.986 The Human Past: Introduction to Archaeology (HASS-S)</td>
<td>12</td>
</tr>
<tr>
<td><strong>Elective</strong></td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>9-12</td>
</tr>
<tr>
<td>3.981 Communities of the Living and the Dead: the Archaeology of Ancient Egypt</td>
<td></td>
</tr>
<tr>
<td>3.982 The Ancient Andean World</td>
<td></td>
</tr>
<tr>
<td>3.983 Ancient Mesoamerican Civilization</td>
<td></td>
</tr>
<tr>
<td>3.987 Human Evolution: Data from Palaeontology, Archaeology, and Materials Science</td>
<td></td>
</tr>
<tr>
<td>3.990 Seminar in Archaeological Method and Theory</td>
<td></td>
</tr>
<tr>
<td>3.993 Archaeology of the Middle East</td>
<td></td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>69-72</strong></td>
</tr>
</tbody>
</table>

All of these subjects, with the exception of 3.990, provide HASS-S credit.

With the approval of the minor advisor, students may substitute one subject taken outside the Course 3 program, provided the coverage is equivalent. The 3-C minor advisor, Dr. Max Price, will ensure that the minor program forms a coherent group of subjects.

A general description of the minor program at MIT may be found under Undergraduate Education (p. 35).

**Inquiries**

Additional information regarding undergraduate programs may be obtained from the DMSE Academic Office, Room 6-107, 617-258-5816.

**Graduate Study**

The Department of Materials Science and Engineering (DMSE) offers the degrees of Master of Science, Doctor of Philosophy, and Doctor of Science in Materials Science and Engineering.

**Admission Requirements for Graduate Study**

General admissions requirements are described under Graduate Education (p. 61). Programs are arranged on an individual basis depending upon the preparation and interests of the student. Those who have not studied some thermodynamics and kinetics at the undergraduate level are advised to take 3.012 Fundamentals
of Materials Science and Engineering and 3.022 Microstructural Evolution in Materials.

Requirements for Completion of Graduate Degrees
The general requirements for completion of graduate degrees are also described under the section on Graduate Education. Students completing a Master of Science degree are required to present a seminar summarizing the thesis. The department requires that candidates for the doctoral degrees go through a qualifying procedure and pass Institute-mandated general written and oral examinations before continuing with their programs of study and research, and that they satisfy a minor requirement. Information on the qualifying procedure and on the subject areas covered by the general examinations is available in the DMSE Academic Office.

Master of Science in Materials Science and Engineering
The department offers a Master of Science degree in materials science and engineering. The general requirements for the master’s degree are described under the section on Graduate Education (p. 61). The coherent program of subjects (34 units, though not necessarily all DMSE subjects) must be approved by the Department Committee on Graduate Students. Of the 66 total units required for the master’s degree, 42 graduate degree credits are required to be in DMSE subjects at the graduate level. The thesis must have significant materials research content and an internal departmental thesis reader is required if the student’s advisor is outside DMSE.

The department may also recommend awarding a master’s degree without departmental specification; the general requirements are described under Graduate Education (p. 61). The thesis must be materials-related, and an internal departmental thesis reader is required if the thesis advisor is outside DMSE.

Simultaneous Award of Two Master of Science Degrees for Students from Other Departments
Graduate students may seek two Master of Science degrees simultaneously or in sequence, one awarded by the student’s home department and the other by the Department of Materials Science and Engineering. The rules governing dual degrees are found in the section detailing degree requirements under Graduate Education (p. 61). Additional information on requirements that must also be met to obtain the Master of Science degree from the Materials Science and Engineering Department is available from the department.

Doctoral Degree
All doctoral degree programs have the same foundation of required subjects:

<table>
<thead>
<tr>
<th>Doctoral Program Core Requirements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.20     Materials at Equilibrium</td>
<td>15</td>
</tr>
<tr>
<td>3.21     Kinetic Processes in Materials</td>
<td>15</td>
</tr>
<tr>
<td>3.22     Mechanical Behavior of Materials</td>
<td>12</td>
</tr>
</tbody>
</table>

The general written examination covers material in the doctoral core.

In the thesis area examination (oral presentation and examination), students are expected to learn the fundamentals of their chosen field and to develop a deep understanding of one or more of its significant aspects. Students are required to take three further subjects from an approved restricted electives list. A full range of advanced-level subjects is offered in a variety of topics, and arrangements can be made for individually planned study of any relevant topic. The thesis area examinations for the doctoral degree are designed accordingly. In addition, students are required to take a two- or three-subject minor program.

A large and active research program on the structure and properties, preparation, and processing of materials, with emphasis on ceramics, electronic materials, metals, polymers, and biomaterials, is conducted in the department. Graduate research is considered the central part of the educational process, and emphasis is placed on the research thesis. Students choose research projects from the many opportunities that exist within the department, and work closely with an individual faculty member. The results of the thesis must be of sufficient significance to warrant publication in the scientific literature.

The department maintains a large number of well-equipped research laboratories, and there is significant interaction between them, including the sharing of experimental facilities and equipment. Most department members have access to the Materials Research Laboratory, which provides and maintains excellent central facilities and interdisciplinary research opportunities as described in the section on Research and Study (p. 88).

Interdisciplinary Programs

Program in Archaeological Materials
The Department of Materials Science and Engineering offers an interdisciplinary doctoral program for individuals who wish to consider the study of archaeology and materials science and pursue research in the field of archaeological materials. Admission to the program is through the department. The program requires four core subjects—half in materials science and engineering, half in archaeology—and six additional subjects. Many of the subject requirements may be met with coursework in the Architecture; Civil and Environmental Engineering; Earth, Atmospheric, and Planetary Sciences; Mechanical Engineering; and Urban Studies and Planning departments; or in the Technology and Policy Program; the Program in Science, Technology, and Society; and the Anthropology Department at Harvard University. Field research opportunities are available, most notably in Mesoamerica and South America.
Polymers and Soft Matter
The Program in Polymers and Soft Matter (PPSM) (http://polymerscience.mit.edu) offers students from participating departments an interdisciplinary core curriculum in polymer science and engineering, exposure to the broader polymer community through seminars, contact with visitors from industry and academia, and interdepartmental collaboration while working towards a PhD or ScD degree.

Research opportunities include functional polymers, controlled drug delivery, nanostructured polymers, polymers at interfaces, biomaterials, molecular modeling, polymer synthesis, biomimetic materials, polymer mechanics and rheology, self-assembly, and polymers in energy. The program is described in more detail under Interdisciplinary Graduate Programs (p. 376).

Technology and Policy Program
The Master of Science in Technology and Policy is an engineering research degree with a strong focus on the role of technology in policy analysis and formulation. The Technology and Policy Program (TPP) curriculum provides a solid grounding in technology and policy by combining advanced subjects in the student’s chosen technical field with courses in economics, politics, and law. Many students combine TPP’s curriculum with complementary subjects to obtain dual degrees in and either a specialized branch of engineering or an applied social science such as political science or urban studies and planning. For additional information, see the program description (p. 377) under Interdisciplinary Programs or visit the program website (http://tpp.mit.edu).

Financial Support
The Department of Materials Science and Engineering offers assistantships and fellowships for graduate study. Research and teaching assistantships are available in the fields in which the department is active.

Inquiries
Additional information regarding graduate programs, admissions, and financial aid may be obtained by contacting the Academic Office (dmse-admissions@mit.edu), Room 6-107.

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Sidney Yip, PhD
Professor Emeritus of Nuclear Science and Engineering
Professor Emeritus of Materials Science and Engineering
DEPARTMENT OF MECHANICAL ENGINEERING

Mechanical engineering is concerned with the responsible development of products, processes, and power, at scales ranging from molecules to large and complex systems. Mechanical engineering principles and skills are involved at some stage during the conception, design, development, and manufacture of every human-made object with moving parts. Many innovations crucial to our future will have their roots in the world of mass, motion, forces, and energy—the world of mechanical engineers.

Mechanical engineering is one of the broadest and most versatile of the engineering professions. This is reflected in the portfolio of current activities in the Department of Mechanical Engineering (MechE), one that has widened rapidly in the past decade. Today, our faculty are involved in a wide range of projects, including designing tough hydrogels, using nanostructured surfaces for clean water and thermal management of microelectronics, developing efficient methods for robust design, the building of robotics for land and underwater exploration, creating optimization methods that autonomously generate decision-making strategies, developing driverless cars, inventing cost-effective photovoltaic cells, developing thermal and electrical energy storage systems, using acoustics to explore the ocean of one of Jupiter’s moons, studying the biomimetics of swimming fish for underwater sensing applications, developing physiological models for metastatic cancers, inventing novel medical devices, exploring 3D printing of nanostructures and macrostructures, and developing coatings to create nonstick surfaces.

The department carries out its mission with a focus on the seven areas of excellence described below. Our education and research agendas are informed by these areas, and these are the areas in which we seek to impassion the best undergraduate and graduate students.

Area 1: Mechanics: Modeling, Experimentation, and Computation (MMEC). At the heart of mechanical engineering lies the ability to measure, describe, and model the physical world of materials and mechanisms. The MMEC area focuses on teaching the fundamental principles, essential skills, and scientific tools necessary for predicting thermo-mechanical phenomena and using such knowledge in rational engineering design. We provide students with the foundations in experimental, modeling, and computational skills needed to understand, exploit, and enhance the thermo-physical behavior of advanced engineering devices and systems, and to make lifelong creative contributions at the forefront of the mechanical sciences and beyond. Research in the MMEC area focuses on four key thrusts:

- Computational mechanics
- Fluid dynamics and transport
- Mechanics of solid materials
- Nonlinear dynamics

The fundamental engineering principles embodied in these topics can be applied over a vast range of force, time, and length scales, and applications of interest in the MMEC area span the spectrum from the nano/micro world to the geophysical domain. A Course 2-A track is offered in this area.

Area 2: Design, Manufacturing, and Product Development. Design, manufacturing, and product development is the complete set of activities needed to bring new devices and technologies to the marketplace. These activities span the entire product life-cycle, from the identification of a market opportunity or need, through design, testing, manufacture and distribution, and end of useful life. Our work includes everything from understanding the voice of the customer to finding new ways of processing materials to improving product performance and tracking product flow through a distribution network. A central component of this area is the design and construction of novel equipment, either for consumer products or for industrial uses. This spans scales from meters to microns, and involves mechanical, electronic and electromechanical devices.

Many MechE students apply design, manufacturing, and product development skills and techniques to extracurricular design work for organizations and student activities such as Design that Matters, Formula SAE, Satellite Engineering Team, and the Solar Electric Vehicle Team. Some projects lead to flagship products for new companies. A Course 2-A track in product development is offered along with a unique Master of Engineering degree in manufacturing.

Area 3: Controls, Instrumentation, and Robotics. The mission in this area is to promote research and education for automating, monitoring, and manipulating systems. The focus is on system-level behavior that emerges primarily from interactions and cannot be explained from individual component behavior alone. We seek to identify fundamental principles and methodologies that enable systems to exhibit intelligent, goal-oriented behavior, and develop innovative instruments to monitor, manipulate, and control systems.

The core competencies in which we seek to excel are:

- Methodologies for understanding system behavior through physical modeling, identification, and estimation.
- Technologies for sensors and sensor networks; actuators and energy transducers; and systems for monitoring, processing, and communicating information.
- Fundamental theories and methodologies for analyzing, synthesizing, and controlling systems; learning and adapting to unknown environments; and effectively achieving task goals.

We seek to apply our core competencies to diverse areas of social, national, and global needs. These include health care, security, education, medical and security related imaging, space and ocean exploration, and autonomous systems in air, land, and underwater environments. We also offer a Course 2-A track in this area.
Area 4: Energy Science and Engineering. Energy is one of the most significant challenges facing humanity and is a central focus of mechanical engineering's contribution to society. Our research focuses on efficient and environmentally friendly energy conversion and utilization from fossil and renewable resources. Programs in the department cover many of the fundamental and technological aspects of energy, with applications to high performance combustion engines, batteries and fuel cells, thermoelectricity and photovoltaics, wind turbines, and efficient buildings. Work in very-low-temperature thermodynamics includes novel sub-Kelvin refrigeration. Efforts in high-temperature thermodynamics and its coupling with transport and chemistry include internal combustion engine analysis, design, and technology; control of combustion dynamics and emissions; thermoelectric energy conversion; low- and high-temperature fuel cells; and novel materials for rechargeable batteries and thermal energy storage. Work in heat and mass transport covers thermal control of electronics from manufacturing to end use; microscale and nanoscale transport phenomena; desalination and water purification; high heat flux engineering; and energy-efficient building technology. Work in renewable energy encompasses the design of offshore and floating wind turbines and tidal wave machines; and analysis and manufacturing of photovoltaic and thermophotovoltaic devices. Energy storage, hybrid systems, fuel synthesis, and integration of energy systems are active research areas in the department. We also offer a Course 2-A track in energy.

Area 5: Ocean Science and Engineering. The oceans cover over 70 percent of the planet’s surface and constitute a critical element in our quality of life, including the climate and the resources and food that we obtain from the sea. This area's objectives are to support the undergraduate and graduate programs in ocean engineering, including the naval construction program, the MIT/Woods Hole Oceanographic Institution Joint Program in Applied Oceanography and the Course 2-Œ degree in mechanical and ocean engineering. It also serves as the focus point of ocean-related research and education at MIT. Major current research activities include marine robotics and navigation of underwater vehicles and smart sensors for ocean mapping and exploration; biomimetics to extract new understanding for the development of novel ocean systems studying marine animals; the study of the mechanics and fluid mechanics of systems for ultradepth ocean gas and oil extraction; ocean wave and offshore wind energy extraction; the free surface hydrodynamics of ocean-going vehicles; the development of advanced naval and commercial ships and submersibles, including the all-electric ship; the mechanics and crashworthiness of ocean ships and structures; ocean transportation systems; ocean acoustics for communication, detection, and mapping in the ocean; and adaptive sampling and multidisciplinary forecasting of the ocean behavior. The design of complex ocean systems permeates all these areas and provides the cohesive link for our research and teaching activities.

Area 6: Bioengineering. Engineering analysis, design, and synthesis are needed to understand biological processes and to harness them successfully for human use. Mechanical forces and structures play an essential role in governing the function of cells, tissues, and organs. Our research emphasizes integration of molecular-to-systems—level approaches to probe the behavior of natural biological systems, and to design and build new systems, ranging from analysis of gene regulatory networks to microfluidic assays for drug screening or new technologies for quantitative, high-throughput biomedical imaging. Emphasis is also placed on creating new physiological or disease models, including multicellular engineered living systems, using nano- and micro-fabrication as well as new biomaterials. Applications include understanding, diagnosing, and treating diseases such as atherosclerosis, osteoarthritis, spinal cord injury or liver failure; new tools for drug discovery and drug development; and tissue-engineered scaffolds and devices for in vivo regeneration of tissues and organs. Work also includes design and fabrication of new devices and tools for rehabilitation of stroke victims and for robotic surgery. We offer many elective subjects at the undergraduate and graduate levels, as well as a bioengineering track in Course 2-A.

Area 7: Nano/Micro Science and Technology. The miniaturization of devices and systems of ever-increasing complexity has been a fascinating and productive engineering endeavor during the past few decades. Near and long term, this trend will be amplified as physical understanding of the nano world expands, and widespread commercial demand drives the application of manufacturing to micro- and nanosystems. Micro- and nanotechnology can have tremendous impact on a wide range of mechanical systems. Examples include microelectromechanical system (MEMS) devices and products that are already deployed as automobile airbag sensors, smart phone parts, and for drug delivery; stronger and lighter nanostructured materials now used in airplanes and automobiles; and nanostructured energy conversion devices that significantly improve the efficiency of renewable energy systems. Research in this area cuts across mechanical engineering and other disciplines. Examples include sensors and actuators; micro-fluidics, heat transfer, and energy conversion at the micro- and nanoscales; optical and biological micro- and nano-electromechanical systems (MEMS and NEMS); engineered nanomaterials; atomic scale precision engineering; and the nano-photonics in measurement, sensing, and systems design. Students interested in micro/nano technology are encouraged to explore the Course 2-A nanoengineering track.

In order to prepare the mechanical engineers of the future, the department has developed undergraduate and graduate educational programs of the depth and breadth necessary to address the diverse and rapidly changing technological challenges that society faces. Our educational programs combine the rigor of academic study with the excitement and creativity inherent to innovation and research.
**Undergraduate Study**

The Department of Mechanical Engineering (MechE) offers three programs of undergraduate study. The first of these, the traditional program that leads to the bachelor’s degree in mechanical engineering, is a more structured program that prepares students for a broad range of career choices in the field of mechanical engineering. The second program leads to a bachelor’s degree in engineering and is intended for students whose career objectives require greater flexibility. It allows them to combine the essential elements of the traditional mechanical engineering program with study in another, complementary field. The third program, in mechanical and ocean engineering, is also a structured program for students interested in mechanical engineering as it applies to the engineering aspects of ocean science, exploration, and utilization, and of marine transportation.

All of the educational programs in the department prepare students for professional practice in an era of rapidly advancing technology. They combine a strong base in the engineering sciences (mechanics, materials, fluid and thermal sciences, systems and control) with project-based laboratory and design experiences. All strive to develop independence, creative talent, and leadership, as well as the capability for continuing professional growth.

**Bachelor of Science in Mechanical Engineering (Course 2)**

The program in mechanical engineering provides a broad intellectual foundation in the field of mechanical engineering. The program develops the relevant engineering fundamentals, includes various experiences in their application, and introduces the important methods and techniques of engineering practice.

The educational objectives of the program leading to the degree Bachelor of Science in Mechanical Engineering (p. 417) are that:

Within a few years of graduation, a majority of our graduates will have completed or be progressing through top graduate programs; advancing in leadership tracks in industry, non-profit organizations, or the public sector; or pursuing entrepreneurial ventures. In these roles they will: (1) apply a deep working knowledge or technical fundamentals in areas related to mechanical, electromechanical, and thermal systems to address needs of the customer and society; (2) develop innovative technologies and find solutions to engineering problems; (3) communicate effectively as members of multidisciplinary teams; (4) be sensitive to professional and societal contexts and committed to ethical action; (5) lead in the conception, design, and implementation of new products, processes, services, and systems.

Students are urged to contact the MechE Undergraduate Office as soon as they have decided to enter mechanical engineering so that a faculty advisor may be assigned. Students, together with their faculty advisors, plan a program that best utilizes the departmental electives and the 48 units of unrestricted electives available in the Course 2 degree program.

This program is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org) as a mechanical engineering degree.

**Bachelor of Science in Engineering as Recommended by the Department of Mechanical Engineering (Course 2-A)**

Course 2-A is designed for students whose academic and career goals demand greater breadth and flexibility than are allowed under the mechanical engineering program, Course 2. To a large extent, the 2-A program allows students an opportunity to tailor a curriculum to their own needs, starting from a solid mechanical engineering base. The program combines a rigorous grounding in core mechanical engineering topics with an individualized course of study focused on a second area that the student designs with the help and approval of the 2-A faculty advisor. The program leads to the degree Bachelor of Science in Engineering as Recommended by the Department of Mechanical Engineering.

This program is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org) as an engineering degree.

The educational objectives of the program leading to the degree Bachelor of Science in Engineering as recommended by the Department of Mechanical Engineering (p. 409) are that:

Within a few years of graduation, a majority of our graduates will have completed or be progressing through top graduate programs; advancing in leadership tracks in industry, non-profit organizations, or the public sector; or pursuing entrepreneurial ventures. In these roles they will: (1) apply a deep working knowledge or technical fundamentals in areas related to mechanical, electromechanical, and thermal systems to address needs of the customer and society; (2) develop innovative technologies and find solutions to engineering problems; (3) communicate effectively as members of multidisciplinary teams; (4) be sensitive to professional and societal contexts and committed to ethical action; (5) lead in the conception, design, and implementation of new products, processes, services, and systems.

A significant part of the 2-A curriculum consists of electives chosen by the student to provide in-depth study of a field of the student’s choosing. A wide variety of popular concentrations are possible in which well-selected academic subjects complement a foundation in mechanical engineering and general Institute requirements. Some examples of potential concentrations include robotics, engineering management, product development, biomedical engineering and pre-medicine, energy conversion engineering, sustainable development, architecture and building technology, and any of the seven departmental focus areas mentioned above. The MechE faculty have developed specific recommendations in some of these...
areas; details are available from the MechE Undergraduate Office and on the departmental website.

Concentrations are not limited to those listed above. Students are encouraged to design and propose technically oriented concentrations that reflect their own needs and those of society.

The student's overall program must contain a total of at least one and one-half years of engineering content (150 units) appropriate to the student's field of study. The required core and second-level subjects include approximately 78 units of engineering topics. The self-designed concentration must include at least 72 more units of engineering topics. While engineering topics are usually covered through engineering subjects, subjects outside the School of Engineering may provide material essential to the engineering program of some concentrations. For example, management subjects usually form an essential part of an engineering management concentration. In all cases, the relationship of concentration subjects to the particular theme of the concentration must be obvious.

To pursue the 2-A degree, students must submit the online 2-A enrollment form no later than Add Date of their second term in the program.

**Bachelor of Science in Mechanical and Ocean Engineering (Course 2-OE)**

This program is intended for students who are interested in combining a firm foundation in mechanical engineering with a specialization in ocean engineering. The program includes engineering aspects of the ocean sciences, ocean exploration, and utilization of the oceans for transportation, defense, and extracting resources. Theory, experiment, and computation of ocean systems and flows are covered in a number of subjects, complementing a rigorous mechanical engineering program; a hands-on capstone design class allows students to master the design of advanced marine systems, including autonomous underwater vehicles and smart sensors.

This program is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org) in both mechanical engineering and ocean engineering.

The educational objectives of the program leading to the degree Bachelor of Science in Mechanical and Ocean Engineering (p. 416) are that within a few years of graduation, a majority of our graduates will have completed or be progressing through top graduate programs; advancing in leadership tracks in industry, non-profit organizations, or the public sector; or pursuing entrepreneurial ventures. In these roles they will: (1) apply a deep working knowledge or technical fundamentals in areas related to mechanical, electromechanical, and thermal systems to address needs of the customer and society; (2) develop innovative technologies and find solutions to engineering problems; (3) communicate effectively as members of multidisciplinary teams; (4) be sensitive to professional and societal contexts and committed to ethical action; (5) lead in the conception, design, and implementation of new products, processes, services, and systems.

Graduates have exciting opportunities in offshore industries, naval architecture, the oceanographic industry, the Navy or government, or for further study in graduate school.

**Minor in Mechanical Engineering**

Students pursuing a minor in the department must complete a total of six 12-unit subjects in the Mechanical Engineering Department program. At least three of the subjects must be selected from among the required subjects for the Course 2 and Course 2-OE degree programs, which are listed below. In addition, two subjects may be selected from restricted electives in those programs.

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03</td>
<td>Differential Equations 1</td>
<td>12</td>
</tr>
<tr>
<td>2.001</td>
<td>Mechanics and Materials I</td>
<td></td>
</tr>
<tr>
<td>2.002</td>
<td>Mechanics and Materials II</td>
<td></td>
</tr>
<tr>
<td>2.003</td>
<td>Dynamics and Control I</td>
<td></td>
</tr>
<tr>
<td>2.004</td>
<td>Dynamics and Control II</td>
<td></td>
</tr>
<tr>
<td>2.005</td>
<td>Thermal-Fluids Engineering I</td>
<td></td>
</tr>
<tr>
<td>2.006</td>
<td>Thermal-Fluids Engineering II</td>
<td></td>
</tr>
<tr>
<td>2.007</td>
<td>Design and Manufacturing I</td>
<td></td>
</tr>
<tr>
<td>2.008</td>
<td>Design and Manufacturing II</td>
<td></td>
</tr>
<tr>
<td>2.009</td>
<td>The Product Engineering Process</td>
<td></td>
</tr>
<tr>
<td>2.017</td>
<td>Design of Electromechanical Robotic Systems</td>
<td></td>
</tr>
<tr>
<td>2.019</td>
<td>Design of Ocean Systems</td>
<td></td>
</tr>
<tr>
<td>2.612</td>
<td>Marine Power and Propulsion</td>
<td></td>
</tr>
<tr>
<td>2.086</td>
<td>Numerical Computation for Mechanical Engineers</td>
<td></td>
</tr>
<tr>
<td>2.671</td>
<td>Measurement and Instrumentation</td>
<td></td>
</tr>
</tbody>
</table>

Select two additional subjects from the required subjects or restricted electives for either Course 2 or Course 2-OE.

| Total Units | 72 |

1. 18.032 Differential Equations is also an acceptable option. Consult department for other alternatives.
2. For information about restricted electives in these programs, please refer to the department's website (http://meche.mit.edu/academic/undergraduate/mechminor).

**Inquiries**

Further information on undergraduate programs may be obtained from the MechE Undergraduate Office (me-undergradoffice@mit.edu), Room 1-110, 617-253-2305, and from the downloadable Guide to the Undergraduate Program in Mechanical Engineering (http://web.mit.edu/me-ugoffice/gamed.pdf).
Graduate Study

The Department of Mechanical Engineering (MechE) provides opportunities for graduate work leading to the following degrees: Master of Science in Mechanical Engineering, Master of Science in Ocean Engineering, Master of Science in Naval Architecture and Marine Engineering, Master of Science in Oceanographic Engineering, Master of Engineering in Manufacturing, degree of Mechanical Engineer, degree of Naval Engineer, and the Doctor of Philosophy (PhD) or Doctor of Science (ScD), which differ in name only.

The Master of Engineering in Manufacturing degree is a 12-month professional degree intended to prepare students for technical leadership in the manufacturing industries.

The Mechanical Engineer's and Naval Engineer's degrees offer preparation for a career in advanced engineering practice through a program of advanced coursework that goes well beyond the master's level. These degrees are not a stepping stone to the PhD.

The Doctor of Philosophy (or Science), the highest academic degree offered, is awarded upon the completion of a program of advanced study and significant original research, design, or development.

Admission Requirements for Graduate Study

Applications to the mechanical engineering graduate program are accepted from persons who have completed, or will have completed by the time they arrive, a bachelor's degree if they are applying for a master's degree, or a master's degree if they are applying for a PhD. Most incoming students have a degree in mechanical engineering or ocean engineering, or some related branch of engineering. The department's admission criteria are not specific, however, and capable students with backgrounds in different branches of engineering or in science may gain entry. Nevertheless, to qualify for a graduate degree, the candidate is expected to have had at least an undergraduate-level exposure to the core subject areas in mechanical engineering (applied mechanics, dynamics, fluid mechanics, thermodynamics, materials, control systems, and design) and to be familiar with basic electrical circuits and electromagnetic field theory.

Applications for September entry are due on December 15 of the previous year and decisions are reported in March. International students applying from abroad may be admitted, but they will be allowed to register only if they have full financial support for the first year.

All applicants to the graduate program in mechanical engineering must submit the GRE test results. International students whose native language is not English are required to take either the International English Language Testing System (IELTS) exam and receive a minimum score of 7 or the TOEFL exam with a minimum acceptable score of 577 (PBT), 233 (CBT) or 100 (IBT).

Early Admission to Master's Degree Programs in Mechanical Engineering

At the end of the junior year, extraordinarily qualified students in the Department of Mechanical Engineering will be invited to apply for early admission to the graduate program. Students who are admitted will then be able to enroll in core graduate subjects during the senior year and to find a faculty advisor who is willing to start and supervise research for the master's thesis while the student is still in the senior year. With the consent of the faculty advisor, the student may also use a portion of the work conducted towards the master's thesis in the senior undergraduate year to satisfy the requirements of the bachelor's thesis.

Writing Ability Requirement

The Mechanical Engineering Department requires that all incoming graduate students demonstrate satisfactory English writing ability, or successfully complete appropriate training in writing. This requirement reflects the faculty's conviction that writing is an essential skill for all engineers. All incoming graduate students, native as well as international, must take the departmental writing ability test, which is administered online in June. Depending on the results, a student will either pass or be required to take a short course during the Independent Activities Period (p. 43) in January.

Master of Science in Mechanical Engineering

To qualify for the Master of Science in Mechanical Engineering, a student must complete at least 72 credits of coursework, not including thesis. Of these, at least 48 must be graduate subjects (refer to the Guide to Graduate Study [http://meche.mit.edu/documents/MechE_Grad_Guide.pdf] on the MechE website). The remainder of the 72 units may include advanced undergraduate subjects that are not requirements in the undergraduate mechanical engineering curriculum.

At least three of the graduate subjects must be taken in mechanical engineering sciences (refer to the Guide to Graduate Study [http://meche.mit.edu/documents/MechE_Grad_Guide.pdf] on the MechE website). Students must take at least one graduate mathematics subject (12 units) offered by the MIT Mathematics Department. For the Master of Science in Oceanographic Engineering, see also the requirements listed in the Joint Program with Woods Hole Oceanographic Institution.

Finally, a thesis is required. The thesis is an original work of research, development, or design, performed under the supervision of a faculty or research staff member, and is a major part of any graduate program in the Mechanical Engineering Department. A master's student usually spends as much time on thesis work as on coursework. A master's degree usually takes about one and one-half to two years to complete.
Master of Science in Ocean Engineering/Master of Science in Naval Architecture and Marine Engineering/Master of Science in Oceanographic Engineering
The requirements for each of these three degrees are that the student takes 72 credit units of graduate subjects and complete a thesis.

At least three of the subjects must be chosen from a prescribed list of ocean engineering subjects (refer to the Guide to Graduate Study on the MechE website). Students must also take at least one graduate mathematics subject (12 units) offered by MIT's Mathematics Department. For the Master of Science in Oceanographic Engineering, see also the requirements listed under the Joint Program with Woods Hole Oceanographic Institution.

The required thesis is an original work of research, development, or design, conducted under the supervision of a faculty or senior research staff member. The thesis usually takes between one and two years to complete.

Master of Engineering in Manufacturing
The Master of Engineering in Manufacturing (http://web.mit.edu/meng-manufacturing) is a 12-month professional degree in mechanical engineering that is intended to prepare the student to assume a role of technical leadership in the manufacturing industries. The degree is aimed at practitioners who will use this knowledge to become leaders in existing, as well emerging, manufacturing companies. To qualify for this degree, a student must complete a highly integrated set of subjects and projects that cover the process, product, system, and business aspects of manufacturing, totaling 90 units, plus complete a group-based thesis project with a manufacturing industry. While centered in engineering and firmly grounded in the engineering sciences, this degree program considers the entire enterprise of manufacturing. Students will gain both a broad understanding of the many facets of manufacturing and a knowledge of manufacturing fundamentals from which to build new technologies and businesses. The admission process is identical to that of the Master of Science degree, with the exception that two additional essay questions are required.

Mechanical Engineer's Degree
The Mechanical Engineer's degree provides an opportunity for further study beyond the master's level for those who wish to enter engineering practice rather than research. This degree emphasizes breadth of knowledge in mechanical engineering and its economic and social implications, and is quite distinct from the PhD, which emphasizes depth and originality of research.

The engineer's degree requires a broad program of advanced coursework in mechanical engineering totaling at least 162 credit units (typically about 14 subjects), including those taken during the master's degree program. The engineer's degree program is centered around the application of engineering principles to advanced engineering problems and includes a Mechanical Engineering examination and an applications-oriented thesis, which may be an extension of a suitable master's thesis. An engineer's degree typically requires at least one year of study beyond the master's degree.

Naval Engineer's Degree—Program in Naval Construction and Engineering
The Naval Construction and Engineering (NVE) program provides US Navy and US Coast Guard officers, foreign naval officers, and civilian students interested in ships and ship design a broad graduate-level education for a career as a naval engineer.

The program leads to the Naval Engineer's degree, which requires a higher level of professional competence and broader range of knowledge than is required for the degree of Master of Science in Naval Architecture and Marine Engineering or Ocean Engineering. Subjects in the areas of economics, industrial management, and public policy and law, and at least 12 units of comprehensive design are required, in addition to an in-depth curriculum that includes naval architecture, hydrodynamics, ship structures, materials science, and power and propulsion. The program is appropriate for naval officers and civilians who plan to participate in the design and construction of naval ships, as well as those interested in commercial ship design.

For students working toward a simultaneous Naval Engineer's degree and a master's degree, a single thesis is generally acceptable, provided it is appropriate to the specifications of both degrees, demonstrating an educational maturity expected of the Naval Engineer's degree.

Doctor of Philosophy and Doctor of Science
The highest academic degree is the Doctor of Science, or Doctor of Philosophy (the two differ only in name). This degree is awarded upon the completion of a program of advanced study, and the performance of significant original research, design, or development. Doctoral degrees are offered in all areas represented by the department's faculty.

Students become candidates for the doctorate by passing the doctoral qualifying examinations. The doctoral program includes a major program of advanced study in the student's principal area of interest, and a minor program of study in a different field. The MechE Graduate Office should be consulted about the deadline for passing the qualifying exam.

The principal component of the program is the thesis. The thesis is a major, original work that makes a significant research, development, or design contribution in its field. The thesis and the program of study are done under a faculty supervisor and a doctoral committee selected by the student and his or her supervisor, and perhaps other interested faculty members. The committee makes an annual examination of the candidate’s progress and makes a final
recommendation for a public defense of the work. The doctoral program typically requires three years of work beyond the master’s degree, although this time is strongly topic dependent. In concert with the Center for Computational Engineering (CCE), the department also offers a doctoral program in Computational Science and Engineering (ME-CSE). The program enables students to specialize at the doctoral level in a computation-related field of their choice through focused coursework and a doctoral thesis which makes extensive use of sophisticated computation or develops new computational methods. The ME-CSE PhD degree highlights this specialization by using the thesis field “Mechanical Engineering and Computation.” More information can be found at the CEE website (http://cce.mit.edu).

Interdisciplinary Programs
Graduate students registered in the Department of Mechanical Engineering may elect to participate in interdisciplinary programs of study.

Computation for Design and Optimization
The Computation for Design and Optimization (CDO) (http://computationalengineering.mit.edu/education) program offers a master’s degree to students interested in the analysis and application of computational approaches to designing and operating engineered systems. The curriculum is designed with a common core serving all engineering disciplines and an elective component focusing on specific applications. Current MIT graduate students may pursue a CDO master’s degree in conjunction with a department-based master’s or PhD program. For more information, see the full program description (p. 368) under Interdisciplinary Graduate Programs.

Computational Science and Engineering
The Computational Science and Engineering (CSE) (http://computationalengineering.mit.edu/education) program allows students to specialize at the doctoral level in a computation-related field of their choice through focused coursework and a doctoral thesis through a number of participating host departments. The CSE program is administered jointly by the Center for Computational Engineering (CCE) and the host departments, with the emphasis of thesis research activities being the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science. For more information, see the full program description (p. 370) under Interdisciplinary Graduate Programs.

Joint Program with the Woods Hole Oceanographic Institution
The Joint Program with the Woods Hole Oceanographic Institution (WHOI) (http://mit.whoi.edu) is intended for students whose primary career objective is oceanography or oceanographic engineering. Students divide their academic and research efforts between the campuses of MIT and WHOI. Joint Program students are assigned an MIT faculty member as academic advisor; thesis research may be supervised by MIT or WHOI faculty. While in residence at MIT, students follow a program similar to that of other students in their home department. The program is described in more detail under Interdisciplinary Graduate Programs (p. 372).

Leaders for Global Operations
The 24-month Leaders for Global Operations (LGO) (http://lgo.mit.edu) program combines graduate degrees in engineering and management for those with previous postgraduate work experience and strong undergraduate degrees in a technical field. During the two-year program, students complete a six-month internship at one of LGO’s partner companies, where they conduct research that forms the basis of a dual-degree thesis. Students finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of seven engineering programs, some of which have optional or required LGO tracks. After graduation, alumni take on leadership roles at top global manufacturing and operations companies.

Polymers and Soft Matter
The Program in Polymers and Soft Matter (PPSM) (http://polymerscience.mit.edu) offers students from participating departments an interdisciplinary core curriculum in polymer science and engineering, exposure to the broader polymer community through seminars, contact with visitors from industry and academia, and interdepartmental collaboration while working towards a PhD or ScD degree.

Research opportunities include functional polymers, controlled drug delivery, nanostructured polymers, polymers at interfaces, biomaterials, molecular modeling, polymer synthesis, biomimetic materials, polymer mechanics and rheology, self-assembly, and polymers in energy. The program is described in more detail under Interdisciplinary Graduate Programs (p. 376).

Technology and Policy
The Master of Science in Technology and Policy is an engineering research degree with a strong focus on the role of technology in policy analysis and formulation. The Technology and Policy Program (TPP) (http://tpp.mit.edu) curriculum provides a solid grounding in technology and policy by combining advanced subjects in the student’s chosen technical field with courses in economics, politics, quantitative methods, and social science. Many students combine TPP’s curriculum with complementary subjects to obtain dual degrees in TPP and either a specialized branch of engineering or an applied social science such as political science or urban studies and planning. For additional information, see the program description under the Institute for Data, Systems, and Society (p. 181).

Financial Support
The Department of Mechanical Engineering offers three types of financial assistance to graduate students: research assistantships, teaching assistantships, and fellowships.

The majority of students in the department are supported by research assistantships (RAs), which are appointments to work
on particular research projects with particular faculty members. Faculty members procure research grants for various projects and hire graduate students to carry out the research. The research is almost invariably structured so that it becomes the student’s thesis. An RA appointment provides a full-tuition scholarship (i.e., covers all tuition) plus a salary that is adequate for a single person. The financial details are outlined in a separate handout available from the MechE Graduate Office. An RA may register for a maximum of 24 units (about two subjects) of classroom subjects per regular term and 12 units in the summer term, and must do at least the equivalent of 24 units of thesis (i.e., research on the project) per term. (Please note that Master of Engineering in Manufacturing students are not eligible for RA or TA positions since their subject credits exceed these limits.)

Teaching assistants (TAs) are appointed to work on specific subjects of instruction. As the name implies, they usually assist a faculty member in teaching, often grading homework problems and tutoring students. In the Mechanical Engineering Department, TAs are very seldom used for regular full-time classroom teaching. Full-time TAs are limited to 24 units of credit per regular term, including both classroom subjects and thesis. The TA appointment does not usually extend through the summer.

A fellowship provides the student with a direct grant, and leaves the student open to select his or her own research project and supervisor. A limited number of awards and scholarships are available to graduate students directly through the department. A number of students are also supported by fellowships from outside agencies, such as the National Science Foundation, Office of Naval Research, and Department of Defense. Scholarships are awarded each year by the Society of Naval Architects and Marine Engineers. These awards are normally granted to applicants whose interest is focused on naval architecture and marine engineering or on ocean engineering. Applications are made directly to the granting agency, and inquiries for the fall term should be made in the preceding fall term.

Prospective students are invited to communicate with the Department regarding any of these educational and financial opportunities.

Experience has shown that the optimum graduate program consists of about equal measures of coursework and research, consistent with an RA appointment. The main advantage of a fellowship is a greater freedom in choosing a research project and supervisor. A teaching assistantship gives the student teaching experience and can also be extremely valuable for reviewing basic subject material—for example, in preparation for the doctoral qualifying exams. It does not, however, leave much time for thesis research and may extend the time that the student needs to complete his or her degree.

**Inquiries**

For additional information on mechanical engineering graduate admissions, contact Una Sheehan. For general inquiries on the mechanical engineering graduate program, contact Leslie Regan. All can be reached in the MechE Graduate Office (megradoffice@mit.edu), Room 1-112, 617-253-2291.

**Research Laboratories and Programs**

The Mechanical Engineering Department is organized into seven areas that collectively capture the broad range of interests and activities within it. These areas are:

- Mechanics: Modeling, Experimentation, and Computation (MMEC)
- Design, Manufacturing, and Product Development
- Controls, Instrumentation, and Robotics
- Energy Science and Engineering
- Ocean Science and Engineering
- Bioengineering
- Nano/Micro Science and Technology

The educational opportunities offered to students in mechanical engineering are enhanced by the availability of a wide variety of research laboratories and programs, and well-equipped shops and computer facilities.

The department provides many opportunities for undergraduates to establish a close relationship with faculty members and their research groups. Students interested in project work are encouraged to consult their faculty advisor or approach other members of the faculty.

Many members of the Department of Mechanical Engineering participate in interdepartmental or school-wide research activities. These include the Center for Biomedical Engineering, Center for Computational Engineering, Center for Materials Science and Engineering, Computation for Design and Optimization Program, Computational and Systems Biology Program, Computer Science and Artificial Intelligence Laboratory, Institute for Soldier Nanotechnologies, Laboratory for Manufacturing and Productivity, MIT Energy Initiative, Operations Research Center, Program in Polymers and Soft Matter, and Sea Grant College Program. Detailed information about many of these can be found under Research and Interdisciplinary Graduate Programs. The department also hosts a number of industrial consortia, which support some laboratories and research projects. Research in the department is supported, in addition, by a broad range of federal agencies and foundations.

A partial list of departmental laboratories, listed according to the seven core areas of research, follows.
**Mechanics: Modeling, Experimentation, and Computation**

**AMP Mechanical Behavior of Materials Laboratory**
Mechanisms of deformation and fracture processes in engineering materials.

**Center for Nonlinear Science**
Interdisciplinary research into nonlinear phenomena. Incorporates the Nonlinear Dynamical Systems Lab (modeling, simulation, analysis), Nonlinear Dynamics Lab (experiments), and Nonlinear Systems Lab.

**Composite Materials and Nondestructive Evaluation Laboratory**
Development of quantitative nondestructive evaluation characterizations which are directly correlatable with the mechanical properties of materials and structures.

**Finite Element Research Group**
Computational procedures for the solution of problems in structural, solid, and fluid mechanics.

**Hatsopoulos Microfluids Laboratory**
Fundamental research on the behavior of complex fluid systems at microscopic scales, and associated engineering applications.

**Design, Manufacturing, and Product Development**

**Auto-ID Laboratory**
Creation of the “Internet of Things” using radio frequency identification and wireless sensor networks, and of a global system for tracking goods using a single numbering system called the Electronic Product Code.

**Computer-Aided Design Laboratory**
Advancing the state of the art in design methodology and computer-aided design methods.

**Laboratory for Manufacturing and Productivity**
An interdepartmental laboratory in the School of Engineering. Polymer microfabrication for microfluidic devices, chemical mechanical planarization for the semiconductor industry, precision macro- and micro-scale devices, and novel metrology methods for micro-scale devices. Small-scale fuel cells design, photovoltaic material and process research, and manufacture of photovoltaic panels. Identification technologies such as RFID, wireless sensors, and complex systems. Methods to integrate data and models across global networks. Factory-level manufacturing systems design and control, and supply chain design and management. Environmentally benign manufacturing.

**Martin Center for Engineering Design**
Design methodology, design of integrated electrical-mechanical systems, prototype development, advanced computer-aided design techniques.

**Park Center for Complex Systems**
Research to understand complexity, educating students and scholars on complexity, designing complex systems for the benefit of humankind, and disseminating knowledge on complexity to the world at large.

**Precision Engineering Laboratory**
Fundamental and applied research on all aspects of the design, manufacture, and control of high precision machines ranging from manufacturing machines to precision consumer products.

**Precision Systems Design and Manufacturing Laboratory**
Modeling, design, and manufacturing methods for nanoscale positioning equipment, carbon nanotube-based mechanisms and machines, and compliant mechanisms.

**Controls, Instrumentation, and Robotics**

**d'Arbeloff Laboratory for Information Systems and Technology**
Research on mechatronics, home and health automation, interface between hardware and software, and development of sensing technologies.

**Field and Space Robotics Laboratory**
Fundamental physics of robotic systems for unstructured environments. Development, design, and prototyping of control and planning algorithms for robotic applications, including space exploration, rough terrains, sea systems, and medical devices and systems.

**Nonlinear Systems Laboratory**
Analysis and control of nonlinear physical systems with emphasis on adaptation and learning in robots.

**Energy Science and Engineering**

**Center for Energy and Propulsion Research**
Innovative science and technology for a sustainable energy future in a carbon-constrained world. Fundamental and applied research in energy conversion and transportation, with applications to low-carbon efficient energy and propulsion systems. Includes several research groups:

- **Electrochemical Energy Laboratory.** Engineering of advanced materials for lithium batteries, proton exchange membrane and solid oxide fuel cells, and air battery and fuel cell hybrids.
- **Reacting Gas Dynamics Laboratory.** Fluid flow, chemical reaction, and combustion phenomena associated with energy
conversion in propulsion systems, power generation, industrial processes, and fires.

- **Sloan Automotive Laboratory.** Processes and technology that control the performance, efficiency, and environmental impact of internal combustion engines, their lubrication, and fuel requirements.

**Cryogenic Engineering Laboratory**

Application of thermodynamics, heat transfer, and mechanical design to cryogenic processes and instrumentation and the operation of a liquid helium facility.

**Rohsenow Kendall Heat Transfer Laboratory**

Fundamental research in microscale/nanoscale transport, convection, laser/material interaction, and high heat fluxes; applied research in water purification, thermoelectric devices, energy-efficient buildings, and thermal management of electronics.

**Ocean Science and Engineering**

**Center for Ocean Engineering**

Provides an enduring ocean engineering identity, giving visibility to the outside world of MIT’s commitment to the oceans, and serves as the focus point of ocean-related research at the Institute. Supports the research activities of the MIT-WHOI Joint Program in Oceanographic Engineering and the Naval Construction and Engineering Program. Encompasses the activities of the following research groups and laboratories:

- **Autonomous Marine Sensing Lab.** Distributed ocean sensing concepts for oceanographic science, national defense, and coastal management and protection. Oceanographic sensing and modeling, sonar system technology, computational underwater acoustics, and marine robotics and communication networking.

- **Design Lab.** Ship design, offshore structure design, marine robotics, geometric and solid modeling, advanced manufacturing, and shipbuilding. Includes the Center for Environmental Sensing and Modeling.

- **Experimental Hydrodynamics Lab.** Advanced surface ship, offshore platform, and underwater vehicle design. Development of non-invasive flow measurement and visualization methods.

- **Impact and Crashworthiness Laboratory.** Industry-oriented fracture testing and prediction technology of advanced high-strength steel sheets for automotive and shipbuilding applications. Includes both quasi-static and high strain rate response and effect of loading history on fracture.

- **Experimental and Nonlinear Dynamics Lab.** Laboratory experiments to obtain insight into all manner of dynamical phenomena, from micro-scale diffusive processes to global-scale oceanic wave fields. Field studies for ocean-related problems.

- **Laboratory for Ship and Platform Flows.** Modeling of free surface flows past conventional and high-speed vessels and estimation of their resistance and seakeeping in deep and shallow waters. Analytical and computational techniques.

- **Laboratory for Undersea Remote Sensing.** Ocean exploration, undersea remote sensing of marine life and geophysical phenomena, wave propagation and scattering theory in remote sensing, statistical estimation and information theory, acoustics and seisms, Europa exploration.

- **Marine Hydrodynamics Laboratory (Propeller Tunnel).** A variable-pressure recirculating water tunnel capable of speeds up to 10 m/s. Experiments are performed using state-of-the-art measurement techniques and instrumentation.

- **Multidisciplinary Ocean Dynamics and Engineering Laboratory.** Complex physical and interdisciplinary oceanic dynamics and processes. Mathematical model and computation methods for ocean predictions, dynamical diagnostics, and for data assimilation and data-model comparisons.

- **Ocean Engineering Testing Tank.** The tank is 108 feet long, 8.5 feet wide, with an average depth of 4.5 feet. The wave generator can generate harmonic or random waves. The tank also houses several laser flow visualization systems.

- **Vortical Flow Research Laboratory.** Advanced capabilities for simulation of complex vertical flows. Powerful computer workstations and LINUX clusters, computer-video image conversion, and state-of-the-art flow simulation animation technologies.

- **MIT Sea Grant AUV Lab.** Dedicated to autonomous underwater vehicles (AUVs), the lab is a leading developer of advanced unmanned marine robots, with applications in oceanography, environmental monitoring, and underwater resource studies. It engages in instrumentation and algorithm development for underwater vehicles performing navigation- and information-intensive tasks. Various vehicle platforms, and fabrication tools and materials are available.

**Bioengineering**

**Bioinstrumentation Laboratory**

Utilization of biology, optics, mechanics, mathematics, electronics, and chemistry to develop innovative instruments for the analysis of biological processes and new devices for the treatment and diagnosis of disease.

**Human and Machine Haptics**

Interdisciplinary studies aimed at understanding human haptics, developing machine haptics, and enhancing human-machine interactions in virtual reality and teleoperator systems.

**Laboratory for Biomechanics of Cells and Biomolecules**

Development of new instruments for the measurement of mechanical properties on the scale of a single cell or single molecule to better understand the interactions between biology and mechanics.
Newman Laboratory for Biomechanics and Human Rehabilitation
Research on bioinstrumentation, neuromuscular control, and technology for diagnosis and remediation of disabilities.

Nano/Micro Science and Technology

Pappalardo Laboratory for Micro/Nano Engineering
Creation of new engineering knowledge and products on the nano and micro scale through multidomain, multidisciplinary, and multiscale research.

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DEPARTMENT OF NUCLEAR SCIENCE AND ENGINEERING

The Department of Nuclear Science and Engineering (NSE) provides undergraduate and graduate education for students interested in developing new nuclear technologies for the benefit of society and the environment.

This is an exciting time to study nuclear science and engineering. There is an upsurge of innovative activity in the field, including a drastic increase in nuclear start-up companies, as energy resource constraints, security concerns, and the risks of climate change are creating new demands for safe, secure, cost-competitive nuclear energy systems. At the same time, powerful new tools for exploring, measuring, modeling, and controlling complex nuclear and radiation processes are laying the foundations for major advances in the application of nuclear technologies in medicine and industry as well as in fundamental science.

In response to these developments, the department has created programs of study that prepare students for scientific and engineering leadership roles in energy and non-energy applications of nuclear science and technology. Applications include nuclear fission energy systems, fusion energy systems, and systems for securing nuclear materials against the threats of nuclear proliferation and terrorism. Underlying these applications are core fields of education and research, including low-energy nuclear physics; plasma physics; thermal sciences; radiation sources, detection, and control; the study of materials in harsh chemomechanical, radiation, and thermal environments; and advanced computation and simulation.

Students in nuclear science and engineering study the scientific fundamentals of the field, engineering methods for integrating these fundamentals into practical systems, and the interactions of nuclear systems with society and the environment. Undergraduate and graduate students take core subjects in the field and can then select from a wide variety of application areas through more specialized subjects.

Principal areas of research and education in the department are described below.

Nuclear Fission Energy. Nuclear reactors, utilizing the fission of heavy elements such as uranium, supply approximately 13% of the world’s electricity, powering grids, ships and submarines. They produce radioisotopes for medical, biological, and industrial uses, and for long-lived on-board power sources for spacecraft. They can also provide energy for chemical and industrial processing and portable fuel production (e.g., synthetic fuels or hydrogen).

Electricity generation is the most familiar application. In some countries, the fraction of electricity obtained from nuclear power exceeds 50%. In the United States, 100 nuclear power plants supply almost 20% of the nation’s electricity. Thirty countries generate nuclear power today, and more than 40 others have recently expressed an interest in developing new nuclear energy programs. Nuclear power is the only low-carbon energy source that is both inherently scalable and already generating a significant share of the world’s electricity supplies. Fission technology is entering a new era in which upgraded existing plants, next-generation reactors, and new fuel cycle technologies and strategies will contribute to meeting the rapidly growing global demand for safe and cost-competitive low-carbon electricity supplies.

Fission energy research in the Nuclear Science and Engineering department is focused on developing advanced nuclear reactor designs for electricity, process heat, and fluid fuels production that include passive safety features; developing innovative proliferation-resistant fuel cycles; extending the life of nuclear fuels and structures; and reducing the capital and operating costs of nuclear energy systems. These research goals are pursued via targeted technology options, based on advanced modeling and simulation techniques and state-of-the-art experimental facilities. Progress toward these goals also entails advances in the thermal, materials, nuclear, and computational sciences. The overall objective is to advance the role of nuclear energy as an economical, safe, environmentally benign, and flexible energy source, thereby contributing to energy security, economic growth, and a sustainable global climate.

Plasma Physics and Fusion Technology. A different source of nuclear energy results from the controlled fusion of light elements, notably hydrogen isotopes. Since the basic source of fuel for fusion can be easily and inexpensively extracted from the ocean or from very abundant lithium, the supply is virtually inexhaustible. Fusion reactions can only readily occur in a fully ionized plasma heated to ultra high temperatures (150 million K). Such hot plasmas cannot be contained by material walls and are usually confined instead by strong magnetic fields. An alternative approach entails inertial confinement, usually achieved with very high-power lasers. Recent progress within the international fusion community increases the likelihood that controlled fusion will become a practical source of energy within the next half-century. Attainment of a fusion power plant involves the solution of many intellectually challenging physics and engineering problems. Included among these challenges are a mastery of the sophisticated field of plasma physics; the discovery of improved magnetic geometries to enhance plasma confinement; the development of materials capable of withstanding high stresses and exposure to intense radiation; and the need for great engineering ingenuity in integrating fusion power components into a practical, safe, and economical system. The department has strong programs in plasma fundamentals, materials for intense radiation fields, and engineering of fusion systems.

Plasma processes are key to many naturally occurring phenomena, and to many practical applications. Solar physics, space weather, and dusty plasma physics, are basic plasma research areas of departmental expertise. Treatment of toxic gases, magnetohydrodynamic energy conversion, ion propulsion, radiation...
generation, materials processing, and various other industrial applications use the knowledge students gain in applied plasma physics. The Department of Nuclear Science and Engineering leads MIT’s interdepartmental graduate instruction in plasma physics and many of its research applications.

**Nuclear Security.** The field of nuclear security concerns itself with the challenges and dangers of nuclear weapons and nuclear materials. Various areas of nuclear security include nuclear nonproliferation, arms control treaty verification, cargo security, as well as nuclear safeguards. In order for nuclear fission power to retain its societal relevance, it is important for the nuclear community to develop a culture of safety just as it has developed a culture of safety. Thus, nuclear security in its broadest sense becomes of paramount importance to the nuclear engineering community. MIT in particular is perfectly positioned to perform long-term research in the field of nuclear security, to make the use of nuclear energy less risky for global security. Part of this effort of necessity contains a component of policy, as well as a component of technological research necessary to stop proliferation, improve nuclear safeguards, and intercept any attempts at nuclear terrorism: a successful program cannot be either purely technology driven or purely policy driven but rather a careful integration of these two areas. MIT is actively pursuing an integration of both technology and policy development.

**Quantum Physics.** An exciting new frontier in nuclear science and engineering is to precisely control the quantum mechanical wave function of atomic and subatomic systems. Thus far, this has been achieved only in low-energy processes, particularly nuclear magnetic resonance, a form of nuclear spectroscopy which has allowed the basic techniques needed for quantum control to be explored in unprecedented detail. The department has initiated an ambitious program in this area, which promises to be widely applicable in nanotechnology. The ultimate achievement would be the construction of a "quantum computer," which would be capable of solving problems that are far beyond the capacities of classical computers. Other significant applications are quantum-enabled sensors and actuators, secure communication, and the direct simulation of quantum physics.

**Materials for Extreme Environments.** An important area of research in the department which unites many of the primary applications of nuclear science and technology involves the study of materials in extreme environments. To achieve the full potential of nuclear energy from both fission and fusion reactors, it is necessary to develop special materials capable of withstanding intense radiation for long periods of time as well as high temperatures and mechanical stresses. It is also crucial to understand the phenomenon of corrosion in radiation environments. To develop a fundamental understanding of these phenomena, chemical and physical processes must be followed at multiple scales, from the atomic to the macroscopic, over timescales from less than a nanosecond to many decades, and even, in the case of nuclear waste, thousands of years. Materials research in the department draws on a wide array of new scientific tools, including advanced compact radiation sources, material probes and characterization at the nanoscale, and advanced computational simulations.

**Interdisciplinary Research.** Students and faculty in the department work closely with colleagues in several other departments, including Physics, Materials Science and Engineering, Mechanical Engineering, Electrical Engineering and Computer Science, and Political Science, and with the Sloan School of Management. The department is an active participant in the MIT Energy Initiative and in MIT’s interdisciplinary programs of instruction and research in the management of complex technological systems and technology and public policy.

**Undergraduate Study**

**Bachelor of Science in Nuclear Science and Engineering (Course 22)**

The department’s undergraduate program offers a strong foundation in science-based engineering, providing the skills and knowledge for a broad range of careers, with an emphasis on hands-on exploration of the subject matter. The program develops scientific and engineering fundamentals in the production, interactions, measurement, and control of radiation arising from nuclear processes. In addition, the program introduces students to thermal-fluid engineering, electronics, and computational methods. Building upon these fundamentals, students understand the principles, design, and appropriate application of nuclear-based systems that have broad societal impacts in energy, human health, and security—for example, reactors, imaging systems, detectors, and plasma confinement. In addition, they develop professional skills in quantitative research, written and oral technical communication, team building, and leadership. The program provides excellent preparation for subsequent graduate education and research in a broad range of fields. In the nuclear field, there is high demand for nuclear engineers around the world as the nuclear energy industry continues to expand. Other nuclear and radiation applications are increasingly important in medicine, industry, and government.

A characteristic of the curriculum is the development of practical skills through hands-on education. This is accomplished through a laboratory subject on radiation physics, measurement, and protection (22.09 Principles of Nuclear Radiation Measurement and Protection), and through the laboratory components and exercises of the electronics (22.071 Electronics, Signals, and Measurement), ionizing radiation, and computational subjects. Even foundational courses in nuclear unit processes (22.01 Introduction to Nuclear Engineering and Ionizing Radiation) and neutronics (22.05 Neutron Science and Reactor Physics) include hands-on activities and analyses of real objects/systems. Examples include burning 1,000 bananas to measure their radioactivity, predicting and measuring the criticality of a six-foot graphite/uranium pile, and analyzing trace impurities in various foods, minerals, or even toenails in our nuclear
reactor. The concept of hands-on learning is continued with a 15-unit design subject focusing on nuclear-centric design and prototyping, and a 12-unit undergraduate thesis that is normally organized between the student and a faculty member of the department. Thesis subjects can touch on any area of nuclear science and engineering, including nuclear energy applications (fission and fusion) and nuclear science and technology (medical, physical, chemical, security, and materials applications).

The department offers one undergraduate program leading to a Bachelor of Science in Nuclear Science and Engineering (p. 418), Course 22, which is normally completed in four years. The Bachelor of Science program prepares students for a broad range of careers, from practical engineering work in the nuclear and other energy industries to graduate study in a wide range of technical fields, as well as entrepreneurship, law, medicine, and business.

The Course 22 degree program is accredited by the Engineering Accreditation Commission of ABET (http://www.abet.org).

Additional information may be obtained from the student’s departmental advisor or from the department’s Academic Office (Room 24-102).

**Combined Bachelor’s and Master’s Programs**

The five-year programs leading to a joint Bachelor of Science in Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, Nuclear Science and Engineering, or Physics and a Master of Science in Nuclear Science and Engineering are designed for students who decide relatively early in their undergraduate career that they wish to pursue a graduate degree in nuclear science and engineering. Students must submit their application for this program during the second term of their junior year and be judged to satisfy the graduate admission requirements of the department. The normal expectations of MIT undergraduates for admission to the five-year program are an overall MIT grade point average of at least 4.3, and a strong mathematics, science, and engineering background with GPA of at least 4.0.

The nuclear science and engineering thesis requirements of the two degrees may be satisfied either by completing both an SB thesis and an SM thesis, or by completing an SM thesis and any 12 units of undergraduate credit.

For further information, interested students should contact either their undergraduate department or the Department of Nuclear Science and Engineering.

**Minor in Nuclear Science and Engineering**

This minor allows students from any major outside of Course 22 to delve deeper into advanced topics within the department or to support interdisciplinary areas of interest in nuclear science and engineering.

**Required subjects**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03</td>
<td>Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>22.01</td>
<td>Introduction to Nuclear Engineering and Ionizing Radiation</td>
<td>12</td>
</tr>
</tbody>
</table>

**NSE Electives**

Select two of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.02</td>
<td>Introduction to Applied Nuclear Physics</td>
</tr>
<tr>
<td>22.033</td>
<td>Nuclear Systems Design Project</td>
</tr>
<tr>
<td>22.05</td>
<td>Neutron Science and Reactor Physics</td>
</tr>
<tr>
<td>22.06</td>
<td>Engineering of Nuclear Systems</td>
</tr>
<tr>
<td>22.09</td>
<td>Principles of Nuclear Radiation Measurement and Protection</td>
</tr>
</tbody>
</table>

**Foundation and Specialized Subjects**

Select one of the following options:

**Option 1**

- 2.005 Thermal-Fluids Engineering I
- or 8.03 Physics III
- 12 units of Course 22 coursework

**Option 2**

- 24 units of Course 22 coursework

**Total Units** 72

1 Subject has prerequisites that are outside the program.

2 Selected subjects must be letter-graded. Research/UROP subjects cannot be used.

**Inquiries**

Further information on undergraduate programs, admissions, and financial aid may be obtained from the department’s Academic Office (cegan@mit.edu), Room 24-102, 617-258-5682.

**Graduate Study**

The nuclear science and engineering field is broad and many undergraduate disciplines provide suitable preparation for graduate study.

An undergraduate degree in physics, engineering physics, chemistry, mathematics, materials science, or chemical, civil, electrical, mechanical, or nuclear science and engineering can provide a good foundation for graduate study in the department. Optimal undergraduate preparation would include the following:

- **Physics:** At least three introductory subjects covering classical mechanics, electricity and magnetism, and wave phenomena. An introduction to quantum mechanics is quite helpful, and an advanced subject in electricity and magnetism (including a description of time-dependent fields via Maxwell’s equations) is recommended for those wishing to specialize in fusion.

- **Mathematics:** It is essential that incoming students have a solid understanding of mathematics, including the study and
application of ordinary differential equations. It is also highly recommended that students will have studied partial differential equations and linear algebra.

- **Chemistry**: At least one term of general, inorganic, and physical chemistry.
- **Engineering fundamentals**: The graduate curriculum builds on a variety of engineering fundamentals, and incoming students are expected to have had an introduction to thermodynamics, fluid mechanics, heat transfer, electronics and measurement, and computation. A subject covering the mechanics of materials is recommended, particularly for students wishing to specialize in fission.
- **Laboratory experience**: This component is essential. It may have been achieved through an organized subject, and ideally was supplemented with an independent undergraduate research activity or a design project.

Applicants for admissions are required to take the Graduate Record Examination (GRE).

**Master of Science in Nuclear Science and Engineering**

The object of the master of science program is to give the student a good general knowledge of nuclear science and engineering and to provide a foundation either for productive work in the nuclear field or for more advanced graduate study. The general requirements for the SM degree are listed under Graduate Education. In addition to the general requirements, 22.11 Applied Nuclear Physics and 22.12 Radiation Interactions, Control, and Measurement are required for all master of science degree candidates.

Other subjects may be selected in accordance with the student’s particular field of interest. Master of science candidates may specialize in one of several fields: including nuclear fission technology, applied plasma physics, nuclear materials, nuclear security, and nuclear science and technology. Some students pursue a master of science degree in technology and policy in parallel with the Course 22 master of science program.

Students with adequate undergraduate preparation take approximately 18 months to complete the requirements for the master of science. Actual completion time ranges from one to two years. Additional information concerning the requirements for the Master of Science in Nuclear Science and Engineering, including lists of recommended subjects, may be obtained from the department’s Academic Office, Room 24-102.

**Nuclear Engineer**

The program of study leading to the nuclear engineer’s degree provides deeper knowledge of nuclear science and engineering than is possible in the master’s program and is intended to train students for creative professional careers in engineering application or design.

The general requirements for this degree, as described under Graduate Education, include 162 units of subject credit plus a thesis. Each student must plan an individually selected program of study, approved in advance by the faculty advisor, and must complete, and orally defend, a substantial project of significant value.

The objectives of the program are to provide the candidate with broad knowledge of the profession and to develop competence in engineering applications or design. The emphasis in the program is more applied and less research-oriented than the doctoral program.

The engineering project required of all candidates for the nuclear engineer’s degree is generally the subject of an engineer’s thesis. A student with full undergraduate preparation normally needs two years to complete the program. Additional information may be obtained from the department.

**Doctor of Philosophy and Doctor of Science**

The program of study leading to either the doctor of philosophy or the doctor of science degree aims to give comprehensive knowledge of nuclear science and engineering, to develop competence in advanced engineering research, and to develop a sense of perspective in assessing the role of nuclear science and technology in our society.

General requirements for the doctorate are described under Graduate Education and in the Graduate School Policy and Procedures Manual. The specific requirements of the Department of Nuclear Science and Engineering are the math and physics competency requirement, the engineering requirement, the core requirement, the field of specialization requirement, the oral examination, the advanced subject and minor requirements, and the doctoral thesis.

Upon satisfactory completion of the requirements, the student ordinarily receives a PhD unless he or she requests an ScD. The requirements for both degrees are the same.

Students admitted for the master of science or nuclear engineer’s degree must apply to the Department of Nuclear Science and Engineering’s Admissions Committee for admission to the doctoral program.

Students admitted for a doctoral degree must complete the math and physics competency requirement and the engineering requirement prior to entering the doctoral program.

Candidates for the doctoral degree must demonstrate competence at the graduate level in the core areas of nuclear science and engineering. The NSE core consists of the following six modules:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>22.11</td>
<td>Applied Nuclear Physics</td>
<td>6</td>
</tr>
<tr>
<td>22.12</td>
<td>Radiation Interactions, Control, and Measurement</td>
<td>6</td>
</tr>
<tr>
<td>22.13</td>
<td>Nuclear Energy Systems</td>
<td>6</td>
</tr>
<tr>
<td>22.14</td>
<td>Materials in Nuclear Engineering</td>
<td>6</td>
</tr>
<tr>
<td>22.15</td>
<td>Essential Numerical Methods</td>
<td>6</td>
</tr>
</tbody>
</table>
The core requirement must be completed by the end of the fourth graduate term.

Candidates for the doctoral degree are also required to complete three 12-unit (or greater than 12-unit) graduate subjects in their field of specialization with a grade of B or better. All three subjects must be completed by the end of the fourth regular graduate term. The field-of-specialization subjects should together provide a combination of depth and breadth of knowledge. The field-of-specialization plan must be submitted by the beginning of the second graduate term.

Candidates for a doctoral degree are required to demonstrate their readiness to undertake doctoral research by passing an oral examination by the end of their fourth graduate term. Oral exams are held twice a year, at the beginning of February and at the end of May. Students will generally take the oral exam for the first time in February of their second year. Two attempts are allowed at the oral exam. An overall GPA in graduate subjects of 4.0 is required to take the oral.

Students will be permitted to embark on doctoral research only if, by the end of their fourth graduate term, they have demonstrated satisfactory performance in the core requirement, the field of specialization, and the oral examination.

Candidates for the doctoral degree must satisfactorily complete (with an average grade of B or better) an approved program of two advanced subjects (24 units) that are closely related to the student’s doctoral thesis topic. Neither of these subjects may be from the list of three subjects selected to satisfy the field-of-specialization requirement. The advanced subjects should be arranged in consultation with the student’s thesis advisor and the student’s registration officer, and should have the approval of the registration officer. In addition, students must satisfactorily complete at least 24 units of coordinated subjects outside the field of specialization and the area of thesis research (the minor). The minor should be chosen in consultation with and have the approval of the registration officer.

Doctoral research may be undertaken either in the Department of Nuclear Science and Engineering or in a nuclear-related field in another department. Appropriate areas of research are described generally in the introduction to the department, and a detailed list may be obtained from the Department of Nuclear Science and Engineering.

**Interdisciplinary Programs**

**Computational Science and Engineering**

The Computational Science and Engineering (CSE) (http://computationalengineering.mit.edu/education) program allows students to specialize at the doctoral level in a computation-related field of their choice through focused coursework and a doctoral thesis through a number of participating host departments. The CSE program is administered jointly by the Center for Computational Engineering (CCE) and the host departments, with the emphasis of thesis research activities being the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science. For more information, see the full program description (p. 370) under Interdisciplinary Graduate Programs.

**Technology and Policy**

The Master of Science in Technology and Policy is an engineering research degree with a strong focus on the role of technology in policy analysis and formulation. The Technology and Policy Program (TPP) (http://tpp.mit.edu) curriculum provides a solid grounding in technology and policy by combining advanced subjects in the student’s chosen technical field with courses in economics, politics, quantitative methods, and social science. Many students combine TPP’s curriculum with complementary subjects to obtain dual degrees in TPP and either a specialized branch of engineering or an applied social science such as political science or urban studies and planning. For additional information, see the program description under the Institute for Data, Systems, and Society (p. 181).

**Financial Support**

Financial aid for graduate students is available in the form of research and teaching assistantships, department-administered fellowships, and supplemental subsidies from the College Work-Study Program. Assistantships are awarded to students with high quality academic records. The duty of a teaching assistant is to assist a faculty member in the preparation of subject materials and the conduct of classes, while that of a research assistant is to work on a research project under the supervision of one or more faculty members.

Most fellowships are awarded in April for the following academic year. Assistantships are awarded on a semester basis. The assignment of teaching assistants is made before the start of each semester, while research assistants can be assigned at any time. Essentially all students admitted to the doctoral program receive financial aid for the duration of their education.

Application for financial aid should be made to Professor Jacopo Buongiorno, Room 24-206, 617-253-7316.

**Inquiries**

Additional information on graduate admissions and academic and research programs may be obtained from the department’s Academic Office (cegan@mit.edu), Room 24-102, 617-253-3814.
Research Facilities

The department’s programs are supported by a number of outstanding experimental facilities for advanced research in nuclear science and engineering.

The MIT Research Reactor in the Nuclear Reactor Laboratory operates at a power of 6 MW and is fueled with U-235 in a compact light-water cooled core surrounded by a heavy-water reflector. This reactor provides a wide range of radiation-related research and teaching opportunities for the students and faculty of the department. Major programs to study corrosion in a nuclear environment are currently in place. Details of the laboratory’s research programs and facilities are given in the section on Research and Study (p. 88).

The department utilizes extensive experimental plasma facilities for the production and confinement of large volumes of highly ionized plasmas and for studies of plasma turbulence, particle motions, and other phenomena.

Most of the departmental research on plasmas and controlled fusion is carried out in the Plasma Science and Fusion Center. The department has played a major role in the design and development of high magnetic-field fusion devices. Through its activities in the center, the department is also the national leader in the design of both copper and superconducting magnets.

The thermal hydraulics laboratory is equipped with state-of-the-art instrumentation for measurement of fluid thermo-physical properties, fabrication facilities to engineer surfaces at the micro and nano scale, and flow loops for characterizing convective heat transfer and fluid dynamics behavior. A particularly novel facility uses high-speed infrared thermography to study fundamental phenomena of boiling, such as bubble nucleation, growth, and departure from a heated surface over a broad range of operating pressures, flow rates, and heat fluxes.

The study of nuclear materials plays a central role in the department. Research in the Laboratory for Electrochemical Interfaces centers on understanding the response of surface structure and physical chemistry when driven by dynamic environments of chemical reactivity and mechanical stress. This laboratory is equipped with surface science tools including scanning tunneling microscopy and X-ray photoelectron spectroscopy as well as electrochemical and electronic characterization tools. The H. H. Uhlig Corrosion Laboratory investigates the causes of failure in materials, with an emphasis on nuclear materials. The Mesoscale Nuclear Materials group studies reasons for material property changes due to radiation and rapid ways of measuring them.

The Cappellaro lab is located in the Research Laboratory of Electronics and consists of a 1,200 sq-ft-space dedicated to magnetic resonance and spin physics. One laboratory houses a 7 Tesla superconducting magnet with a wide bore and in-house-made probes, equipped with a spectrometer providing RF modulation and detection for the manipulation and detection of nuclear spins. Two other laboratories are dedicated to NV-based research. The laboratories house three state-of-the-art confocal photoluminescence setups with all of the necessary microwave electronics, RF electronics, and control hardware for manipulating NV quantum spins and one confocal microscope for imaging only.

In addition to the above facilities, the department has a nuclear instrumentation laboratory and a 14 MeV neutron source. Laboratory space and shop facilities are available for research in all areas of nuclear science and engineering. A state-of-the-art scanning electron microscope with an integrated focused ion beam that can be used to study irradiated specimens is available. A number of computer workstations and Beowulf clusters dedicated to simulation, modeling, and visualization, as well as MIT’s extensive computer facilities, are used in research and graduate instruction.

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Professor of Nuclear Science and Engineering
Head, Department of Nuclear Science and Engineering

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Associate Head, Department of Nuclear Science and Engineering

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Professor of Nuclear Science and Engineering
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Professor of Nuclear Science and Engineering
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Professors of the Practice
Kord Smith, PhD
Korea Electric Power Company (KEPCO) Professor of the Practice of Nuclear Science and Engineering
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Principal Research Engineer of Nuclear Science and Engineering
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Principal Research Scientist of Nuclear Science and Engineering
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Research Engineer of Nuclear Science and Engineering
Research Scientists
Bren Phillips, PhD
Research Scientist of Nuclear Science and Engineering
Professors Emeriti
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Sow-Hsin Chen, PhD
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Professor Emeritus of Nuclear Science and Engineering
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Professor Emeritus of Nuclear Science and Engineering
Ronald M. Latanision, PhD
Professor Emeritus of Materials Science and Engineering
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Professor Emeritus of Nuclear Science and Engineering
Professor Emeritus of Electrical Engineering

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Professor Emeritus of Metallurgy
Professor Emeritus of Nuclear Science and Engineering

Neil E. Todreas, PhD
Professor Emeritus of Nuclear Science and Engineering
Professor Emeritus of Mechanical Engineering

Sidney Yip, PhD
Professor Emeritus of Nuclear Science and Engineering
Professor Emeritus of Materials Science and Engineering
**SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCES**

MIT’s mission of meeting the world’s great challenges requires not only superb technical and scientific creativity, but also a deep understanding of the human complexities—cultural, political, and economic—in which the world’s challenges are embedded.

The disciplines taught in MIT’s School of Humanities, Arts, and Social Sciences (SHASS) empower young students, thinkers, and citizens with historical and cultural perspectives, as well as language, critical thinking, and communication skills—capacities that enable projects rich in meaning and wisdom.

The School is made up of 11 units: Anthropology; Comparative Media Studies/Writing; Economics; Global Studies and Languages; History; Linguistics and Philosophy; Literature; Music and Theater Arts; Political Science; Science, Technology, and Society; and Women’s and Gender Studies.

Each year hundreds of MIT students graduate with majors and minors in over 20 SHASS fields. In addition, the School provides the majority of subjects used to fulfill the Institute’s Humanities, Arts, and Social Sciences Requirement. The object of the requirement, broadly stated, is to ensure that every undergraduate at MIT is exposed to a wide range of interpretive and analytic approaches in the humanities, arts, and social sciences.

**Research and Innovation**

SHASS is home to research that has a global impact. The School offers five doctoral programs: Economics; History, Anthropology, and Science, Technology and Society (HASTS); Linguistics; Philosophy; and Political Science. These are among the leading graduate programs of their kind in the world. They prepare students for teaching and research careers in universities and colleges, but also for government service, industry, and finance. The School offers master’s degrees in Comparative Media Studies, Economics, Political Science, and Science Writing.

**Interdisciplinary Programs**

Providing opportunities for interdisciplinary study is a priority at SHASS. Students can choose from among a number of interdisciplinary fields, including: Ancient and Medieval Studies, Applied International Studies, Public Policy, and five Regional Studies areas (African and African Diaspora Studies; Asian and Asian Diaspora Studies; Latin American and Latino/a Studies; Middle Eastern Studies; Russian and Eurasian Studies). In addition to more traditional departments, the School houses the multifaceted programs in Comparative Media Studies/Writing; Science, Technology and Society; and Women’s and Gender Studies. Some of the many SHASS programs and projects that combine humanities with the sciences include the Abdul Latif Jameel Poverty Action Laboratory, the Center for International Studies, the Hyperstudio, the Knight Science Journalism Program, and the MIT International Science and Technology Initiatives (MISTI), the School’s flagship international education program. See the Research and Study (p. 88) section for further information.

**Global Citizens**

The School has a central role in international education at MIT, and in preparing students to be leaders and good global citizens. MISTI, located in the Center for International Studies, supports student internship, research, and teaching opportunities in Belgium, Brazil, Chile, China, France, Germany, India, Israel, Italy, Japan, Jordan, Korea, Mexico, Netherlands, Peru, Portugal, Russia, Singapore, Spain, Switzerland and various African countries. Through MISTI, MIT students develop practical intercultural skills via hands-on experience working beside international colleagues.

More locally, the Global Studies and Languages Section offers language and culture programs in Chinese, English, French, German, Japanese, Korean, Portuguese, Russian, and Spanish. Global Studies also offers subjects taught in English on cultural globalization, transnational media, arts, and literature, global migration, global ecology and social justice, and other contemporary and historical global phenomena. These subjects help prepare students to be engaged global citizens and leaders.

**A Brief History of SHASS**

The School was founded in 1950 as a response to the challenges that followed the Second World War. The 1960s was a period of rapid growth, in which the School was reorganized into most of its current departments and sections, and began to grant full-scale degrees. In the 1970s and 1980s, the School continued to define separate programs and rearrange sections. In 1990 the School replaced the generic SB degree in Humanities with SB degrees in specified areas of humanistic study: Anthropology, History, Literature, Foreign Languages and Literatures, Music, and Writing.

**Degrees Offered in the School of Humanities, Arts, and Social Sciences**

**Anthropology (Course 21A)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Anthropology</td>
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**Comparative Media Studies/Writing (Course CMS and Course 21W)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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</thead>
<tbody>
<tr>
<td>SB</td>
<td>Comparative Media Studies</td>
</tr>
<tr>
<td>SB</td>
<td>Writing</td>
</tr>
<tr>
<td>SM</td>
<td>Comparative Media Studies</td>
</tr>
<tr>
<td>Degree</td>
<td>Program</td>
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</tr>
<tr>
<td>SB</td>
<td>Computer Science, Economics, and Data Science</td>
</tr>
</tbody>
</table>

**Computer Science, Economics, and Data Science (Course 6-14)**

**Economics (Course 14)**

<table>
<thead>
<tr>
<th>Degree</th>
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<tbody>
<tr>
<td>SB</td>
<td>Economics</td>
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<tr>
<td>SB</td>
<td>Mathematical Economics</td>
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<td>SM</td>
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<tr>
<td>PhD</td>
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<td>PhD</td>
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**Global Studies and Languages (Course 21G)**

<table>
<thead>
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<th>Degree</th>
<th>Program</th>
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</thead>
<tbody>
<tr>
<td>SB</td>
<td>Global Studies and Languages</td>
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**History (Course 21H)**

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<tr>
<td>SB</td>
<td>History</td>
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**Humanities (Course 21)**

<table>
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<th>Program</th>
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<tbody>
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<tr>
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<td>Humanities and Engineering</td>
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<tr>
<td>SB</td>
<td>Humanities and Science</td>
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</table>

**Linguistics and Philosophy (Course 24)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Linguistics and Philosophy</td>
</tr>
<tr>
<td>SB</td>
<td>Philosophy</td>
</tr>
<tr>
<td>PhD</td>
<td>Linguistics</td>
</tr>
<tr>
<td>PhD</td>
<td>Philosophy</td>
</tr>
</tbody>
</table>

**Literature (Course 21L)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Literature</td>
</tr>
</tbody>
</table>

**Music and Theater Arts (Course 21M)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Music</td>
</tr>
<tr>
<td>SB</td>
<td>Theater Arts</td>
</tr>
</tbody>
</table>

**Political Science (Course 17)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Political Science</td>
</tr>
<tr>
<td>SM</td>
<td>Political Science</td>
</tr>
<tr>
<td>PhD</td>
<td>Political Science</td>
</tr>
</tbody>
</table>

**Program in Science, Technology, and Society (STS)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Science, Technology, and Society</td>
</tr>
</tbody>
</table>

**Statistics and Humanities**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>Economics and Statistics</td>
</tr>
<tr>
<td>PhD</td>
<td>Political Science and Statistics</td>
</tr>
</tbody>
</table>

**Notes**

Many departments make it possible for a graduate student to pursue a simultaneous master’s degree.

1 See Interdisciplinary Programs (p. 337).

2 Students majoring in one of the designated interdisciplinary major fields within SHASS receive the generic SB degree in Course 21, Humanities.

**Admissions**

The selection process at MIT is holistic and student centered: each application is evaluated within its unique context. Selection is based on outstanding academic achievement as well as a strong match between the applicant and the Institute.

Undergraduate applicants do not apply to a particular school, department or program and, although the application asks about a preferred field of study, most admitted undergraduates do not declare a major until the second semester of their first year. Admissions information for regular, transfer, and non-degree applicants is provided in the section on Undergraduate Education (p. 31).

Applicants for graduate study apply directly to the particular department or program of interest. See the individual department and program descriptions for specific requirements.

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Communications Director
ANTHROPOLOGY

Anthropology studies humankind from a comparative perspective that emphasizes the diversity of human behavior and the importance of culture in both describing and explaining that variety. While the discipline encompasses the biological nature of our species and the material aspects of human adaptation, it takes as fundamental the idea that humans respond to nature and natural forces in large part through culture—that is, the system of practices and signs through which people interact and communicate. Anthropology, then, is the study of human beings as cultural animals. Sociocultural anthropology, the focus of the MIT program, draws its data from the direct study of contemporary peoples living in a wide variety of circumstances, from peasant villagers to tropical forest hunters and gatherers to professionals working in technological organizations to urban populations in modern societies.

Anthropology at MIT offers students a broad exposure to scholarship on human culture. The field is more generally distinguished from other humanities and social science disciplines by its insistence that understanding people’s ways of life is often best accomplished by living and working among them—that is, by doing fieldwork. This immersive work—often described as ethnography—reveals the multiple positions and perspectives that constitute social worlds. Ethnographic representations in texts and films can provide the help of the minor advisor to ensure that they gain a coherent grounding in cultural anthropology.

The anthropology student comes to understand that the hallmark of the discipline is the comparative study of human societies. Emphasis is on understanding diversity and the importance of the concept of culture in explaining that variety, as well as on learning about the universals of behavior that may underlie diversity.

Undergraduate Study

MIT’s Anthropology Program provides introductions to intensive studies in such areas as environmentalism; agriculture and food production; the organization and cultures of science, medicine, and technology; gender, sex, race, and class; and nationalism and ethnic identity.

Excluding Independent Study, Thesis, and Special Subjects, the Anthropology curriculum is divided into six topic clusters that provide depth on related topics:

- 21A.00 and 21A.01 are core subjects.
- 21A.100 to 21A.199 address general issues related to culture and identity.
- 21A.300 to 21A.399 examine health, disease, medicine, and biology in global and local settings.
- 21A.400 to 21A.499 investigate issues and conflicts related to the environment.
- 21A.500 to 21A.599 focus on science, technology, and media in various institutional, economic, and political contexts.
- 21A.800 to 21A.899 are methods and theory subjects.

For additional information, visit the anthropology website (http://web.mit.edu/anthropology/undergraduate/subjects.html).

Students taking a concentration in anthropology should enroll in either 21A.00 Introduction to Anthropology: Comparing Human Cultures or 21A.01 How Culture Works, and two other subjects. Anthropology subjects qualify for several interdisciplinary concentrations, including those in Women’s and Gender Studies, Latin American and Latino/a Studies, and Science, Technology, and Society.

Bachelor of Science in Anthropology (Course 21A)

The undergraduate program leading to the degree of Bachelor of Science in Anthropology (Course 21A) (p. 421) provides a thorough grounding in cultural anthropology.

Majors learn about the concept of culture and the processes by which humans make meaningful transactions, the nature of ethnographic fieldwork, and the connections between anthropology and the other social sciences. Majors study the theories explaining human behavior as well as the range of methods anthropologists use to analyze empirical data. Students can focus on particular geographical areas, such as Latin America, Europe, North America, Africa, or Asia, and on issues like neocolonialism, ethnic conflict, human rights, environmental movements, globalization, or expressive, medical, or scientific cultures.

The anthropology student comes to understand that the hallmark of the discipline is the comparative study of human societies. Emphasis is on understanding diversity and the importance of the concept of culture in explaining that variety, as well as on learning about the universals of behavior that may underlie diversity.

Joint Degree Programs

Joint degree programs are offered in anthropology in combination with a field in engineering or science (21E, 21S). See the joint degree programs listed under Humanities (p. 261).

Either 21A.00 Introduction to Anthropology: Comparing Human Cultures or 21A.01 How Culture Works is strongly recommended as a preliminary subject for all anthropology degree programs.

Minor in Anthropology

The Minor in Anthropology consists of six subjects arranged into two tiers as shown below. Students create individual programs with the help of the minor advisor to ensure that they gain a coherent understanding of the methods, approaches, and some of the results of the discipline.

### Tier I

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>21A.00</td>
<td>Introduction to Anthropology: Comparing Human Cultures</td>
<td>12</td>
</tr>
<tr>
<td>or 21A.01</td>
<td>How Culture Works</td>
<td></td>
</tr>
</tbody>
</table>

### Tier II
With approval of the minor advisor, select five subjects with a unifying theme (not to include 21A.00 or 21A.01)  

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>66-72</td>
</tr>
</tbody>
</table>

Examples of five subjects with a unifying theme are: Global Health (four subjects from 21A.300[J] - 21A.311 and 21A.331[J]); Gender (21A.101[J], 21A.111[J], 21A.141[J], 21A.143[J] and 21A.504[J]); or Culture and Identity (21A.104, 21A.111[J], 21A.130[J], 21A.150 and 21A.155).

Graduate Study

HASTS Graduate Program
The Anthropology Program, the History faculty, and the Program in Science, Technology, and Society collaborate in the graduate program History, Anthropology, and Science, Technology, and Society (HASTS) leading to a PhD; see the description under the Program in Science, Technology, and Society (p. 279).

Inquiries
Further information on subjects and programs may be obtained from the Anthropology Office, Room E53-335, 617-452-2837.

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Interim Head, Anthropology Program

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Amy Moran-Thomas, PhD
Assistant Professor of Anthropology

Professors Emeriti
James Howe, PhD
Professor Emeritus of Anthropology

Jean E. Jackson, PhD
Professor Emerita of Anthropology

Arthur Steinberg, PhD
Professor Emeritus of Anthropology
COMPARATIVE MEDIA STUDIES/WRITING

Comparative Media Studies/Writing combines the study of contemporary media (film, television, social media, and digital interactive forms) with the study of creative and journalistic practices of producing these and other forms of modern fiction, poetry, film, and non-fiction prose. The section offers two undergraduate majors, one in Comparative Media Studies and another in Writing, as well as two graduate SM degrees in Comparative Media Studies and Science Writing. The curriculum seeks to encourage students to think across various forms of media and to learn about contemporary forms of media through the practices of creating and producing them.

The program in Comparative Media Studies/Writing is home to two centers that serve as key resources to the MIT community. The MIT Writing and Communication Center offers free individual consultation on communication on an appointment or drop-in basis to all members of the MIT community, as well as other services. For more information about the WCC and other academic resources for students, see Academic Resources (p. 27).

The Writing, Rhetoric, and Professional Communication (WRAP) staff helps provide the integration of instruction and feedback in writing and speaking in subjects in all undergraduate departments and programs. For information about all of WRAP’s services, visit the WRAP website (http://cmsw.mit.edu/education/writing-across-the-curriculum).

Undergraduate Study

Bachelor of Science in Comparative Media Studies (CMS)
The program leading to the Bachelor of Science in Comparative Media Studies (p. 422) degree is designed to integrate the study of contemporary media (film, television, digital systems) with a broad historical understanding of older forms of human expression. The program embraces theoretical and interpretive principles drawn from the central humanistic disciplines of literary study, history, anthropology, art history, and film studies, but aims as well for a comparative synthesis that is responsive to the distinctive emerging media culture of the 21st century. Students explore the complexity of the media environment by learning to think across media, to see beyond the boundaries imposed by older medium-specific approaches to the study of audio-visual and literary forms. The undergraduate program serves as preparation for advanced study in a range of scholarly and professional disciplines and also for careers in media or industry.

The comparative and cross-disciplinary nature of both the undergraduate and graduate programs is reflected by the extensive participation of faculty drawn from Art and Architecture; Anthropology; Global Studies and Languages; History; Literature; Music and Theater Arts; Philosophy; Science, Technology, and Society; Media Arts and Sciences; Political Science; and Urban Studies and Planning.

The SB in Comparative Media Studies requires 10 subjects. Majors are required to take CMS.100 Introduction to Media Studies, a Media Practice and Production subject, CMS.701 Current Debates in Media (CI-M), a second CI-M subject, and six electives. A pre-thesis tutorial (CMS.THT) and thesis (CMS.THU) may be substituted for one elective.

Bachelor of Science in Writing (Course 21W)
The writing major offers students the opportunity to study the craft, forms, and traditions of contemporary writing, journalism, and digital media. Some students explore writing as a means of artistic expression. Some learn how to write for a variety of media or to communicate the results of their science and technical work to broad audiences and members of their professions. Others work collaboratively within the evolving framework of digital media to become skillful in interactive and nonlinear forms of communication. All subjects in the major emphasize the development of the foundational skills, creative initiative, and critical sensibility necessary to become a good writer.

Subjects in the program’s three areas of emphasis—creative writing (p. 450) (fiction, nonfiction prose, poetry), science writing (p. 452), and digital media (p. 451)—are taught at both introductory and advanced levels. All subjects require extensive writing and revision. Student work is typically discussed in workshops and receives the written commentary of the instructor.

The writing major is an option for students interested in journalism, longer forms like the science documentary, and communication issues related to the public understanding of science and technology. It is also designed to work as a complementary major for students majoring in science, engineering, or another field of study at MIT. Students also fulfill an internship requirement, which provides in-depth practical experience.

The digital media emphasis offers in-depth study of emerging interactive and nonlinear styles of narrative, as well as individual and collaborative experience in producing digitally mediated forms, both aesthetic and utilitarian. Students may gain extensive experience in using a variety of authoring systems to develop large-scale websites, web-based hypertext products, computer games, interactive fiction and poetry, and digitally mediated visual worlds. Knowledge of programming is often helpful, but not necessary.

Joint Degree Programs in Comparative Media Studies
The joint undergraduate degree program in CMS (21E or 21S) requires eight CMS subjects, plus six subjects in an engineering or science major. Students are required to take CMS.100 Introduction to Media Studies, a Media Practice and Production subject, CMS.701 Current Debates in Media, and five CMS electives. A pre-thesis tutorial (CMS.THT) and thesis (CMS.THU) may be substituted for one CMS elective. Students must obtain approval for their
subject selection from an advisor in their engineering or science field, and must also file a petition with the Subcommittee on the Communication Requirement. See joint degree programs under the Department of Humanities section (p. 261).

**Joint Degree Programs in Writing**
Joint degree programs are offered in writing in combination with a field in engineering or science (the 21E and 21S degrees). See the joint degree programs listed under Humanities (p. 261).

**Minor in Comparative Media Studies**
The minor requires six subjects that reflect the comparative study of media. It is organized into three tiers, and each student designs his or her own plan of study in consultation with an advisor in the field.

**Introductory**
- CMS.100 Introduction to Media Studies 12

**Intermediate**
Select one of the following:
- CMS.335[J] Short Attention Span Documentary 12
- CMS.362 Civic Media Collaborative Design Studio
- CMS.400 Media Systems and Texts
- CMS.405 Visual Design
- CMS.590[J] Design and Development of Games for Learning
- CMS.609[J] The Word Made Digital
- CMS.614[J] Network Cultures

**CMS.622 Applying Media Technologies in the Arts and Humanities**
- CMS.633 Digital Humanities: Topics, Techniques, and Technologies
- CMS.634 Designing Interactions
- 21W.752 Making Documentary: Audio, Video, and More

**Advanced**
- CMS.701 Current Debates in Media 12

**Electives**
Select three elective subjects 36

**Total Units** 72

**Minor in Writing**
The minor consists of six subjects that are selected to focus on one of three areas: creative writing, science writing, or digital media. It is arranged in two tiers of study as follows:

**Tier I**
Select one of the following:
- 21W.011 Writing and Rhetoric: Rhetoric and Contemporary Issues 12

**Tier II**
Select five subjects from among the writing subjects in the area of focus 60

**Total Units** 72

See the department’s website (http://cmsw.mit.edu/education/subject-lists/writing) for information about available subjects.

**Graduate Study**

**Master of Science in Comparative Media Studies**
The graduate program is a two-year course of study leading to a Master of Science in Comparative Media Studies. The program aims to prepare students for careers in fields such as journalism, teaching and research, government or public service, museum work, information science, corporate consulting, media industry marketing and management, and educational technology.

The graduate degree program in Comparative Media Studies places extensive emphasis on student participation in collaborative sponsored research of one or more of its research groups, including the Center for Civic Media; the Open Documentary Lab; the Education Arcade; the MIT Game Lab; the Imagination, Computation,
and Expression Laboratory; HyperStudio; the Trope Tank; the Creative Communities Initiative; and the Mobile Experience Laboratory. Typically graduate students spend 20 hours per week on funded group-project work during their two-year program, for which they receive funding that supports their graduate study at MIT. For further information on research, visit the CMS/W website (http://cmsw.mit.edu/research-groups).

CMS graduate students usually take three 12-unit subjects per term, plus a 3-unit colloquium. All students take three introductory seminars (Media Theories and Methods I and II, and Major Media Texts) during their first year, as well as Workshop, and another subject that offers hands-on experience in media. In their final year, they are required to take Media in Transition and a 24-unit subject devoted to completing the master’s thesis, plus the 3-unit Colloquium in Comparative Media.

Students may enter the program with a degree from a wide range of undergraduate majors, including the liberal arts, the social sciences, journalism, computer science, and management.

Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMS.790</td>
<td>Media Theories and Methods I</td>
<td>12</td>
</tr>
<tr>
<td>CMS.791</td>
<td>Media Theories and Methods II</td>
<td>12</td>
</tr>
<tr>
<td>CMS.796</td>
<td>Major Media Texts</td>
<td>12</td>
</tr>
<tr>
<td>CMS.801</td>
<td>Media in Transition</td>
<td>12</td>
</tr>
<tr>
<td>CMS.950</td>
<td>Workshop I</td>
<td>12</td>
</tr>
<tr>
<td>CMS.990</td>
<td>Colloquium in Comparative Media</td>
<td>3</td>
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<tr>
<td>CMS.THG</td>
<td>Master’s Thesis (One subject from the following list):</td>
<td>9-18</td>
</tr>
<tr>
<td>CMS.935</td>
<td>Documentary Photography and Photojournalism: Still</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Images of a World in Motion</td>
<td></td>
</tr>
<tr>
<td>CMS.864</td>
<td>Game Design</td>
<td></td>
</tr>
<tr>
<td>CMS.863[J]</td>
<td>Design and Development of Games for Learning</td>
<td></td>
</tr>
<tr>
<td>CMS.862</td>
<td>Civic Media Collaborative Design Studio</td>
<td></td>
</tr>
<tr>
<td>CMS.834[J]</td>
<td>Designing Interactions</td>
<td></td>
</tr>
<tr>
<td>CMS.828</td>
<td>Advanced Identity Representation</td>
<td></td>
</tr>
<tr>
<td>21W.890</td>
<td>Short Attention Span Documentary</td>
<td></td>
</tr>
<tr>
<td>21W.824</td>
<td>Making Documentary: Audio, Video, and More</td>
<td></td>
</tr>
<tr>
<td>MAS.500</td>
<td>Hands on Foundations in Media Technology</td>
<td></td>
</tr>
<tr>
<td>MAS.532</td>
<td>Mathematical Methods in Imaging</td>
<td></td>
</tr>
<tr>
<td>MAS.863[J]</td>
<td>How to Make (Almost) Anything</td>
<td></td>
</tr>
<tr>
<td>4.369</td>
<td>Studio Seminar in Art and the Public Sphere</td>
<td></td>
</tr>
</tbody>
</table>

4.353 Advanced Video and Related Media

**Master of Science in Science Writing**

The one-year graduate program in Science Writing leads to a Master of Science in Science Writing, and it is aimed at students who wish to write about science and technology for general readers, in ordinary newsstand magazines and newspapers, in popular and semi-popular books, on the walls of museums, or on television or radio programs. Students may be graduates of undergraduate science, engineering, journalism, or writing programs; experienced journalists and freelance writers; working scientists or engineers; historians of science and technology; or other scholars, including those already holding advanced degrees.

The program is built around an intensive year-long advanced science writing seminar. In addition, students choose one elective each semester, write a substantial thesis, observe in a lab, and complete an internship. Complete information is available on the program’s website (http://sciwrite.mit.edu). The graduate program maintains links to MIT’s Program in Science, Technology, and Society; and to the Knight Science Journalism Program. For more information, see the descriptions of the Science, Technology, and Society Program (p. 278) and Research and Study (p. 88) for more information about the Knight Science Journalism Program.

**Inquiries**

Further information on subjects and programs may be obtained from the Comparative Media Studies/Writing office (cmsw@mit.edu), Room 14N-338, 617-253-3599.

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Jing Wang, PhD  
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Suzanne T. Lane, PhD  
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Research Staff

Principal Research Associates
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Principal Research Associate of Comparative Media Studies/Writing

Research Scientists
Allan Adams III, PhD
Research Scientist of Comparative Media Studies/Writing

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Research Scientist of Comparative Media Studies/Writing

Philip Tan, MS
Research Scientist of Comparative Media Studies/Writing

Sarah Wolozin, BA
Research Scientist of Comparative Media Studies/Writing

Professors Emeriti
Anita Desai, BA
John E. Burchard Professor Emerita of Humanities

Joe Haldeman, MFA
Adjunct Professor Emeritus of Fiction

Robert Kanigel, BS
Professor Emeritus of Science Writing

Cynthia Griffin Wolff, PhD
Class of 1922 Professor Emerita of Literature
DEPARTMENT OF ECONOMICS

Economics is the study of all those aspects of individual and social activities related to the choice, production, distribution, and consumption of goods and services. In relation to these decisions, economics is concerned with the behavior and interaction of individuals, private firms, and other institutions and government agencies. Economics contributes to the understanding of many important social problems: changes in efficiency and productivity, fluctuations in the overall levels of economic activity and employment, inflation, the effects of government deficits, the growth and decline of industries, changes in foreign exchange rates, increases in international indebtedness, and the behavior of the centrally planned and less developed countries.

Subjects are offered in the major areas of economics: theoretical and applied analysis at the levels of the individual consumer, the firm, and the industry, as well as aggregate economic activity, industrial organization and health economics, econometrics, public finance, energy economics, labor economics, game theory, international trade and finance, economic history, economic development, and political economy.

Undergraduate Study

Bachelor of Science in Economics (Course 14-1)

Course 14-1, leading to the Bachelor of Science in Economics (p. 423), combines training in technical economics with opportunities for a broad and balanced undergraduate education. Students may choose from a diversified group of undergraduate subjects and are encouraged to engage in independent research.

The aims of the SB in Economics degree program are threefold: to give students a firm grounding in modern economic theory and a basic understanding of economic processes; to provide a descriptive knowledge of the US and world economies; and to develop in students the capabilities for quantitative analysis and independent thought. These aims correspond roughly to the requirements in the Course 14-1 program of theory, electives, statistics and econometrics, and research.

The requirements allow substantial freedom for students in designing individual programs within economics and balancing the programs with subjects in other disciplines. The large amount of unrestricted elective time encourages students to shape programs close to their own needs and interests. Students may select programs that concentrate on economics and other social sciences or may combine economics with other fields. They may emphasize the relation of economics and technology by choosing their free electives in engineering and science, or they may combine their studies in economics with subjects in history and the other humanities.

The successful completion of the degree program prepares students for further study in economics or for careers in business administration and finance, consulting, law and related fields, and public policy.

Although there are several satisfactory alternative subject sequences, students who by the end of their second year have taken 14.01 Principles of Microeconomics and 14.02 Principles of Macroeconomics can follow a program that permits considerable depth in electives in their third and fourth years. With that preparation, students can complete an intermediate micro subject, 14.05 Intermediate Macroeconomics or 14.18 Mathematical Economic Modeling, 14.30 Introduction to Statistical Methods in Economics, and 14.32 Econometric Data Science in the third year. This program satisfies the prerequisites for all subjects (including 14.33 Research and Communication in Economics: Topics, Methods, and Implementation) and prepares students for research on their thesis and in other elective subjects. The department strongly recommends that students take additional subjects in mathematics if professionally interested in economics.

Bachelor of Science in Mathematical Economics (Course 14-2)

The SB in Mathematical Economics (p. 441) is designed for students who desire a deeper mathematical foundation than that provided by the SB in Economics, and allows them to concentrate in a subset of economics subjects, typically those more oriented toward microeconomics or technical subjects. Course 14-2 majors will gain the strong mathematical and theoretical preparation needed for subsequent graduate study in economics. This program is well suited to students interested in game theory, other types of microeconomic theory, and econometrics.

Students majoring in Mathematical Economics are required to successfully complete the most important introductory courses in economics before undertaking more technical and mathematical studies in economics. Substantial coursework in mathematics is required, including 18.100x Real Analysis, a choice between 18.06 Linear Algebra or 18.03 Differential Equations, and at least one elective in mathematics.

Bachelor of Science in Computer Science, Economics, and Data Science (Course 6-14)

Contemporary electronically mediated platforms for market-level and individual exchange combine complex human decisions with intensive computation and data processing, all interacting within an engineered economic environment. Examples include: online markets, crowdsourcing platforms, spectrum auctions, financial platforms, crypto currencies, and large scale matching/allocation systems such as kidney exchange and public school choice systems. These platforms encompass a growing slice of economic activity and are shifting the scope and efficiency of market and non-market exchanges. Some forms of exchange that were simply infeasible due to coordination or information frictions (centralized kidney exchange, vehicle sharing) are suddenly available and important.

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Other market activities that were previously thought to require centralization and oversight, can now be decentralized and self-regulated (crypto-currency being the leading example). Moreover, the technology enabling that decentralization (so-called blockchain) is likely to have many further applications.

The Bachelor of Science in Computer Science, Economics and Data Science (Course 6-14) (p. 484) is aimed at educating students at this intellectual nexus and equipping them with a foundational knowledge of economic analysis, computing, optimization and data science, as well as hands-on experience with empirical analysis of economic data, to identify, analyze and solve real-world challenges in real and virtual settings.

**Minor in Economics**

The objective of the minor is to extend the understanding of economic issues beyond the level of the concentration. This is done through specialized analytical subjects and elective subjects that provide an extensive treatment of economic issues in particular areas.

The Minor in Economics consists of six subjects arranged into three levels of study:

<table>
<thead>
<tr>
<th>Tier</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier I</td>
<td>14.01 Principles of Microeconomics ¹</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>14.02 Principles of Macroeconomics ¹</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>14.30 Introduction to Statistical Methods in Economics</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>or 18.05 Introduction to Probability and Statistics</td>
<td></td>
</tr>
</tbody>
</table>

- **Tier II**

Select one of the following:

- 14.03 Microeconomic Theory and Public Policy
- 14.04 Intermediate Microeconomic Theory
- 14.05 Intermediate Macroeconomics

- **Tier III**

Select two elective subjects in applied economics. ²

Total Units 72

² Under no circumstances may a student complete a minor with fewer than six subjects. Any student who receives permission from the Economics Department to skip 14.01 and/or 14.02 in order to take a higher-level subject must take a replacement subject for each subject that is skipped.

² See the department’s website (http://economics.mit.edu/under/minors) for a list of available subjects.

**Graduate Study**

**Admission Requirements for Graduate Study**

The Department of Economics specifies the following prerequisites for graduate study in economics: one full year of college mathematics and an appreciable number of professional subjects in economics for those qualified students who have majored in fields other than economics. Applicants for admission who have deficiencies in entrance requirements should consult with the department about programs to remedy such deficits.

**Master of Science in Economics**

Under special circumstances, admission may be granted to current MIT students seeking the Master of Science degree. The general requirements for the SM are given in the section on Graduate Education (p. 60).

**Doctor of Philosophy**

A candidate for the doctorate must demonstrate a mastery of economic theory, including both microeconomics and macroeconomics, and four fields of study; achieve a specified level of competence in econometrics; submit and defend a dissertation that represents a contribution to knowledge; and be in residence for a minimum of two years. Two of the four fields are covered by the written General Examination. Two minor fields may each be satisfied by one year of coursework. The four major and minor elective fields may be chosen from advanced economic theory, econometrics, economic development, finance, industrial organization, international economics, labor economics, monetary economics, organizational economics, political economy, and public economics.

There is no required minimum number of graduate subjects in the department. However, candidates ordinarily need two full academic years of study to prepare adequately for the General Examinations and to meet the other pre-thesis requirements. The doctoral thesis must be written in residence, which typically requires three years of research.

**Interdisciplinary Program**

**Economics and Statistics**

The Interdisciplinary Doctoral Program in Statistics provides training in statistics, including classical statistics and probability as well as computation and data analysis, to students who wish to integrate these valuable skills into their primary academic program. The program is administered jointly by the departments of Aeronautics and Astronautics, Economics, Mathematics, and Political Science, and the Statistics and Data Science Center within the Institute for Data, Systems, and Society. It is open to current doctoral students in participating departments, who may apply to enroll in the program at any time after the end of their first year. For more information, see the full program description (p. 376) under Interdisciplinary Graduate Programs.
Financial Support
A limited number of students are supported by scholarship and fellowship grants, as well as by teaching and research assistantships.

Inquiries
For more information regarding admissions or financial aid, contact Eva Konomi (evako@mit.edu), 617-253-8787. For undergraduate admissions and academic programs, contact Gary King (gking@mit.edu), 617-253-0951. For any other information, contact Kara Nemergut (nemergut@mit.edu), 617-253-3807.

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Associate Director, Institute for Data, Systems, and Society

Daron Acemoglu, PhD
Elizabeth and James Killian (1926) Professor
Professor of Economics
Member, Institute for Data, Systems, and Society

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Professor of Economics

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Professor of Marketing and Management Science
Professor of Economics
Professor of Brain and Cognitive Sciences

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Professor of Applied Economics
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Robert M. Solow Professor
Professor of Economics

Michael Whinston, PhD
Society of Sloan Fellows Professor of Management
Professor of Economics
Professor of Applied Economics

Muhamet Yildiz, PhD
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Anna Mikusheva, PhD
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Alp Simsek, PhD
Rudiger Dornbusch Career Development Professor
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Alexander Greenberg Wolitzky, PhD
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Castle-Krob Career Development Professor
Assistant Professor of Economics

Martin Beraja, PhD
Pentti Kouri Career Development Professor
Assistant Professor of Economics

Simon Jaeger, PhD
Silverman (1968) Family Career Development Professor
Assistant Professor of Economics

Frank Schilbach, PhD
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Professor Emeritus of Economics

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Paul L. Joskow, PhD
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Michael J. Piore, PhD
David W. Skinner Professor Emeritus
Professor Emeritus of Political Economy
Professor Emeritus of Political Science
Richard Schmalensee, PhD
Howard W. Johnson Professor Emeritus
Professor Emeritus of Management
Professor Emeritus of Economics

Robert M. Solow, PhD
Institute Professor Emeritus
Professor Emeritus of Economics

Peter Temin, PhD
Elisha Gray II Professor Emeritus
Professor Emeritus of Economics

William C. Wheaton, PhD
Professor Emeritus of Urban Studies and Planning
Professor Emeritus of Economics
GLOBAL STUDIES AND LANGUAGES

The Global Studies and Languages Section offers a variety of programs. There are subject sequences in Chinese, French, German, Japanese, Korean, Portuguese, Russian, and Spanish languages and literatures taught in the original; a subject sequence on literature in English translation (SILC); studies in bilingualism; and a comprehensive program in English Language Studies.

The Global Studies and Languages curriculum is arranged in three tiers. Fundamental language subjects familiarize students with the principles of the language in both its spoken and written forms, and introduce them to the culture of the country where the language is spoken. Levels III and IV language subjects provide review and refinement of grammar, study of more difficult reading matter with cultural and literary content, and include compositions and discussions in the target language.

Subjects in language, literature, and culture are conducted in the target language. They introduce students to the form and content of world literatures and of global cultures and societies. These subjects also offer the opportunity to develop more refined communication skills in the language. Advanced subjects, conducted in the target language, encourage students to explore the cultural history of the particular country in which the language is spoken.

Offerings in Studies in International Literatures and Cultures (SILC), taught in English, give students both a specific and comparative focus on global cultures.

Concentrations are available in a given language, literature, or culture in the original language or in English. Concentrations should be arranged on an individual basis in consultation with a designated advisor in each language group.

The Minor Programs in Chinese, French, German, Japanese, and Spanish lead students who have already reached an intermediate level of proficiency into more advanced study of the language, literature, and culture. Note that language levels I and II do not count toward the minor. Also note that, unlike other minor programs in HASS, the minor advisor in each of these languages can, at his or her discretion, approve a minor in which MIT subjects comprise at least one-third of the subjects of the program. However, this exception to the general HASS Minor Requirement is only allowed in those cases in which students have received transfer credits equal to four subjects through study abroad in a country where the language of the minor is the dominant tongue.

Undergraduate Study

Bachelor of Science in Global Studies and Languages (Course 21G)

Program I in French Studies (p. 424), Program II in German Studies (p. 425), and Program III in Spanish Studies (p. 426) are designed to provide competence in reading, writing, and speaking; general knowledge of French, German, or Spanish culture and literature; and advanced subjects in literature, film, and cultural studies.

For each option, the student designs a program in consultation with an advisor in order to meet individual interests, abilities, and goals. However, all majors reflect a balance of historical, geographical, cultural, and linguistic competence.

Other Degree Programs

Joint degree programs are offered in French, German, and Spanish, and include majors in combination with a field in engineering or science (21E, 21S). See the Department of Humanities section (p. 261) for further information.

Minor in Chinese

The Minor in Chinese typically consists of six subjects arranged into three levels of study as follows:

Tier I

Two language subjects at the intermediate level:
Select one of the following options: 24

<table>
<thead>
<tr>
<th>Option 1:</th>
<th></th>
<th>Option 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.103</td>
<td>Chinese III (Regular)</td>
<td>21G.109</td>
</tr>
<tr>
<td>21G.104</td>
<td>Chinese IV (Regular)</td>
<td>21G.110</td>
</tr>
</tbody>
</table>

Tier II

Two language subjects at the advanced level:
Select one of the following options: 24

<table>
<thead>
<tr>
<th>Option 1 (Regular):</th>
<th></th>
<th>Option 2 (Streamlined):</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.105</td>
<td>Chinese V (Regular): Discovering Chinese Cultures and Societies</td>
<td>21G.113</td>
</tr>
<tr>
<td>21G.106</td>
<td>Chinese VI (Regular): Discovering Chinese Cultures and Societies</td>
<td>21G.120</td>
</tr>
</tbody>
</table>

Tier III

Select two of the following subjects in Chinese literature, history, or culture, at least one of which must be a Chinese Language Option subject: 25
21G.043 Introduction to Asian American Studies: Historical and Contemporary Issues
21G.045 Global Chinese Food
21H.151 Traditional China: Earliest Times to 1644
21H.152 Modern China: 1644 to the Present
21H.351 Shanghai and China’s Modernization

**Chinese Language Option (CLO) Subjects:**

21G.138 Romantic Love in Chinese Narrative and Cinematic Traditions
21G.190 Advertising and Media: Comparative Perspectives
21G.192 Modern Chinese Fiction and Cinema
21G.193 Introduction to East Asian Cultures: From Zen to K-Pop
21G.194 China in the News: The Untold Stories
21G.195 Classics of Chinese Literature in Translation
21G.196 The Global Chinese: Chinese Migration, 1567-Present

**Capstone Subject**

21G.199 Chinese Youths and Web Culture

**Total Units:** 73

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**Minor in French**

The Minor in French consists of six subjects typically arranged into three levels of study as follows:

**Tier I**

Two subjects or fewer depending on demonstrated level of entering competence:

- 21G.303 French III
- 21G.304 French IV

**Tier II**

Select two or three of the following intermediate subjects in French language, literature, and culture:

- 21G.308 Writing (Like the) French
- 21G.310 French Conversation: Intensive Practice
- 21G.311 Introduction to French Culture
- 21G.312 Basic Themes in French Literature and Culture
- 21G.315 A Window onto Contemporary French Society

**Tier III**

Select two or three of the following advanced subjects in French literature and culture:

- 21G.049 French Photography
- 21G.052 French Film Classics
- 21G.053 Understanding Contemporary French Politics
- 21G.054 France: Enlightenment and Revolution
- 21G.068 The Invention of French Theory: A History of Transatlantic Intellectual Life since 1945
- 21G.320 Introduction to French Literature
- 21G.321 Childhood and Youth in French and Francophone Cultures
- 21G.322 Frenchness in an Era of Globalization
- 21G.325 New Culture of Gender: Queer France
- 21G.326 Global Africa: Creative Cultures
- 21G.328 African Migrations
- 21G.341 Contemporary French Film and Social Issues
- 21G.344 French Feminist Literature: Yesterday and Today
- 21G.346 Topics in Modern French Literature and Culture
- 21G.347 Social and Literary Trends in Contemporary Short French Fiction
- 21G.348 Global Paris

**Total Units:** 72

---

**Minor in German**

The Minor in German consists of six subjects arranged into three levels of study as follows:

**Tier I**

Two subjects or fewer depending on demonstrated level of entering competence:

- 21G.403 German III
- 21G.404 German IV

**Tier II**

Select two or three of the following subjects in German language, literature, and culture:

- 21G.408 Writing (Like the) German
- 21G.410 German Conversation: Intensive Practice
- 21G.411 Introduction to German Literature
- 21G.412 Basic Themes in German Literature and Culture
- 21G.415 A Window onto Contemporary German Society
- 21G.416 German Film Classics
- 21G.417 Understanding Contemporary German Politics
- 21G.418 Germany: Enlightenment and Revolution
- 21G.419 The Invention of German Theory: A History of Transatlantic Intellectual Life since 1945
- 21G.420 Introduction to German Literature
- 21G.421 Childhood and Youth in German and Germanophone Cultures
- 21G.422 New Culture of Gender: Queer Germany
- 21G.424 Global German

**Total Units:** 72
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.405</td>
<td>Intermediate German: Intensive Study of Language and Culture</td>
</tr>
<tr>
<td>21G.409</td>
<td>Advanced German: Visual Arts, Media, Creative Expression</td>
</tr>
<tr>
<td>21G.410</td>
<td>Advanced German: Communication for Professionals</td>
</tr>
<tr>
<td>21G.412</td>
<td>Advanced German: Literature and Culture</td>
</tr>
</tbody>
</table>

**Tier III**

Select two or three of the following advanced subjects in German literature and culture:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.561</td>
<td>European Politics</td>
</tr>
<tr>
<td>21G.057[J]</td>
<td>Media in Weimar and Nazi Germany</td>
</tr>
<tr>
<td>21G.056</td>
<td>Gender in Science, Technology, and Environment</td>
</tr>
<tr>
<td>21G.058</td>
<td>Migration, Race and Ethnicity in a New Europe and Germany</td>
</tr>
<tr>
<td>21G.059</td>
<td>Paradigms of European Thought and Culture</td>
</tr>
<tr>
<td>21G.064</td>
<td>German Culture, Media, and Society</td>
</tr>
<tr>
<td>21G.065</td>
<td>Germany and Its European Context</td>
</tr>
<tr>
<td>21G.066</td>
<td>20th- and 21st-Century German Literature</td>
</tr>
<tr>
<td>21G.067</td>
<td>Cultural Geographies of Germany: Nature, Culture, and Politics</td>
</tr>
<tr>
<td>21G.068</td>
<td>Migration, Race and Ethnicity in a New Europe and Germany</td>
</tr>
<tr>
<td>21G.069</td>
<td>Visual Histories: German Cinema 1945 to Present</td>
</tr>
</tbody>
</table>

**Total Units** 72

**Minor in Japanese**

The Minor in Japanese consists of six subjects arranged into three levels of study as follows:

**Tier I**

Two language subjects at the intermediate level:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.503</td>
<td>Japanese III</td>
</tr>
<tr>
<td>21G.504</td>
<td>Japanese IV</td>
</tr>
</tbody>
</table>

**Tier II**

Two language subjects at the advanced level:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.505</td>
<td>Japanese V</td>
</tr>
<tr>
<td>21G.506</td>
<td>Japanese VI</td>
</tr>
</tbody>
</table>

**Tier III**

Select two of the following subjects in Japanese literature, history, or culture, at least one of which must be a Japanese Language Option subject:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.433</td>
<td>International Relations of East Asia</td>
</tr>
</tbody>
</table>

**Minor in Spanish**

The Minor in Spanish consists of six subjects arranged into three levels of study as follows:

**Tier I**

Two subjects or fewer depending on demonstrated level of entering competence:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.703</td>
<td>Spanish III</td>
</tr>
<tr>
<td>21G.793</td>
<td>Spanish III in Madrid</td>
</tr>
<tr>
<td>21G.704</td>
<td>Spanish IV</td>
</tr>
</tbody>
</table>

**Tier II**

Select three of the following subjects or fewer depending on demonstrated level of entering competence from the Spanish Intermediate Subjects in Language, Literature, and Culture listing:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.710</td>
<td>Advanced Communication in Spanish: Topics in Language and Culture</td>
</tr>
<tr>
<td>21G.711</td>
<td>Advanced Spanish Conversation and Composition: Perspectives on Technology and Culture</td>
</tr>
</tbody>
</table>

1. The five 13-unit Japanese Language Option subjects—21G.590, 21G.591, 21G.592, 21G.593, 21G.594, and 21G.597—include some assignments that require reading and writing in Japanese, and they meet with the following 12-unit subjects, respectively: 21G.027[J], 21G.039[J], 21G.064, 21G.065, 21G.094, 21G.063, and 21G.067. The 12-unit subjects may be substituted for the 13-unit subjects.
### 21G.712
Spanish Conversation and Composition

### 21G.713
Spanish through Film: Mexico, Chile, Argentina, and Spain

### 21G.714
Spanish for Heritage Learners

### 21G.715
Topics in Medicine and Public Health in the Hispanic World

### 21G.795
Advanced Spanish Communication in Spain

#### Tier III
Select two of the following subjects or more depending on demonstrated level of entering competence from the Spanish Advanced Subjects in Literature and Culture listing:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.070</td>
<td>Latin America and the Global Sixties: Counterculture and Revolution</td>
</tr>
<tr>
<td>21G.072</td>
<td>The New Latin American Novel</td>
</tr>
<tr>
<td>21G.084[J]</td>
<td>Introduction to Latin American Studies</td>
</tr>
<tr>
<td>21G.716[J]</td>
<td>Introduction to Contemporary Hispanic Literature and Film</td>
</tr>
<tr>
<td>21G.717[J]</td>
<td>Introduction to Hispanic Culture</td>
</tr>
<tr>
<td>21G.731[J]</td>
<td>Creation of a Continent: Representations of Hispanic America, 1492-1898, in Literature and Film</td>
</tr>
<tr>
<td>21G.732</td>
<td>The Making of the Latin American City: Culture, Gender, and Citizenship</td>
</tr>
<tr>
<td>21G.735</td>
<td>Advanced Topics in Hispanic Literature and Film</td>
</tr>
<tr>
<td>21G.736</td>
<td>The Short Story in Spain and Hispanic America</td>
</tr>
<tr>
<td>21G.738[J]</td>
<td>Literature and Social Conflict: Perspectives on the Hispanic World</td>
</tr>
</tbody>
</table>

### Total Units
72

#### Other Minors

Please also refer to the Minor in Applied International Studies (p. 351) and the HASS Minors in Regional Studies, which include African and African Diaspora Studies (p. 349), Asian and Asian Diaspora Studies (p. 352), Latin American and Latino/a Studies (p. 360), Middle Eastern Studies (p. 361), and Russian and Eurasian Studies (p. 363).

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**Inquiries**

Further information on subjects and programs may be obtained from the Global Studies and Languages Section Office (http://mitgsl.mit.edu), Room 14N-305, 617-253-4771, or via email (mitgsl@mit.edu).

#### Faculty and Teaching Staff

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**HISTORY**

History is the study of the recorded past. Since interest in the past is closely linked with a desire to understand the present, the history curriculum at MIT is tailored in part to put the modern world in historical perspective. Subjects explore the social, cultural, economic, and political transformations that shape the present; and efforts are made to suggest where traditional assumptions remain in present-day politics, society, and culture.

The curriculum seeks to encourage both an understanding of the human past and the development of skills necessary to express that knowledge effectively.

**Undergraduate Study**

**Bachelor of Science in History (Course 21H)**
The program leading to the degree of Bachelor of Science in History (p. 427) is designed to encourage students to discover and reconstruct the past, to confront and understand the complexity of past human behavior for itself, and to inform their sense of the historical present. The curriculum includes the selection of at least one subject taken from the curriculum’s 21H undergraduate seminars. Students are expected to take seven additional subjects of their own choice, selected in consultation with a major advisor. These must include subjects drawn from at least two geographical areas, as well as one pre-modern (before 1700) and one modern subject.

During the junior year, the history major is required to take subject 21H.390 Theories and Methods in the Study of History, which is intended to develop skills for independent research and writing, followed in the senior year by 21H.THT History Pre-Thesis Tutorial and 21H.THU History Thesis. Subjects 21H.390 Theories and Methods in the Study of History and 21H.THU History Thesis satisfy the CI-M component of the Communication Requirement. Supplemen
ting these requirements within the history curriculum is the stipulation of three additional subjects in a second field of humanities, arts, and social sciences that provide the perspectives of another discipline on the history of human thought and behavior. This program is intentionally flexible; the relatively large number of electives and unrestricted time allows for the design of a course of study that meets individual needs and interests.

**Joint Degree Programs**
Joint degree programs are offered in history in combination with a field in engineering or science (21E, 21S). See the joint degree programs listed under Humanities (p. 261).

**Minor in History**
The goal of this minor is to lead the student from basic survey subjects into more focused studies of individual countries or periods of time, and to encourage thinking about broader analytical and comparative issues in historical study.

The Minor in History consists of six subjects, which must include:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21H.390</td>
<td>Theories and Methods in the Study of History</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Select five subjects as follows: ¹</td>
<td>51-60</td>
</tr>
<tr>
<td></td>
<td>Select at least one 21H seminar, excluding 21H.390</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select four introductory or intermediate subjects from the history curriculum</td>
<td></td>
</tr>
</tbody>
</table>

Total Units: 63-72

¹ At least two temporal periods—one pre-modern (before 1700) and one modern—must be covered by these five subjects. For a list of available subjects, consult the History website (http://history.mit.edu/subjects).
² Select from 21H subjects for which the first digit after the decimal is 3.

**Minor in Applied International Studies**
A range of subjects in history can fulfill requirements for the interdisciplinary Minor in Applied International Studies (p. 351). For more information, see the program description under Interdisciplinary Programs (p. 338).

**Inquiries**
Further information on subjects and programs may be obtained from the History Office, Room E51-255, 617-324-5134.

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Arthur J. Connor Professor  
Professor of History

Merritt Roe Smith, PhD  
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Lerna Ekmekcioglu, PhD  
Genevieve McMillan and Reba Stewart Career Development  
Professor of the Study of Women in the Developing World  
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(On leave)

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Society

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Ford International Professor of History Emeritus

Loren Graham, PhD  
Professor Emeritus of the History of Science

Harold John Hanham, PhD  
Professor Emeritus of History and Political Science

Peter C. Perdue, PhD  
Professor Emeritus of History

William B. Watson, PhD  
Associate Professor Emeritus of History
DEPARTMENT OF HUMANITIES

The Department of Humanities consists of six autonomous sections and programs, each with its own headquarters: Anthropology, Comparative Media Studies/Writing, Global Studies and Languages, History, Literature, Music and Theater Arts. There are also two programs affiliated with the Department: Science, Technology, and Society, and Women’s and Gender Studies.

In addition to the degrees offered in the six sections, other undergraduate degree programs are available, either in combination with a field in engineering or science (the 21E and 21S joint majors) or as interdisciplinary options within the Bachelor of Science in Humanities degree (Course 21). Students interested in any of these degree programs should consult an advisor in the field, as well as the section or program office.

Undergraduate Study

Bachelor of Science in Humanities (Course 21)

The interdisciplinary Bachelor of Science in Humanities (p. 428) degree provides an option for students who wish to pursue their humanistic studies extensively and at an advanced level. All options in this major are by special arrangement, requiring approval by the Dean of the School of Humanities, Arts, and Social Sciences. The available options are as follows:

- American Studies
- Ancient and Medieval Studies
- Asian and Asian Diaspora Studies
- Latin American and Latino/a Studies
- Russian and Eurasian Studies
- Women’s and Gender Studies

Humanities and Engineering / Science

Bachelor of Science in Humanities and Engineering (Course 21E) / Bachelor of Science in Humanities and Science (Course 21S)

These joint degree programs combine humanities with scientific/engineering studies. Groups of subjects from the humanistic and technical areas are conjoined to yield a basic command of each mode of inquiry. One part is a selection from the undergraduate degree curriculum of a science or engineering department approved by a faculty member in the field. The other part consists of subjects in a humanities field, chosen by the student in consultation with an advisor from the appropriate humanities faculty. In most cases, a senior thesis or sequence of advanced seminars is also required.

This arrangement yields a humanities program of considerable depth while allowing for continued serious commitment to a scientific or engineering interest. Available humanities fields include:

- American Studies
- Ancient and Medieval Studies
- Anthropology
- Asian and Asian Diaspora Studies
- Comparative Media Studies
- Global Studies and Languages (in French, German, or Spanish)
- History
- Latin American and Latino/a Studies
- Literature
- Music
- Russian and Eurasian Studies
- Science, Technology, and Society
- Theater Arts
- Women’s and Gender Studies
- Writing (Creative, Digital Media, or Science Writing)

Faculty advisors in each discipline help students to arrange programs suited to both their interests and professional objectives. Any one of these fields may be joined with any science or engineering field to form a major. Some combinations naturally lend themselves not only to an understanding of each field but also to an integrative and comparative view of the relationship between the two.

Students may take Course 21E (p. 430) or Course 21S (p. 434) as part of the double major program outlined in the section on Undergraduate Education. However, because 21E and 21S are composite degrees, a second major is not allowed in either field of a student’s chosen program. For example, if a student pursues a 21S degree with the Science portion in Course 8, the student would not be permitted to apply for a second major in Course 8. Similarly, if the Humanities portion of the 21S degree were in Course 21L, the student could not apply for a second major in Course 21L.
DEPARTMENT OF LINGUISTICS AND PHILOSOPHY

As its name suggests, the Department of Linguistics and Philosophy houses a linguistics section and a philosophy section. Though they share a number of intellectual interests and a joint undergraduate major, these two sections are administratively autonomous with separate chairpersons, faculties, admissions procedures, curricular and degree requirements, and financial aid programs.

Undergraduate Study

Bachelor of Science in Philosophy (Course 24-1)
This major (p. 443) is designed to provide familiarity with the history and current status of the main problems in epistemology, metaphysics, and ethics; mastery of some of the technical skills requisite for advanced work in philosophy; facility at independent philosophical study; and work at an advanced level in an allied field. A relatively large amount of unrestricted elective time is available so that students can devise programs suited to individual needs and interests.

Bachelor of Science in Linguistics and Philosophy (Course 24-2)
This major, also known as the Program in Language and Mind, aims to provide students with a working knowledge of a variety of issues that currently occupy the intersection of philosophy, linguistics, and cognitive science. Central among these topics are the nature of language, of those mental representations that we call “knowledge” and “belief,” and of the innate basis for the acquisition of certain types of knowledge (especially linguistic knowledge). Students have the option of pursuing either a philosophy track (p. 439) or a linguistics track (p. 438). Both require a core set of subjects drawn from both fields and are designed to teach students the central facts and issues in the study of language and the representation of knowledge. Each track requires, in addition, a set of subjects drawn primarily from its discipline and is designed to prepare students for graduate study either in philosophy/cognitive science or in linguistics. A coherent program of three restricted electives (drawn from one or two of the following three areas: linguistics, philosophy, or a related area) rounds out the major.

Note that students are prohibited from majoring in both 24-1 and 24-2.

Minor in Philosophy
The goal of the Minor in Philosophy is to introduce students to the methods of analytic philosophy and then to have them study a broad range of philosophers and philosophical issues at a more sophisticated level, culminating in an advanced seminar.

The minor consists of six subjects arranged into three levels of study as follows:

Minor in Linguistics

The Minor in Linguistics consists of six subjects arranged in three levels of study, intended to provide students with breadth in the field of theoretical linguistics as a whole. The three levels are as follows:

Tier I
Select any introductory philosophy subject numbered 24.00 - 24.09 1
Select one of the following logic subjects: 2

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.118</td>
<td>Paradox and Infinity</td>
</tr>
<tr>
<td>24.241</td>
<td>Logic I</td>
</tr>
<tr>
<td>24.242</td>
<td>Logic II</td>
</tr>
<tr>
<td>24.243</td>
<td>Classical Set Theory</td>
</tr>
<tr>
<td>24.244</td>
<td>Modal Logic</td>
</tr>
<tr>
<td>24.245</td>
<td>Theory of Models</td>
</tr>
</tbody>
</table>

Tier II
Select three non-introductory philosophy subjects, approved by the minor advisor

Tier III
24.260  Topics in Philosophy 12

Total Units 72

1 Students may substitute an appropriate philosophy concourse subject with the permission of the minor advisor.

2 Students may take a logic subject offered by another department (e.g., Mathematics) with the permission of the minor advisor.

Minor in Linguistics

<table>
<thead>
<tr>
<th>Tier I</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.900</td>
</tr>
</tbody>
</table>

Tier II

<table>
<thead>
<tr>
<th>Tier II</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.901</td>
</tr>
<tr>
<td>24.902</td>
</tr>
<tr>
<td>24.903</td>
</tr>
</tbody>
</table>

Tier III
Select two of the following:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.904</td>
<td>Language Acquisition</td>
</tr>
<tr>
<td>24.905[J]</td>
<td>Laboratory in Psycholinguistics</td>
</tr>
<tr>
<td>24.906[J]</td>
<td>The Linguistic Study of Bilingualism</td>
</tr>
<tr>
<td>24.909</td>
<td>Field Methods in Linguistics</td>
</tr>
<tr>
<td>24.910</td>
<td>Advanced Topics in Linguistic Analysis</td>
</tr>
<tr>
<td>24.914</td>
<td>Language Variation and Change</td>
</tr>
<tr>
<td>24.915</td>
<td>Linguistic Phonetics</td>
</tr>
</tbody>
</table>

Total Units 72

1 24.9000 How Language Works is also an acceptable option.
Graduate Study

Master of Science in Linguistics
The Department of Linguistics (http://linguistics.mit.edu) and Philosophy (http://web.mit.edu/philosophy) has an Indigenous Language Initiative program leading to a Master of Science in Linguistics. For more information about this experimental degree, visit the website or contact the program administrator (mitlli@mit.edu).

Doctor of Philosophy in Linguistics
The Linguistics Section offers a demanding program leading to the degree of Doctor of Philosophy in Linguistics. The normal course of study is five years, including the writing of the dissertation. The orientation of the program is highly theoretical, its central aim being the development of a general theory that reveals the rules and laws that govern the structure of a given language and the general laws and principles that govern all natural languages. The topics that form the core of this program are the traditional ones of phonology, syntax, and semantics, but the program’s interests also extend into questions of the interrelations between linguistics and other disciplines such as philosophy and logic, speech science and technology, computer science and artificial intelligence, and study of the brain and cognition.

Approximately eight students enter the program each year in a highly selective admissions process. The department does not require that applicants have taken any particular set of subjects or that they be trained in any particular discipline. Instead, applicants must present evidence that they are able to engage in serious scholarly inquiry of complex subject matter.

All students in the linguistics program must complete a set of required subjects unless they have acquired adequate preparation elsewhere. Before degree candidates begin their doctoral research, they are required to pass a comprehensive general examination that is composed of two parts. The first part is a written examination consisting of two substantial papers on topics chosen in consultation with members of the faculty. The two papers must present research on two distinct topics in two distinct subdisciplines of linguistics. The subdisciplines include phonetics, phonology, syntax, semantics, pragmatics, language acquisition, language processing, or any other area of linguistics, so long as there is a substantial theoretical-linguistic component to the papers. In conformity with Institute regulations, the second part of the examination is oral. It deals with topics treated in the candidate’s written examination, but is not limited to these and probes into the candidate’s competence in linguistics in general.

For more information about the PhD program requirements, visit the website (http://web.mit.edu/philosophy/PhDprogram.html).

Doctor of Philosophy in Philosophy
The program of studies leading to the doctorate in philosophy provides subjects and seminars in such traditional areas as logic, ethics, metaphysics, epistemology, philosophy of science, philosophy of language, philosophy of mind, aesthetics, social and political philosophy, and history of philosophy. Interest in philosophical problems arising from other disciplines, such as linguistics, psychology, mathematics, and physics, is also encouraged.

To enter the doctoral program, students must have done well in their previous academic work and must be formally accepted as candidates for the degree by the Department of Linguistics and Philosophy. Although there are no formal course requirements for admission, applicants must satisfy the committee on admissions that their preparation in philosophy and allied disciplines is sufficient for undertaking the study of philosophy at the graduate level.

Before beginning dissertation research, students are required to take two years of coursework, including a proseminar in contemporary philosophy that all students must complete in their first year of graduate study. Students are also required to demonstrate competence in the following areas: value theory, logic, and the history of philosophy.

Interdisciplinary study is encouraged, and candidates for the doctorate may take a minor in a field other than philosophy. Options for minors include linguistics, psychology, and logic. Students who elect one of these options are expected to complete three

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.951</td>
<td>Introduction to Syntax</td>
<td>12</td>
</tr>
<tr>
<td>24.961</td>
<td>Introduction to Phonology</td>
<td>12</td>
</tr>
<tr>
<td>24.970</td>
<td>Introduction to Semantics</td>
<td>12</td>
</tr>
<tr>
<td>24.952</td>
<td>Advanced Syntax</td>
<td>12</td>
</tr>
<tr>
<td>24.962</td>
<td>Advanced Phonology</td>
<td>12</td>
</tr>
<tr>
<td>24.973</td>
<td>Advanced Semantics</td>
<td>12</td>
</tr>
<tr>
<td>24.993</td>
<td>Tutorial in Linguistics and Related Fields</td>
<td></td>
</tr>
<tr>
<td>24.942</td>
<td>Topics in the Grammar of a Less Familiar Language</td>
<td>12</td>
</tr>
<tr>
<td>24.949[J]</td>
<td>Language Acquisition I</td>
<td>9</td>
</tr>
</tbody>
</table>
approved graduate subjects in their minor field. There is no general language requirement for the doctorate, except in those cases in which competence in one or more foreign languages is needed to carry on research for the dissertation.

For more information about the PhD program requirements, visit the website (http://web.mit.edu/philosophy/PhDprogram.html).

Inquiries
Information regarding undergraduate or graduate academic programs, research activities, admissions, financial aid, and assistantships may be obtained from the Department of Linguistics and Philosophy, Room 32-D808, 617-253-9372.

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Head, Department of Linguistics and Philosophy

Professors
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James Wesley Harris, PhD  
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Professor Emeritus of Spanish  

Irene R. Heim, PhD  
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Samuel Jay Keyser, PhD  
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Robert Stalnaker, PhD  
Laurance S. Rockefeller Professor in Philosophy Emeritus  

Judith Jarvis Thomson, PhD  
Professor Emerita of Philosophy  

Kenneth Wexler, PhD  
Professor Emeritus of Psychology  
Professor Emeritus of Linguistics
LITERATURE

The Literature curriculum is arranged in four graduated categories: Undergraduate Study taught that term and includes specific information about subject either online A supplement to this catalog is available before each semester, that will remain with you the rest of your life. the world, and lead to a competence in writing and communication choice, our courses will introduce you to the pleasures of reading and interpretation, expose you to different ways of thinking about Depending on the depth of one’s engagement, a student may major, minor, or concentrate in Literature. Regardless of the individual choice, our courses will introduce you to the pleasures of reading and interpretation, expose you to different ways of thinking about the world, and lead to a competence in writing and communication that will remain with you the rest of your life.

A supplement to this catalog is available before each semester, either online (http://lit.mit.edu) or from Literature Headquarters, Room 14N-407. It offers detailed descriptions of all subjects being taught that term and includes specific information about subject content and required texts.

Undergraduate Study

The Literature curriculum is arranged in four graduated categories:

- **Introductory** subjects (21L.000[J] to 21L.024) focus on major literary texts grouped in broad historical and generic sequences; all introductory subjects carry HASS and Communication-Intensive credit.
- **Samplings** (21L.310[J] to 21L.339[J]), 21L.345 to 21L.355) are 6-unit subjects that provide both an alternative route into literary and filmic 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 6-unit Samplings subjects to count as a HASS subject in the Humanities category and the equivalent of a subject in the Intermediate tier. However, no more than four 6-unit subjects may be combined in this manner. See the HASS

Requirement website (http://web.mit.edu/hassreq) or contact Literature Headquarters (lit@mit.edu) for details.

- **Intermediate** subjects (21L.400 to 21L.639[J]) explore literary and visual forms as well as critical analysis in greater depth. Some subjects center on historical periods, literary themes, or genres; others focus on media studies, comparative cultural studies, or national literatures.
- **Seminar** subjects (21L.640 to 21L.715) are usually restricted to students who have taken at least two previous subjects in Literature and encourage a greater degree of independent work, such as oral reports and other special projects. Enrollment in seminars is strictly limited to a maximum of 12 students.

The Literature Section also offers a few subjects in languages other than English (21L.607 to 21L.640[J]) for students with adequate preparation. If appropriate, they may count toward the Literature major and minor requirements after consultation with the major/minor advisor.

In addition, the Literature Section often offers 6-unit special subjects for credit during IAP. Students may also choose to take special subjects (21L.S88 to 21L.S97) and independent study or research supervised by a faculty member (21L.900 and 21L.901) during the fall and spring terms.

Concentrations in Literature are available in particular genres (e.g., poetry, drama, fiction) and in historical periods (e.g., ancient studies, 19th-century literature, modern and contemporary literature), as well as in media and film studies, world literatures and cultures, popular culture, minority and ethnic studies, literary theory, and a range of national literatures.

**Bachelor of Science in Literature (Course 21L)**

The program in Literature leading to the Bachelor of Science in Literature (p. 440) is equivalent to the curricula in English (or literary studies) at major liberal arts institutions. The Literature curriculum is notable also for its integration of materials drawn from film and media, popular culture, and minority and ethnic cultures.

Majors are required to take a minimum of 10 subjects, three of which must be seminars and no more than three of which may be introductory subjects. Students develop an appropriate course of study in consultation with a faculty advisor; majors choose from one of two areas in organizing four of their restricted electives (three for joint majors): historical periods or thematic complexes.

**Joint Degree Programs**

Joint degree programs are offered in Literature in combination with a field in engineering or science (21E, 21S). See the joint degree programs listed under Humanities (p. 261).

**Minor in Literature**

The minor aims to lay a foundation for advanced study and to enhance a student’s appreciation of major narrative, poetic, and dramatic texts in relation to the cultures that produced them. It
consists of six subjects arranged into three levels of study as described below; at least two subjects must focus primarily on material prior to 1900.

**Tier I: Introductory Level**

*Select at least one and no more than two subjects from the following:*  
9-24

- 21L.000[J] Writing About Literature
- 21L.001 Foundations of Western Literature: Homer to Dante
- 21L.002 Foundations of Western Literature: From Shakespeare to the Present
- 21L.003 Reading Fiction
- 21L.004 Reading Poetry
- 21L.005 Introduction to Drama
- 21L.006 American Literature
- 21L.007 World Literatures
- 21L.008[J] Black Matters: Introduction to Black Studies
- 21L.009 Shakespeare
- 21L.010[J] Writing with Shakespeare
- 21L.011 The Film Experience
- 21L.012 Forms of Western Narrative
- 21L.013[J] The Supernatural in Music, Literature and Culture
- 21L.014[J] Introduction to Ancient and Medieval Studies
- 21L.015 Children’s Literature
- 21L.017 The Art of the Probable
- 21L.018 Introduction to English Literature
- 21L.019 Introduction to European and Latin American Fiction
- 21L.020[J] Globalization: The Good, the Bad and the In-Between
- 21L.021 Comedy
- 21L.022[J] Darwin and Design
- 21L.023[J] Folk Music of the British Isles and North America

**Tier II: Intermediate Level**

*Select two or three subjects from the following:*  
21-36

- 21L.430 Popular Culture and Narrative
- 21L.431 Shakespeare on Film and Media
- 21L.432 Understanding Television
- 21L.433 Film Styles and Genres
- 21L.434 Science Fiction and Fantasy
- 21L.435 Literature and Film
- 21L.449 The Wilds of Literature
- 21L.451 Literary Theory
- 21L.455 Ancient Authors
- 21L.458 The Bible
- 21L.460 Arthurian Literature
- 21L.471 Major Novels
- 21L.473[J] Jane Austen
- 21L.475 Enlightenment and Modernity
- 21L.485 Modern Fiction
- 21L.486 Modern Drama
- 21L.487 Modern Poetry
- 21L.488 Contemporary Literature
- 21L.489[J] Interactive Narrative
- 21L.490[J] Introduction to the Classics of Russian Literature
- 21L.501 The American Novel
- 21L.504[J] Race and Identity in American Literature
- 21L.512 American Authors
- 21L.590 Cultural Encounters: Global Literature Abroad
- 21L.603[J] Old English and Beowulf
- 21L.638[J] Literature and Social Conflict: Perspectives on the Hispanic World

**Tier III: Seminar Level**

*Select at least two of the following:*  
24

- 21L.701 Literary Methods
- 21L.702 Studies in Fiction
- 21L.703 Studies in Drama
- 21L.704 Studies in Poetry
- 21L.705 Major Authors
- 21L.706 Studies in Film
- 21L.707 Problems in Cultural Interpretation
- 21L.709 Studies in Literary History
- 21L.715 Media in Cultural Context

Total Units 66-72

1. Note: In most cases, two 6-unit Samplings subjects may be combined to substitute for an intermediate level subject.

**Inquiries**

Further information on subjects and programs may be obtained from Literature Headquarters (lit@mit.edu), Room 14N-407, 617-253-3581.
Faculty and Teaching Staff

Mary C. Fuller, PhD
Professor of Literature
Head, Literature Section

Professors
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Professor of Literature
(On leave, fall)

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(On leave)

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Professor of Literature
(On leave)

Shankar Raman, PhD
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Lecturers
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Lecturer in Literature

Joaquín Terrones, PhD
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Professors Emeriti
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Professor Emeritus of Literature

Louis Kampf, BA
Professor Emeritus of Literature

Irene Tayler, PhD
Professor Emerita of Literature
MUSIC AND THEATER ARTS

Music and Theater Arts invites students to explore these disciplines as artistic practices and as cultural, intellectual, and personal avenues of inquiry and discovery. Students may pursue concentrations, minors, or majors in either Music or Theater Arts, as well as joint majors with Engineering or Science.

The Music program develops students’ creativity, talent, research ability and aesthetic sensibility through performance, composition, history, culture, technology, and analysis. Understanding of the various facets of music is cultivated through both the making and the study of music, in close contact with professors, performers, conductors, coaches, and scholars. The scope of musical investigation and experience incorporates classical, vernacular, and experimental traditions from a wide range eras and cultures, western and non-western.

Classes are tailored to the prior experiences of students who take them, from introductory subjects for students with no previous background to advanced seminars, private lessons, and performance opportunities for musicians ready to work at near-professional levels. The program integrates and deepens connections between music and technology, science, society, and other humanities disciplines, creating an experience that is intensely rich and uniquely MIT.

Theater Arts is taught as a mode of inquiry into self and society with the intention that such an inquiry can become the vehicle for transformation of one or both. The Theater Arts program is process-oriented and committed to diversity of creative forms. The curriculum is designed to help students acquire the necessary artistic, technical and intellectual skills to create theater of quality and imagination.

Performance is the testing ground for what is learned in the classroom. Performance and design experiences range from student-generated workshops in the studio to fully-realized productions on the stage. These curricular activities are guided by professional faculty and staff, often with enriching participation of guest artists.

Music and Theater Arts is united in our pursuit of artistic, intellectual, creative, and technical excellence. This requires intense focus and dedication by all members of our community.

We value diversity and practice inclusion with regard to identities, backgrounds, opinions, and beliefs. Because we see our students as whole people, we prioritize their mental, emotional, and physical health above the quality of their work. This ethos extends to both our advisory and pedagogical relationships. Diversity, wellness, and inclusion are likewise central to our curriculum and hiring. We are therefore committed to recruiting a diverse faculty and staff to enhance the educational experience of the students we serve.

Undergraduate Study

Bachelor of Science in Music (Course 21M-1)
The undergraduate program leading to the Bachelor of Science in Music (p. 442) degree comprises a grounding in foundational skills in music history and culture, performance, and music theory; a capstone Advanced Seminar; and a coherent program in a musical specialty. Six required subjects (one of which consists of two terms of performance, and two of which satisfy the CI-M requirement) and five restricted electives satisfy these requirements, but should be supplemented by additional electives. The program is analogous to those for music majors at leading liberal arts institutions and prepares a student for graduate study in music. Students should demonstrate proficiency in musical fundamentals and have performance experience before declaring the major and should consult the major advisor in music no later than the first term of their junior year.

Bachelor of Science in Theater Arts (Course 21M-2)
The undergraduate program leading to the Bachelor of Science in Theater Arts (p. 448) degree comprises a broad foundation in theoretical and practical studies, and intensive performance and design practica. To satisfy the requirements, students complete a coherent set of restricted elective subjects (two of which satisfy the CI-M requirement) in addition to a capstone thesis (including a pre-thesis tutorial). With an emphasis on artistic practice, this course of study prepares students who plan either to enter the field or to pursue graduate studies in theater arts. Students should demonstrate proficiency in theater arts fundamentals, should have some performance experience before declaring the major, and should consult the major advisor in Theater Arts no later than the first term of their junior year.

Joint Degree Programs

The undergraduate program leading to the 21E (Humanities and Engineering) or 21S (Humanities and Science) degree with a focus in music, provides an opportunity to study and combine music with a scientific or engineering field. The joint major requires nearly the same foundational and capstone subjects as the full major (five subjects: the additional CI-M in music is not required), six subjects beyond the GIRs in a coherent program in engineering or science (often a subset of a departmental major), and a musical specialty of four subjects. Ideally, some of the subjects in the science or engineering program as well as the musical specialty should complement the forms of learning in the other, adding cohesion to the program. Students should demonstrate proficiency in musical fundamentals and have performance experience before declaring the major and should consult the major advisor in music no later than the first term of their junior year. Additional information can be found under Humanities (p. 264).
Minor in Music
The Minor in Music requires six subjects that will give students experience within the three main branches of music: history/culture, composition/theory, and performance.

Tier I: Introduction
Select up to two of the following: 0-24
21M.011 Introduction to Western Music
21M.013[J] The Supernatural in Music, Literature and Culture
21M.030 Introduction to World Music
21M.051 Fundamentals of Music
21M.065 Introduction to Musical Composition
21M.080 Introduction to Music Technology

Tier II: Breadth
Select three subjects, one from each of the following categories: 36
History/Culture
21M.215 Music of the Americas
21M.220 Medieval and Renaissance Music
21M.223[J] Folk Music of the British Isles and North America
21M.226 Jazz
21M.235 Baroque and Classical Music
21M.250 Nineteenth-Century Music
21M.260 Music since 1900
21M.269 Studies in Western Music History
21M.271 Symphony and Concerto
21M.273 Opera
21M.283 The Musical
21M.284 Film Music
21M.289 Studies in Western Classical Genres
21M.291 Music of India
21M.292 Music of Indonesia
21M.293 Music of Africa
21M.294 Popular Musics of the World
21M.295 American Popular Music
21M.296 Studies in Jazz and Popular Music
21M.299 Studies in World Music
Composition/Theory
21M.301 Harmony and Counterpoint I
21M.302 Harmony and Counterpoint II
21M.303 Writing in Tonal Forms I
21M.304 Writing in Tonal Forms II
21M.310 Techniques of 20th-Century Composition
21M.340 Jazz Harmony and Arranging
21M.341 Jazz Composition
21M.342 Composing for Jazz Orchestra
21M.351 Music Composition
21M.355 Musical Improvisation
21M.359 Studies in Musical Composition, Theory and Analysis

Tier III: Electives
Select one to three subjects from the following: 12-36
History/Culture
21M.215 Music of the Americas
21M.220 Medieval and Renaissance Music
21M.223[J] Folk Music of the British Isles and North America
21M.226 Jazz
21M.235 Baroque and Classical Music
21M.250 Nineteenth-Century Music
21M.260 Music since 1900
21M.269 Studies in Western Music History
21M.271 Symphony and Concerto
21M.273 Opera
21M.283 The Musical
21M.284 Film Music
21M.289 Studies in Western Classical Genres
21M.291 Music of India
21M.292 Music of Indonesia
21M.293 Music of Africa
21M.294 Popular Musics of the World
21M.295 American Popular Music
21M.296 Studies in Jazz and Popular Music
21M.299 Studies in World Music

Performance (12 units)
21M.401 MIT Concert Choir
21M.405 MIT Chamber Chorus
21M.410 Vocal Repertoire and Performance
21M.421 MIT Symphony
21M.423 Conducting and Score-Reading
21M.362  Electronic Music Composition II  
21M.380  Music and Technology  
21M.385[J]  Interactive Music Systems  
21M.387  Fundamentals of Music Processing  

**Performance (four terms)**  
21M.401  MIT Concert Choir  
21M.405  MIT Chamber Chorus  
21M.410  Vocal Repertoire and Performance  
21M.421  MIT Symphony  
21M.423  Conducting and Score-Reading  
21M.426  MIT Wind Ensemble  
21M.442  MIT Festival Jazz Ensemble  
21M.445  Chamber Music Society  
21M.450  MIT Balinese Gamelan  
21M.451  Studio Accompanying for Pianists  
21M.460  MIT Senegalese Drum Ensemble  
21M.480  Advanced Music Performance  
21M.490  Emerson Scholar Solo Recital  

Advanced Seminar in Music  

Total Units  72

**Minor in Theater Arts**  
The Minor in Theater Arts is designed to give students the opportunity to experiment in the making of theater. The flexibility of the minor allows students either to explore the basic principles of several theater disciplines or to concentrate more deeply on one.  
The Minor in Theater Arts consists of the equivalent of six subjects arranged in three levels of study as follows:  

**Tier I: Theoretical Studies**  
Select one of the following:  9-12  
21M.611  Foundations of Theater Practice  
21M.690  Sport as Performance  
21M.700  China on Stage  
21M.706  Asian American Theater  
21M.710  Script Analysis  
21M.711  Production Seminar  
21M.714  Contemporary American Theater  
21M.715  Topics in Theater Arts  
21M.800  All the World’s a Stage: Socio-Political Perspectives in Global Performance  
21M.846  Topics in Performance Studies  
21M.848  Performance Studies: Advanced Theories of Sport  

**Tier II: Practical Studies**  
Select four of the following:  36-48  
21M.600  Introduction to Acting  
21M.601  Drawing for Designers  
21M.603  Introduction to Design for the Theater  
21M.604[J]  Playwriting I  
21M.605  Voice and Speech for the Actor  
21M.606  Introduction to Stagecraft  
21M.608  Beginning Screenwriting  
21M.624  Acting with the Camera  
21M.645  Motion Theater  
21M.704  Music Theater Workshop  
21M.705  The Actor and the Text  
21M.732  Costume Design  
21M.733  Set Design  
21M.734  Lighting Design  
21M.735  Technical Design for Performance  
21M.737  Interactive Design and Projection for Live Performance  
21M.785[J]  Playwrights’ Workshop  
21M.790  Director’s Craft  
21M.830  Acting: Techniques and Style  
21M.840  Performance Media  
21M.842  Live Cinema Performance  
21M.861  Topics in Performance Technique  
21M.862  Topics in Performance Practice  
21M.863  Advanced Topics in Theater Arts  

**Tier III: Performance and Design**  
Select 12 units from the following:  1  
21M.803  Performance and Design Workshop  
21M.806  Applied Performance and Design Production  
21M.809  Performance and Design Intensive  
21M.851  Independent Study in Performance and Design  

Total Units  57-72  

1  The 12 units for Tier III must be taken over at least two terms.

**Inquiries**  
For further information on subjects and programs, contact the Music and Theater Arts Office, Room 4-246, 617-253-3210.
Faculty and Teaching Staff

Keeril Makan, PhD
Michael Koerner (1949) Professor in Music Composition
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Head, Music and Theater Arts

Professors
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Class of 1949 Professor
Professor of Music
(On leave, fall)

Claire Conceison, PhD
Quanta Professorship in Chinese Culture
Professor of Theater Arts

John H. Harbison, MFA
Institute Professor
Professor of Music

Jay R. Scheib, MFA
Class of 1949 Professor
Professor of Theater Arts
(On leave, fall)

Janet Sonenberg, MFA
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(On leave, spring)

Marcus Aurelius Thompson, DMA
Institute Professor
Professor of Music

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Kenan Sahin (1963) Distinguished Professor
Professor of Music

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Senior Lecturer in Music

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Senior Lecturer in Music

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Lecturers
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Lecturer in Music

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Elena Ruehr, PhD
Lecturer in Music

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Peter Whincop, MA
Lecturer in Music

Technical Instructors
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Technical Instructor of Theater Arts

Stephanie Rodemann, MFA
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Professors Emeriti
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Professor Emerita of Music

Alan Brody, PhD
Professor Emeritus of Theater Arts

Ellen T. Harris, PhD
Professor Emerita of Music

Lowell Edwin Lindgren, PhD
Professor Emeritus of Music

Michael Ouelette, MFA
Senior Lecturer Emeritus in Theater Arts

Barry Lloyd Vercoe, DMA
Professor Emeritus of Media Arts and Sciences
Professor Emeritus of Music
DEPARTMENT OF POLITICAL SCIENCE

Political science is concerned with the systematic study of government and the political process. Within the discipline, scholars analyze the development, distribution, and uses of political power; determinants and consequences of various forms of political behavior and sources of political conflict; ways in which conflicts are both intensified and resolved; and the relationship between the individual and the state. Political science is a discipline of special interest to scientists and engineers who must understand the political system within which they live in order to evaluate their influence upon that system. It is of interest as well to those students who are considering careers in public service or university teaching and research.

The Department of Political Science has a research-oriented faculty that welcomes both undergraduate and graduate students in ongoing research. The department covers the fields of American politics and public policy, comparative politics, international relations and foreign policy, and political philosophy and social theory, with particular emphasis on ethnicity and identity, international security, representation, and the politics of globalization. The Department of Political Science offers degree programs at the bachelor’s, master’s, and doctoral levels.

Undergraduate Study

Bachelor of Science in Political Science (Course 17)
The political science curriculum (p. 445) for undergraduates combines professional social science training with opportunities for a broad liberal arts education. Students may choose subjects from a wide range of both undergraduate and graduate offerings, and are encouraged to engage in independent research projects. In addition, the department sponsors an internship program in which students work in governmental agencies, legislative offices, community associations, international organizations, and advocacy groups at all levels.

The undergraduate program prepares students for study in political science, law, public policy, and related fields, and for careers in government, business, law, research, teaching, or journalism. This program is also designed to give students, whatever their career objectives, an understanding of political institutions and processes. Some students want to focus on political systems themselves; others choose to concentrate on the political aspects of public policy, focusing on such issues as the environment, health, or arms control. Both of these perspectives are found in the program.

Subjects are offered by the department in the following fields: political theory, political economy, American politics, public policy, international relations and security studies, comparative politics, and models and methods. Students may work out individualized programs with the assistance of a faculty advisor.

In the junior year students are introduced to the major theoretical and methodological themes of political science in two subjects:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.801</td>
<td>Political Science Scope and Methods (typically fall term, junior year)</td>
<td>12</td>
</tr>
<tr>
<td>17.803</td>
<td>Political Science Laboratory (typically spring term, junior year)</td>
<td>15</td>
</tr>
</tbody>
</table>

The department believes that every political science major should have the experience of conducting and writing at least one substantial research project, a requirement that is fulfilled by the senior thesis. Each undergraduate chooses a thesis advisor and a second thesis reader in his or her area of interest. The student then registers for:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.THT</td>
<td>Thesis Research Design Seminar (fall term, senior year)</td>
<td>12</td>
</tr>
<tr>
<td>17.THU</td>
<td>Undergraduate Political Science Thesis (spring term, senior year)</td>
<td>15</td>
</tr>
</tbody>
</table>

In addition to the thesis, there are numerous other opportunities for students to pursue research interests. Students are eligible to receive academic credit or limited funding for expenses or wages through the Institute-wide Undergraduate Research Opportunities Program (UROP) (p. 44). Students should consult the department’s UROP coordinator to discuss specific projects.

Minor in Political Science

The objective of the minor is to deepen and expand student knowledge of the discipline of political science. It consists of six subjects divided into two tiers, selected from the discipline’s subfields as listed in the online MIT Subject Listing & Schedule (http://student.mit.edu/catalog). The requirements of the minor are as follows:

Tier I

Select at least one but no more than two introductory classes, which are designated by two-digit numbers. These classes provide broad theoretical and/or empirical overviews of their subject matter. Examples include:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.01</td>
<td>Justice</td>
</tr>
<tr>
<td>17.20</td>
<td>Introduction to the American Political Process</td>
</tr>
<tr>
<td>17.40</td>
<td>American Foreign Policy: Past, Present, and Future</td>
</tr>
<tr>
<td>17.50</td>
<td>Introduction to Comparative Politics</td>
</tr>
</tbody>
</table>

Tier II
Select at least four but no more than five upper-level classes, which are designated by three-digit numbers. These specialized classes provide students with advanced and in-depth examination of their subject matter. Examples include:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.317</td>
<td>US Social Policy</td>
</tr>
<tr>
<td>17.473</td>
<td>The Politics of Nuclear Proliferation</td>
</tr>
<tr>
<td>17.483</td>
<td>US Military Power</td>
</tr>
<tr>
<td>17.561</td>
<td>European Politics</td>
</tr>
</tbody>
</table>

Total Units 72

For a listing of available subjects in these areas, consult Tobie Weiner in the Political Science Undergraduate Office, Room E53-484 or the SHASS Dean’s Office, Room 4-240. Examples of subject selections for this minor are also available on the department’s website (http://web.mit.edu/polisci/undergraduate/minor).

Minor in Applied International Studies
The interdisciplinary HASS Minor in Applied International Studies (p. 351) prepares students for an increasingly global business and research environment by integrating international learning into their course of study. A detailed description of this minor may be found under Interdisciplinary Programs (p. 338).

Minor in Public Policy
The Department of Political Science jointly offers a Minor in Public Policy (Course 11) with the Department of Urban Studies and Planning (Course 11). A detailed description and list of requirements for this minor may be found under Interdisciplinary Programs (p. 338).

Graduate Study
The Department of Political Science offers programs leading to the Master of Science in Political Science and the Doctor of Philosophy.

Admission Requirements for Graduate Study
All applicants must take the GRE general test. Non-native English speakers must take the Test of English as a Foreign Language (TOEFL) or International English Language Testing System (IELTS). Applicants from all disciplines are welcome—an undergraduate degree in political science is not necessary. Applicants are encouraged, however, to complete significant coursework in political science or related subjects such as history, economics, philosophy, psychology, or sociology before applying to one of our graduate programs.

Master of Science in Political Science
The Master of Science in Political Science is a one-year program intended for students who wish to develop skills in applied research in preparation for a career in public policy or with a business or research organization. The master's program emphasizes intensive preparation in a single field of study. Applicants to the SM program should specify their field of specialization.

The minimum number of subjects required for the SM degree is six graduate subjects, at least four of which must be completed in the Political Science Department at MIT. The remaining two may be taken elsewhere at MIT or through cross-registration at Harvard University. A 3.5 GPA must be maintained. A master's thesis is required. See the section on Graduate Education (p. 60) for the general requirements for the SM.

Accelerated Master of Science in Political Science
The department offers a five-year program leading to the Bachelor of Science and Master of Science, awarded simultaneously. This program is open to MIT undergraduate Political Science majors only. It allows the student to plan for a single combined SB-SM thesis written during the last three terms at the Institute. Undergraduate Institute requirements may be completed during the fifth year of the program.

Doctor of Philosophy
Doctoral students must complete the following requirements:

- One class for first-year students introducing principles of empirical and theoretical analysis in political science
- One class in statistics
- One class in empirical research methods
- One class in political philosophy
- Reading proficiency in one language other than English (demonstrated by two semesters of intermediate-level college coursework or an exam) or knowledge of advanced statistics (demonstrated by three semesters of course work or an exam)
- A second-year paper and related workshop
- A doctoral thesis

In addition, doctoral students are required to elect two of the following major fields: American politics, comparative politics, international relations, models and methods, political economy, and security studies. In each of the two elected fields, students will take a written general exam followed by a single oral general exam covering both fields. Specific fields may have additional requirements.

Students may take subjects in other MIT departments. Cross-registration arrangements also permit enrollment in subjects taught in the Graduate School of Arts and Sciences at Harvard University and in some of Harvard’s other graduate schools. Students are encouraged to do field research and develop close working ties with faculty members engaged in major research activities.
Interdisciplinary Program

Political Science and Statistics
The Interdisciplinary Doctoral Program in Statistics provides training in statistics, including classical statistics and probability as well as computation and data analysis, to students who wish to integrate these valuable skills into their primary academic program. The program is administered jointly by the departments of Aeronautics and Astronautics, Economics, Mathematics, and Political Science, and the Statistics and Data Science Center within the Institute for Data, Systems, and Society. It is open to current doctoral students in participating departments, who may apply to enroll in the program at any time after the end of their first year. For more information, see the full program description (p. 376) under Interdisciplinary Graduate Programs.

Inquiries
Additional information regarding graduate programs in the department and admissions may be obtained from the graduate administrator, Susan Twarog, 617-253-8336, Room E53-467.

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Head, Department of Political Science

Professors
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Professor of Political Science

Adam Berinsky, PhD
Professor of Political Science
Member, Institute for Data, Systems, and Society

Nazli Choucri, PhD
Professor of Political Science
Member, Institute for Data, Systems, and Society

Fotini Christia, PhD
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Member, Institute for Data, Systems, and Society

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Professor of Political Science

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Melissa Nobles, PhD
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Arthur and Ruth Sloan Professor of Political Science

Barry R. Posen, PhD
Ford International Professor
Professor of Political Science

Richard J. Samuels, PhD
Ford International Professor
Professor of Political Science

Ben Ross Schneider, PhD
Ford International Professor
Professor of Political Science
(On leave)

Charles H. Stewart III, PhD
Kenan Sahin (1963) Distinguished Professor
Professor of Political Science
Member, Institute for Data, Systems, and Society
(On leave, fall)

Kathleen Thelen, PhD
Ford International Professor
Professor of Political Science

Stephen W. Van Evera, PhD
Ford International Professor
Professor of Political Science
(On leave)

Associate Professors
Devin Caughey, PhD
Silverman (1968) Family Career Development Professor
Associate Professor of Political Science
(On leave, fall)

F. Daniel Hidalgo, PhD
Cecil and Ida Green Career Development Professor
Associate Professor of Political Science
(On leave, fall)
In Song Kim, PhD  
Class of 1956 Career Development Associate Professor of Political Science  
Member, Institute for Data, Systems, and Society  
(On leave)

J. Chappell H. Lawson, PhD  
Associate Professor of Political Science

Vipin Narang, PhD  
Associate Professor of Political Science  
(On leave, fall)

Richard Nielsen, PhD  
Associate Professor of Political Science  
Member, Institute for Data, Systems, and Society

David Andrew Singer, PhD  
Associate Professor of Political Science

Lily L. Tsai, PhD  
Associate Professor of Political Science

Tepppei Yamamoto, PhD  
Associate Professor of Political Science  
Member, Institute for Data, Systems, and Society

Assistant Professors

Regina Bateson, PhD  
Assistant Professor of Political Science  
(On leave)

Volha Charnysh, PhD  
Assistant Professor of Political Science

Ariel R. White, PhD  
Assistant Professor of Political Science  
(On leave)

Bernardo Zacka, PhD  
Assistant Professor of Political Science

Professors Emeriti

Michael J. Piore, PhD  
David W. Skinner Professor Emeritus  
Professor Emeritus of Political Economy  
Professor Emeritus of Political Science

Harvey M. Sapolsky, PhD  
Professor Emeritus of Political Science

Eugene B. Skolnikoff, PhD  
Professor Emeritus of Political Science  
Professor Emeritus of Science, Technology, and Society
SCIENCE, TECHNOLOGY, AND SOCIETY

The Program in Science, Technology, and Society (STS) focuses on the ways in which scientific, technological, and social factors interact to shape modern life. The program brings together humanists, social scientists, engineers, and natural scientists, all committed to transcending the boundaries of their disciplines in a joint search for new insights and new ways of reaching science and engineering students. The goal of the program is to set up a forum to explore the relationship between what scientists and engineers do and the constraints, needs, and responses of society.

Located in a major university where most people study science and engineering, STS is dedicated to understanding the context of science and engineering.

Undergraduate Study

MIT students are increasingly seeking to understand the social and historical contexts in which they will work and the social consequences of what they will do in their professional careers. STS subjects help them think realistically and creatively about the intellectual, moral, political, and social issues raised by the rapid growth of science and technology in the 20th century and beyond.

STS contributes to undergraduate education at MIT in several ways. It offers general subjects to introduce students to broad social and intellectual perspectives on science and engineering fields. It also offers more specialized subjects in the history of science and technology and in social and cultural studies of science and technology. Within each of these categories, students can choose both introductory and more advanced subjects.

STS as a Second Major

Students who wish to integrate their professional study of engineering or science with a rigorous treatment of its relation to social and historical forces may pursue STS as a second major (p. 447) in cooperation with the Schools of Engineering and Science. The object of this program is to give those students the full technical and scientific education provided by a science or engineering major, balanced with intensive study of the historical and social contexts of science and technology. Double major applications from students in other Schools (e.g., Architecture and Planning; Management; Humanities, Arts, and Social Sciences) will be considered on a case-by-case basis.

Students in the double major program must complete all the requirements of both majors. The STS requirements include 14 subjects as follows:

- At least one STS Tier I subject (http://sts-program.mit.edu/academics/undergraduate/tier-i-subjects), in addition to STS.004
- At least one STS Tier II subject (http://sts-program.mit.edu/academics/undergraduate/tier-ii-subjects)
- Five other STS subjects
- Four subjects related to the historical and social study of science and technology
- STS.THT Undergraduate Thesis Tutorial
- STS.THU Undergraduate Thesis

If a student's other major also requires a thesis, students may coordinate their thesis effort, pending approval of undergraduate officers in both majors. Further details on the requirements of the STS program may be obtained from the STS undergraduate academic officer and the STS academic administrator.

Joint Degree Programs

Students who wish to integrate studies in STS and science or engineering in the context of a single degree should consider this program. It leads to one degree, either a Bachelor of Science in Humanities and Science or a Bachelor of Science in Humanities and Engineering. The STS requirement for either degree is 10 subjects as follows:

- STS.004 Intersections: Science, Technology, and the World
- At least one STS Tier I subject (http://sts-program.mit.edu/academics/undergraduate/tier-i-subjects), in addition to STS.004
- At least one STS Tier II subject (http://sts-program.mit.edu/academics/undergraduate/tier-ii-subjects)
- Five other STS subjects
- STS.THT Undergraduate Thesis Tutorial
- STS.THU Undergraduate Thesis

Consult the 21E (p. 430) and 21S (p. 434) degree charts for details on the requirements for these joint degrees. Further details may be obtained from the SHASS Dean's Office (hass-www@mit.edu), Room 4-240, and the STS academic administrator.

Minor in Science, Technology, and Society

The goal of the minor program is to give students a broad social perspective on the fields of engineering and science: how they have evolved and how they fit into the wider context of society, culture, politics, and values.

The Minor in Science, Technology, and Society consists of six STS subjects, including STS.004, at least one additional subject from the Tier I list, and at least one subject from the Tier II list.

<table>
<thead>
<tr>
<th>Tier I</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STS.004</td>
<td>Intersections: Science, Technology, and the World</td>
<td>12</td>
</tr>
</tbody>
</table>
Select one of the following:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STS.001</td>
<td>Technology in American History</td>
</tr>
<tr>
<td>STS.002</td>
<td>Finance and Society</td>
</tr>
<tr>
<td>STS.003</td>
<td>The Rise of Modern Science</td>
</tr>
<tr>
<td>STS.006[J]</td>
<td>Bioethics</td>
</tr>
<tr>
<td>STS.007</td>
<td>Technology in History</td>
</tr>
<tr>
<td>STS.008</td>
<td>Technology and Experience</td>
</tr>
<tr>
<td>STS.009</td>
<td>Evolution and Society</td>
</tr>
<tr>
<td>STS.011</td>
<td>Engineering Life: Biotechnology and Society</td>
</tr>
<tr>
<td>STS.012</td>
<td>Science in Action: Technologies and Controversies in Everyday Life</td>
</tr>
</tbody>
</table>

**Tier II**

Select one subject from the list of Tier II subjects 9-12

**Electives**

Select three additional subjects from among Tiers I and II 27-36

Total Units 60-72

2 See list of Tier II subjects [here](http://sts-program.mit.edu/academics/undergraduate/tier-ii-subjects).

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**Graduate Study**

In collaboration, STS, the History Faculty, and the Anthropology Program offer a doctoral program in History, Anthropology, and Science, Technology and Society (HASTS).

The objective of the program is to develop advanced competence in the study of science and technology from a historical and social scientific perspective. Students are expected to develop professional mastery of a field of history or one of the social sciences. They must also master the underlying concepts in science and engineering that relate to their special field of interest.

Graduate students are required to take at least 10 subjects and usually complete them within their first two years. Normally, all students take the following required introductory seminars in their first year:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21A.859[J]</td>
<td>Social Theory and Analysis</td>
</tr>
<tr>
<td>21H.991</td>
<td>Theories and Methods in the Study of History</td>
</tr>
<tr>
<td>STS.260</td>
<td>Introduction to Science, Technology, and Society</td>
</tr>
</tbody>
</table>

Students are encouraged to take 21A.809 Designing Empirical Research in the Social Sciences or 21A.819 Qualitative Research Methods at some point in their program. To fulfill the remaining subject requirement, students choose from among several departmental seminars designed to offer more in-depth study of particular topics. They may also take subjects offered by other MIT departments and through cross-registration with Harvard.

Upon the satisfactory completion of general examinations in the third year, students proceed to the writing of a dissertation proposal and dissertation, usually with the assistance of a multidisciplinary advisory committee.

Students from any academic discipline are invited to apply to the doctoral program.

For additional information about the graduate program, visit the HASTS website [here](http://web.mit.edu/hasts), or contact the STS academic administrator, Room E51-163, 617-253-9759.

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**Inquiries**

Additional information on the Program in Science, Technology, and Society [here](http://sts-program.mit.edu) may be obtained from the STS academic administrator, Room E51-163, 617-253-9759.

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**Faculty and Teaching Staff**

Jennifer S. Light, PhD  
Professor of Science, Technology, and Society  
Professor of Urban Studies and Planning  
Head, Science, Technology, and Society Program

**Professors**

Louis L. Bucciarelli Jr, PhD  
Professor Post-Tenure of Engineering and Technology Studies

Michael M. J. Fischer, PhD  
Andrew W. Mellon Professor in the Humanities  
Professor of Science and Technology Studies  
Professor of Anthropology

Deborah K. Fitzgerald, PhD  
Leverett Howell Cutten ’07 and William King Cutten ’39 Professor of the History of Technology

David I. Kaiser, PhD  
Germeshausen Professor of the History of Science  
Professor of Physics

Kenneth R. Manning, PhD  
Thomas Meloy Professor of Rhetoric  
Professor of Science, Technology, and Society

David A. Mindell, PhD  
Frances and David Dibner Professor in the History of Engineering and Manufacturing  
Professor of Aeronautics and Astronautics  
(On leave, fall)
Merritt Roe Smith, PhD
Leverett Howell Cutten ’07 and William King Cutten ’39 Professor of the History of Technology
Professor of History

Sherry R. Turkle, PhD
Abby Rockefeller Mauzé Professor of the Social Studies of Science and Technology
(On leave)

Rosalind H. Williams, PhD
Bern Dibner Professor Post-Tenure in the History of Science and Technology
Professor Post-Tenure of Science, Technology, and Society
Professor Post-Tenure of Comparative Media Studies/Writing

Leo Marx, PhD
William R. Kenan Professor Emeritus
Professor Emeritus of American Cultural History

Theodore A. Postol, PhD
Professor Emeritus of Science, Technology, and National Security Policy

Eugene B. Skolnikoff, PhD
Professor Emeritus of Political Science
Professor Emeritus of Science, Technology, and Society

Associate Professors
Clapperton Chakanetsa Mavhunga, PhD
Associate Professor of Science, Technology, and Society

Assistant Professors
Dwaipayan Banerjee, PhD
Assistant Professor of Science, Technology, and Society
(On leave)

William Deringer, PhD
Leo Marx Career Development Professor
Assistant Professor of Science, Technology, and Society

Robin Scheffler, PhD
Leo Marx Career Development Professor
Assistant Professor of Science, Technology, and Society

Adjunct Professors
John R. Durant, PhD
Adjunct Professor of Science, Technology, and Society

Lecturers
Valentina Pugliano, PhD
Lecturer in History
Research Associate in the Program in Science, Technology, and Society

Professors Emeriti
Loren Graham, PhD
Professor Emeritus of the History of Science

Evelyn Fox Keller, PhD
Professor Emerita of the History and Philosophy of Science

Kenneth Keniston, PhD
Andrew S. Mellon Professor Emeritus of Human Development
The mission of the MIT Sloan School of Management (http://mitsloan.mit.edu) is to develop principled, innovative leaders who improve the world and to generate ideas that advance management practice.

MIT Sloan is where smart, independent leaders come together, confident that the world should and can be better. MIT Sloan transforms confidence into ability, channeling determination and drive towards bold action and impact.

We do this through an open approach to management education that does the following:

- Relies on and ensures freedom of exploration and experimentation;
- Harnesses MIT’s intellectual resources for a unique understanding of the interconnectedness within and between organizations and technologies;
- Prioritizes learning in the world, through partnerships with innovative enterprises.

At MIT Sloan, we discover tomorrow’s interesting and important challenges and opportunities.

History
In 1914, MIT offered its first course in management: engineering administration. Seventeen years later, General Motors president Alfred P. Sloan, an MIT graduate, asked the Institute to create a comprehensive program for engineers with executive potential. MIT answered with a program for “sponsored fellows” to broaden their business knowledge so they could excel in senior leadership positions. In 1952, a further grant from the Sloan Foundation made possible the creation of the MIT School of Industrial Management—charged with the education of “the ideal manager.” The school was renamed in honor of Alfred Sloan in 1964.

Today, MIT Sloan offers a diverse program portfolio ranging from undergraduate degrees to programs designed for senior executives. From our flagship two-year MBA to the intensive, year-long MIT Sloan Fellows Program, our degree and non-degree programs empower leaders to solve complex business problems, drive innovation, and improve the world.

New Directions
Among MIT Sloan’s key strengths are its exceptionally close ties with other world-class departments at MIT, especially in fields crucial to business, including economics, engineering, and science. One manifestation of this interdisciplinary approach is Leaders for Global Operations (http://lgo.mit.edu), a dual-degree program with the School of Engineering that is transforming manufacturing and manufacturing education, while collaborating with industry partners. Many MIT Sloan students routinely take classes in departments and schools outside of MIT Sloan to round out their knowledge and skills.

In 2016, MIT Sloan launched the Master of Business Analytics (http://mitsloan.mit.edu/master-of-business-analytics) program. This rigorous, 12-month program, recently designated as a STEM program, prepares students for careers that apply and manage modern data science to solve critical business challenges.

Action Learning
MIT Sloan’s signature experiential learning model immerses students in locations all over the world to translate knowledge into useful solutions. Action Learning builds resilient, thoughtful leaders capable of solving unstructured problems across business functions. Global Entrepreneurship Lab (G-Lab), Sustainable Business Lab (S-Lab), China Lab, and USA Lab are just a few of the avenues through which students can apply classroom concepts and theory to real-world business scenarios.

Entrepreneurship
The Martin Trust Center for MIT Entrepreneurship (http://entrepreneurship.mit.edu) provides the expertise, support, and connections MIT students need to become effective entrepreneurs.

The Trust Center’s mission is to advance knowledge and educate students in innovation-driven entrepreneurship that will best serve the nation and the world in the 21st century. The center provides proven frameworks including more than 60 entrepreneurship-focused courses, and co-curricular programs such as capstone educational accelerators, the accelerator program MIT delta v (http://entrepreneurship.mit.edu/accelerator/program), and the New York City Summer Startup Studio. The center’s state-of-the-art collaborative space welcomes more than 1,000 visitors daily, and the Entrepreneurs in Residence and Professional Advisors Network provide practical and customized guidance for student entrepreneurs.

Global Reach
A priority for MIT Sloan is to widen the international reach of its educational and research initiatives. Through MIT Sloan Global Programs, the school has collaborations with partner schools and organizations in China (Tsinghua, Lingnan, and Fudan universities), Malaysia (Asia School of Business (http://mitsloan.mit.edu/global-programs/partner-programs/asia-school-of-business)), Portugal (Lisbon MBA), and Taiwan (Epoch Foundation). These partnerships include International Faculty Fellows and research and educational visits. In addition, Global Programs has an office in Santiago, Chile, and manages the Regional Entrepreneurship Acceleration Program that fosters an evidence-based, practical approach to strengthening innovation-driven entrepreneurial ecosystems around the world, having hosted five cohorts representing 37 regions.

Publications
MIT Sloan produces publications that enjoy robust readership within the MIT community, across the country, and around the world. MIT Sloan Management Review leads the discourse among academic
researchers, business executives, and other influential thought leaders about advances in management practice, particularly those shaped by technology, that are transforming how people lead and innovate. *MIT SMR* disseminates new management research and innovative ideas so that thoughtful executives can capitalize on the opportunities generated by rapid organizational, technological, and societal change. The alumni magazine *MIT Sloan* connects alumni to the school and to one another through compelling news features, faculty articles, student and alumni profiles, and class notes.

**Research Centers**

MIT Sloan faculty actively participate in the following interdisciplinary research centers:

- Center for Collective Intelligence (p. 90)
- Center for Information Systems Research (http://cisr.mit.edu)
- Computer Science and Artificial Intelligence Laboratory (p. 95)
- Initiative on the Digital Economy (p. 98)
- Institute for Work and Employment Research (p. 99)
- Laboratory for Financial Engineering (p. 101)
- Legatum Center for Development and Entrepreneurship (p. 103)
- Martin Trust Center for MIT Entrepreneurship (p. 104)
- MIT Center for Energy and Environmental Policy Research (p. 91)
- MIT Golub Center for Finance and Policy (https://gcfp.mit.edu/about)
- MIT Energy Initiative (p. 106)
- MIT Leadership Center (http://leadership.mit.edu)
- MIT Sloan Initiative for Health Systems Innovation (https://hsi.mit.edu)
- Operations Research Center (p. 110)
- Sustainability Initiative at MIT Sloan (http://mitsloan.mit.edu/sustainability)

Information about these centers is available in the Research and Study section (p. 88) or on the MIT Sloan website (http://mitsloan.mit.edu/faculty/research).

**Degrees Offered in the MIT Sloan School of Management**

<table>
<thead>
<tr>
<th>Management (Course 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
</tr>
<tr>
<td>SB</td>
</tr>
<tr>
<td>SB</td>
</tr>
<tr>
<td>SB</td>
</tr>
<tr>
<td>MBA</td>
</tr>
<tr>
<td>MBAn</td>
</tr>
<tr>
<td>MFin</td>
</tr>
<tr>
<td>SM</td>
</tr>
<tr>
<td>SM</td>
</tr>
</tbody>
</table>

| SM | Management Research |
| SM | Management Studies |
| SM/MBA | Engineering/Management—Leaders for Global Operations |
| PhD | Management |

**Design and Management (Integrated Design and Management & System Design and Management)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>Engineering and Management</td>
</tr>
</tbody>
</table>

**Operations Research**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>Operations Research</td>
</tr>
<tr>
<td>PhD</td>
<td>Operations Research</td>
</tr>
</tbody>
</table>

**Notes**

Many departments make it possible for a graduate student to pursue a simultaneous master’s degree.

1 See Interdisciplinary Programs (p. 337).

**Admissions**

The selection process at MIT is holistic and student centered: each application is evaluated within its unique context. Selection is based on outstanding academic achievement as well as a strong match between the applicant and the Institute.

Undergraduate applicants do not apply to a particular school, department or program and, although the application asks about a preferred field of study, most admitted undergraduates do not declare a major until the second semester of their first year. Admissions information for regular, transfer, and non-degree applicants is provided in the section on Undergraduate Education (p. 31).

Applicants for graduate study apply directly to the particular department or program of interest. See the individual department and program descriptions for specific requirements.

**Office of the Dean**

David C. Schmittlein, PhD
John C Head III Dean, Sloan School of Management
Professor of Marketing

Ezra W. Zuckerman Sivan, PhD
Alvin J. Siteman (1948) Professor of Entrepreneurship and Strategy
Professor of Technological Innovation, Entrepreneurship, and Strategic Management
Deputy Dean
Jacob Cohen, JD, MS  
Senior Lecturer in Accounting and Law  
Senior Associate Dean, Undergraduate and Master’s Programs

Kristina Gulick Schaefer, BA  
Senior Associate Dean, External Relations and International Programs

Peter Hirst, PhD  
Associate Dean, Executive Education

Fiona E. Murray, PhD  
Bill Porter (1967) Professor of Entrepreneurship  
Professor of Technological Innovation, Entrepreneurship, and Strategic Management  
Associate Dean for Innovation

Nelson Repenning, PhD  
School of Management Distinguished Professor of System Dynamics and Organization Studies  
Associate Dean of Leadership and Special Projects

Kristin LeClair, EdM  
Director of Special Initiatives
Undergraduate Study

Bachelor of Science in Management (Course 15-1)
The Bachelor of Science in Management (p. 454) provides students with an innovative business education that is comprehensive and flexible. Students begin with coursework that builds a strong foundation in probability and statistics, managerial communication, managerial psychology, microeconomics, and accounting. They augment this foundation by selecting two restricted electives in core business functions: finance, operations management, marketing, and strategy. Students then tailor the remainder of their program by selecting five electives that go into depth in an individualized concentration area. The Undergraduate Education Office and the Course 15 advisor provide guidance and approval for the concentration to ensure students achieve a coherent focus.

Bachelor of Science in Business Analytics (Course 15-2)
The Bachelor of Science in Business Analytics (p. 455) program is for students with a strong interest and ability in math and computer science. Students learn techniques such as data modeling and analysis, optimization, and machine learning, so as to help businesses make improved decisions and design efficient processes. Electives provide the opportunity to learn additional methodologies, such as artificial intelligence, systems dynamics, and game theory; take advanced subjects in probability, statistics, and optimization; or study how analytics is applied in content areas such as operations, transportation, marketing, and finance. Students can also refine their skills in practice-based project courses.

Bachelor of Science in Finance (Course 15-3)
At the intersection of economics, strategy, and accounting, finance is about managing assets to keep markets and organizations operating. The Bachelor of Science in Finance (p. 457) is designed to train students for careers that focus on the theory and application of the tools of modern finance. The curriculum provides a theoretical foundation in managerial finance, corporate finance, and investments, and requires students to complete laboratory and communications subjects to ensure they have the ability to apply the tools of finance to industry. The restricted electives permit students flexibility to select the rest of their program from advanced topics in, and topics complementary to, finance.

Minor in Management
The Minor in Management provides undergraduates in other majors with an understanding of the business, human, and organizational dimensions of scientific and technological enterprise.

The minor consists of six subjects:

<table>
<thead>
<tr>
<th>Required subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.301 People, Teams, and Organizations Laboratory 9-15</td>
</tr>
<tr>
<td>or 15.668 People and Organizations</td>
</tr>
<tr>
<td>15.501 Corporate Financial Accounting 12</td>
</tr>
</tbody>
</table>

Select one of the following: 9-15

| 15.417 Laboratory in Investments |
| 15.7611 Introduction to Operations Management 1 |
| 15.8141 Marketing Innovation |
| 15.9001 Competitive Strategy |

Electives
Select any three Course 15 subjects other than Undergraduate Research Opportunities Program (UROP) and general-elective transfer credit. (Two six-unit subjects count as a single elective subject.)

Total Units 57-78

1 Subject has prerequisites that are outside of the program.
2 14.01 Principles of Microeconomics is also a permissible elective.

Minor in Business Analytics
The Minor in Business Analytics introduces data analysis techniques and their application to practical business problems. Its focus reflects the core content of the SB degree program in business analytics.

The minor consists of six subjects:

<table>
<thead>
<tr>
<th>Select one of the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.0791 Introduction to Applied Probability 12</td>
</tr>
<tr>
<td>or 18.600 Probability and Random Variables</td>
</tr>
<tr>
<td>15.053 Optimization Methods in Business Analytics</td>
</tr>
<tr>
<td>15.075[J] Statistical Thinking and Data Analysis</td>
</tr>
</tbody>
</table>

Select three additional subjects from a list of electives. (Consult Sloan Undergraduate Education Office regarding additional options.) At least two of the subjects must be from Course 15. Two six-unit subjects count as one elective.

Total Units 39-48

Electives

| 6.050[J] Information, Entropy, and Computation 9 |
| 14.15[J] Networks 12 |
| 15.0341 Econometrics for Managers: Correlation and Causality in a Big Data World 9 |
Minor in Finance
The Minor in Finance provides undergraduates in other majors with an understanding of the major areas of finance—corporate finance and investments. The minor will prepare students to understand the different roles in financial industries and how to apply their major course of study to succeed in these fields.

The minor consists of five subjects:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.417</td>
<td>Laboratory in Investments</td>
<td>15</td>
</tr>
<tr>
<td>15.418</td>
<td>Laboratory in Corporate Finance</td>
<td>15</td>
</tr>
<tr>
<td>15.501</td>
<td>Corporate Financial Accounting</td>
<td>12</td>
</tr>
</tbody>
</table>

Electives
Select two of the following: (Consult the Sloan Office of Undergraduate Education regarding substitutions.):

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.431</td>
<td>Entrepreneurial Finance and Venture Capital</td>
<td></td>
</tr>
<tr>
<td>15.433</td>
<td>Financial Markets</td>
<td></td>
</tr>
<tr>
<td>15.434</td>
<td>Advanced Corporate Finance</td>
<td></td>
</tr>
<tr>
<td>15.437</td>
<td>Options and Futures Markets</td>
<td></td>
</tr>
<tr>
<td>15.445</td>
<td>Mergers, Acquisitions, and Private Equity</td>
<td></td>
</tr>
<tr>
<td>15.487</td>
<td>Algorithmic Trading and Quantitative Investment Strategies</td>
<td></td>
</tr>
<tr>
<td>15.518</td>
<td>Taxes and Business Strategy</td>
<td></td>
</tr>
</tbody>
</table>

Total Units: 60

Interdepartmental (Non-Sloan) Students
Course 15 undergraduate subjects are open for WebSIS pre-registration or online registration. There is no bidding necessary for undergraduate subjects. All students who wish to take unrestricted Sloan graduate subjects must participate in the MIT Sloan course bidding system. Information about the process is available on the bidding website (https://sloanbid.mit.edu). The MIT Sloan course schedule is available on the bidding website, as are most class syllabi, to assist students in subject selection.

Inquiries
For additional information about these Course 15 undergraduate programs or about taking a Course 15 class, students may consult the Office of Undergraduate Education, Room E52-154 (Suite 133), 617-253-8614, and the MIT Sloan undergraduate website (http://mitsloan.mit.edu/undergrad).

Graduate Study
The MIT Sloan School of Management offers opportunity for graduate study leading to the degrees of Master of Business Administration, Master of Science in Management, Master of Science in Management of Technology, Master of Finance, Master of Business Analytics, Master of Science in Management Studies, and Doctor of Philosophy. In addition, there are two dual degree options: an MBA/SM with the MIT School of Engineering, known as the Leaders for Global Operations (LGO) program; and an MBA/MPP or MPA with the Harvard Kennedy School.

Admission Requirements for Graduate Study
Applications are welcome from college graduates in all areas of concentration—the humanities, social sciences, physical sciences, and engineering. Please see the individual program websites for specific entrance requirements and more information.

Master of Business Administration
The MIT Sloan School MBA program (http://mitsloan.mit.edu/mba) offers a course of study in graduate management education, leading to a master’s degree in Business Administration (MBA) or Master of Science in Management (SM). Degree candidates are admitted in winter or spring to a program that begins with a mandatory orientation program in August. The two-year program of study requires candidates to complete a core curriculum plus 144 units of graduate elective subjects. Students also fulfill research and leadership requirements through activities in the mid-term Sloan Innovation Period and through elective coursework. Residency for four academic terms is required. A grade point average (GPA) of 4.0/5.0 (B) is required at the time of graduation.

The MBA curriculum is designed for maximum flexibility, allowing students to create an individual program best suited to their needs and career interests. During the first term, students take a sequence of core subjects with the option of one of three elective subjects.

In the first term, MBA students are assigned to one of 60 teams consisting of six to seven people. These teams are combined into six larger sections, called cohorts or oceans, for the fall core subjects. Students take all the core subjects in the same assigned section, which facilitates cohort integration and the formation of study groups.

After the first term, students have a wide range of elective subject choices. Students are given a great deal of independence in...
choosing their subjects, and they may design a program that includes a depth of focus as well as breadth. This includes the option of earning a certificate by enrolling in and completing the elective requirements for a track or certificate program. The MBA Program currently offers six certificates: in finance, enterprise management, entrepreneurship and innovation, healthcare, sustainability, and business analytics.

The Sloan Innovation Period, offered each term, provides students and faculty with the opportunity to explore jointly, in a nontraditional setting, what makes MIT Sloan unique: exceptional research expertise, leadership acumen, and the hands-on application of knowledge.

Practical exposure to management takes place in the MIT Sloan School through a variety of activities. Students in the MBA program are expected to spend the summer between their first and second years working in an activity or internship that contributes to their understanding of and effectiveness in dealing with management problems.

During the academic year students have additional opportunities both in and outside the classroom to apply their learning. Many Sloan subjects incorporate action learning into their pedagogy and require students to complete projects within companies and organizations as a deliverable for the subject. These subjects may include a 1–3 week international or domestic experience working within a host organization. Corporate leaders are often invited to work with students either through guest lectureships in classes or through interaction with one of the more than 60 student organizations. Some students may also have the opportunity to work as paid teaching and research assistants to the Sloan faculty.

Outside of the classroom, the MBA community’s student organizations and clubs provide students the opportunity to practice leadership through the execution of conferences, international study tours and treks, business plan and case competitions, and other club-related activities.

Master of Business Analytics
The Master of Business Analytics (http://mitsloan.mit.edu/master-of-business-analytics) program is a specialized advanced master's degree designed to prepare students for careers in business analytics.

The program is tailored for students in their final year of their undergraduate education or recent college graduates who plan to pursue a career in the data science industry, as well as those seeking career advancement or change, especially engineers, mathematicians, physicists, computer programmers, and other high-tech professionals.

The full-time, year-long program is divided into three semesters: fall, spring, and a summer capstone. During the 10-week capstone, students work in small teams on site at a US or international company on a real data science problem. Each group completes a written report and gives a final oral presentation to the company and MIT Sloan and MIT Operations Research Center faculty.

For more information, visit the Master of Business Analytics website (http://mitsloan.mit.edu/master-of-business-analytics).

Master of Finance
The Master of Finance (MFin) (https://mitsloan.mit.edu/mfin), offered in either a 12- or 18-month option, prepares students for a broad range of careers in finance requiring analytical rigor and the ability to innovate around market challenges. The program consists of required fundamental and advanced subjects, restricted electives, action learning, ethics modules, and an optional master's thesis. Students are able to complete a concentration in financial engineering, capital markets, or corporate finance.

Required summer-term coursework provides the foundation in finance, accounting, and financial mathematics for continuing with more advanced required and elective subjects in the terms. Restricted electives ensure appropriate depth as well as opportunities for breadth of study, depending on the student’s interest. Students are required to take either a proseminar or the Finance Research Practicum™, project-based classes in which students work in teams to address current problems identified by finance professionals. A thesis option is available for students who wish to research a topic of particular interest.

Frequent seminars, conferences, and major lectures present students with opportunities to hear from recognized leaders from a variety of industries. MFin students have full access to the extensive resources of the MIT Sloan Career Development Office as well as Career Advising and Professional Development. In addition, students participate in a wide array of professional clubs, student government, sports teams, and organizations at the school and campus level.

To graduate, students must attain at least a B (4.0/5.0) for finance core and restricted classes as well as their overall GPA at the time of graduation. Residency for the academic terms is required.

Students may not pursue another degree program while enrolled in the MFin. Except in the case of core requirements, coursework completed at MIT prior to matriculation in the MFin program may not be applied toward the MFin degree without the approval of the MFin faculty director.

In addition to the traditional synergies among finance, economics, and accounting, the program exploits intellectual ties among finance and mathematics, statistics, psychology, management, computer science, and engineering. The program is primarily targeted at recent graduates with zero to four years of experience. Recent graduates of postgraduate programs in mathematics, science, and engineering who wish to enter the finance profession are also encouraged to apply. MFin prepares students for a wide variety of
finance roles in the private and public sector as well as doctoral studies.

Typically, applications to the MFin program are due in early January; decisions are usually announced by mid-March. This is subject to change. For exact deadlines, please refer to the Master of Finance website (https://mitsloan.mit.edu/mfin).

Master of Science in Management Studies
The Master of Science in Management Studies (MSMS) (http://mitsloan.mit.edu/msms) program is a customizable advanced master’s degree that complements an overseas management education. Designed for students in the process of completing, or who have already completed, their MBA (or comparable master's) degree at one of Sloan’s international partner schools, the MSMS program allows students to pursue their area of interest in management and construct an individualized curriculum of all-elective subjects from the offerings at MIT Sloan, other MIT departments, and Harvard University. Students specialize in a specific area within management by designating a concentration, taking elective subjects, and working with a Sloan faculty member to write a compulsory master’s thesis in their area of study.

The 9-month program, which runs from September to June, requires full-time residence. In addition, MSMS students are required to meet MIT’s requirement of at least 66 units of graduate subjects, and a master’s thesis. To graduate, students must attain a GPA of 4.0/5.0 (B) by the time of graduation. For more information, visit the MSMS website (http://mitsloan.mit.edu/msms).

Doctor of Philosophy
The PhD Program (http://mitsloan.mit.edu/phd) is the heart of MIT Sloan’s research community and develops some of the best management researchers in the world. Approximately 19 new students join the program each year, and concentrate in one of nine research groups.

Students are funded for a period of five years, with the funding package consisting of full tuition, health insurance, a fellowship with a Teaching Assistant (TA) or Research Assistant (RA) component, a new laptop in years one and four, and conference travel funds.

MIT Sloan’s PhD students are immersed in our distinctive research culture. Working closely with faculty, students conduct innovative research and lay the groundwork for lifelong careers in academic research. There are two separate research requirements within the program: the master’s thesis and the PhD dissertation.

In the second or third year of the program, students are expected to complete their first major research paper, which will become a master’s thesis, thereby earning them an SM in Management Research. General Exams are usually taken at the end of the second year or beginning of the third year of study, and after successful completion, work begins on choosing and defining a doctoral research topic. The PhD dissertation consists of significant, original scholarly research. Candidates typically require two or three years of full-time work to complete their doctoral theses.

For more information, visit the PhD Program website (http://mitsloan.mit.edu/phd).

Interdisciplinary Programs

Computation for Design and Optimization
The Computation for Design and Optimization (CDO) (http://computationalengineering.mit.edu/education) program offers a master’s degree to students interested in the analysis and application of computational approaches to designing and operating engineered systems. The curriculum is designed with a common core serving all engineering disciplines and an elective component focusing on specific applications. Current MIT graduate students may pursue a CDO master’s degree in conjunction with a department-based master’s or PhD program. For more information, see the full program description (p. 368) under Interdisciplinary Graduate Programs.

Leaders for Global Operations
The 24-month Leaders for Global Operations (LGO) (http://lgo.mit.edu) program combines graduate degrees in engineering and management for those with previous postgraduate work experience and strong undergraduate degrees in a technical field. During the two-year program, students complete a six-month internship at one of LGO’s partner companies, where they conduct research that forms the basis of a dual-degree thesis. Students finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of seven engineering programs, some of which have optional or required LGO tracks. After graduation, alumni take on leadership roles at top global manufacturing and operations companies.

System Design and Management
The System Design and Management (SDM) (http://sdm.mit.edu) program is a partnership among industry, government, and the university for educating technically grounded leaders of 21st-century enterprises. Jointly sponsored by the School of Engineering and the Sloan School of Management, it is MIT’s first degree program to be offered with a distance learning option in addition to a full-time in-residence option.

Master’s Degree Programs for Mid-Career Executives

MIT Sloan Fellows Program
This full-time, 12-month (June–June) immersive MBA program is designed for high-performing mid-career professionals. The program typically enrolls about 120 outstanding individuals with 10–20 years of professional experience from more than 30 nations, representing a wide variety of for-profit and nonprofit industries, organizations, and functional areas. Many participants are sponsored by or have the strong support of their employers, but the program also admits
independent participants, many with unique entrepreneurial experiences and perspectives.

The program is characterized by a rigorous academic curriculum, frequent interactions with international business and government leaders, and a valuable exchange of global perspectives. The fellows work together in a team environment, tackling practical issues with a spirit of intellectual adventure. After collaborating across disciplines, cultures, and backgrounds in this intense learning environment, they leave the program with a robust alumni network and the skills necessary to create change, build alliances, and drive global ventures.

For more information about the MIT Sloan Fellows Program and how to apply, visit the website (http://mitsloan.mit.edu/fellows) or contact the program office (fellows@sloan.mit.edu), 617-253-8600.

Executive MBA
The MIT Executive MBA (EMBA) (http://emba.mit.edu) is a rigorous 20-month, executive schedule Master of Business Administration that builds on MIT Sloan’s history of distinguished MBA programs and mid-career education. The classroom-based program is designed to develop principled, innovative leaders, usually with a decade or more of work experience, who can transform the world’s most important institutions. The MIT Executive MBA is an opportunity to join an elite forum for innovation and leadership in which mid-career executives develop an edge in their general management skills and build a business network that lasts a lifetime.

The program brings together rising executives from diverse industries to collaborate on the complex challenges they face now—and will face in years to come—within their organizations and within the larger international marketplace. Although a large proportion of MIT EMBA’s come from careers in life science, engineering, and technology, our ranks also include leaders in government, start-ups, nonprofits, finance, and the military. All are inspired by this rare opportunity to drive positive change, master the science of management, and integrate global leadership and data-driven analytics.

For more information about the MIT Executive MBA and how to apply, visit the EMBA website (http://emba.mit.edu) or contact the program office (executivemba@mit.edu), Room E52-255, 617-253-5033.

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Senior Lecturer in Management

Carine Simon, PhD
Senior Lecturer in Operations Research and Statistics

Steven J. Spear, PhD
Senior Lecturer in Management

Donald Sull, PhD
Senior Lecturer in Technological Innovation, Entrepreneurship, and Strategic Management

Chintan Vaishnav, PhD
Senior Lecturer in Management

Henry Birdseye Weil, SM
Senior Lecturer in Technological Innovation, Entrepreneurship, and Strategic Management

Lecturers

Kirk Arnold, BA
Lecturer in Management

Jim Baum, MEng
Lecturer in Management

Michael Benedetto, BS
Lecturer in Management

David Birnbach, MBA
Lecturer in Management

Sheila Dodge, SM, MBA
Lecturer in Management

Kit Hickey, BA
Entrepreneur in Residence, Martin Trust Center for MIT Entrepreneurship
Lecturer in Technological Innovation, Entrepreneurship, and Strategic Management

Catherine Iacobo, MS
Lecturer in Management

Michellana Y. Jester, EdD
Lecturer in Management

Miroslav W. Kazakoff, MBA
Lecturer in Management

Michael Koslov, PhD
Lecturer in Management
Harvey G. Michaels, MCP  
Lecturer in Management  
Research Scientist in Management

M. Pilar Opazo, PhD  
Lecturer in Management

Norman Louis Shipley, MBA  
Lecturer in Management

Mikey Shulman, PhD  
Lecturer in Management

Will Sun, MBA  
Lecturer in Management

Mona M. Vernon, SM  
Lecturer in Technological Innovation, Entrepreneurship, and Strategic Management

Melissa J. Webster, MBA  
Lecturer in Management

Andrey Zarur, PhD  
Lecturer in Management

**Visiting Lecturers**  
Irving Wladawsky-Berger, PhD  
Visiting Lecturer in Information Technology

**Research Staff**

**Senior Research Scientists**  
Peter D. Weill, PhD  
Senior Research Scientist in Management

**Principal Research Associates**  
Mark Klein, PhD  
Principal Research Associate of Management

Alexander M. Samarov, PhD  
Principal Research Associate of Management

**Principal Research Scientists**  
Andrew Paul McAfee, DBA  
Principal Research Scientist of Management

Joe Peppard, PhD  
Principal Research Scientist of Management

Jeanne W. Ross, PhD  
Principal Research Scientist of Management

Michael D. Siegel, PhD  
Principal Research Scientist of Management

Richard Y. Wang, PhD  
Principal Research Scientist of Management

George Westerman, PhD  
Principal Research Scientist of Management

Barbara Wixom, PhD  
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**Research Associates**  
Wang Jin, PhD  
Research Associate of Management

Kyle Shohfi, SM  
Research Associate of Management

**Research Scientists**  
Kristine Dery, PhD  
Research Scientist of Management

Peter A. Gloor, PhD  
Research Scientist of Management

Mohammad Jalali, PhD  
Research Scientist of Management

Danica Mijovic-Prelec, PhD  
Research Scientist of Management

Allen Moulton, PhD  
Research Scientist of Management

Anne Sartori, PhD  
Research Scientist of Management

Ina Marie Sebastian, PhD  
Research Scientist of Management

Nick van der Meulen, PhD  
Research Scientist of Management

Stephanie L. Woerner, PhD  
Research Scientist of Management

**Professors Emeriti**  
Thomas J. Allen, PhD  
Howard W. Johnson Professor Emeritus of Management  
Professor Emeritus of Organization Studies

Lotte Bailyn, PhD  
T. Wilson (1953) Professor Emerita of Management

Ernst R. Berndt, PhD  
Louis E. Seley Professor Emeritus in Applied Economics
Arnoldo C. Hax, PhD
Alfred P. Sloan Professor Emeritus of Management
Professor Emeritus of Technological Innovation, Entrepreneurship,
and Strategic Management

Henry D. Jacoby, PhD
William F. Pounds Professor Emeritus of Management
Professor Emeritus of Applied Economics

Gordon M. Kaufman, DBA
Morris A. Adelman Professor Emeritus
Professor Emeritus of Management and Statistics

Donald R. Lessard, PhD
Epoch Foundation Professor Emeritus of International Management
Professor Emeritus of Global Economics and Management

Richard M. Locke, PhD
Class of 1922 Professor Emeritus
Professor Emeritus of Management
Professor Emeritus of Political Science

Robert B. McKersie, PhD
Professor Emeritus of Management

Stewart C. Myers, PhD
Robert C. Merton (1970) Professor Emeritus
Professor Emeritus of Financial Economics and Finance

William F. Pounds, PhD
Professor Emeritus of Management

Edgar H. Schein, PhD
Society of Sloan Fellows Professor Emeritus
Professor Emeritus of Management

Richard Schmalensee, PhD
Howard W. Johnson Professor Emeritus
Professor Emeritus of Management
Professor Emeritus of Economics

Michael S. Scott Morton, PhD
Jay W. Forrester Professor Emeritus of Computer Science

Thomas Martin Stoker, PhD
Gordon Y Billard Professor Emeritus in Management and Economics
Professor Emeritus of Applied Economics

Glen L. Urban, PhD
David Austin Professor Emeritus
Professor Emeritus of Marketing

Ross L. Watts, PhD
Erwin H. Schell Professor Emeritus
Professor Emeritus of Management and Accounting

Alan F. White, PhD
Senior Lecturer Emeritus in Management
SCHOOL OF SCIENCE

The School of Science (http://science.mit.edu) is an amazing enterprise: with approximately 275 faculty members, 1,200 graduate students, 800 undergraduate majors, and comparable numbers of postdoctoral researchers and research staff, the School is large enough to carry out research at the frontiers in every field of science. Our faculty members have won 16 Nobel Prizes and our alumni have won another 16, most of which have been awarded in the past 20 years. The six departments in the School are consistently rated among the best in the world.

The School is a prolific generator of new knowledge. Some members of our community study deep philosophical questions: What is the nature of dark matter and dark energy, which make up 95% of the content of our universe? How does our brain, a complex system of interconnected neurons, give rise to our mind—our consciousness and ability to learn? Other faculty members study problems that have obvious practical implications: How does global warming increase the intensity of hurricanes? Can we make adult stem cells capable of generating any cells in the body, replacing cells damaged by disease without using embryos?

However, the deep commitment to education found in the School of Science makes MIT unique among the great research universities. MIT provides each of its undergraduates with an understanding of the basic elements of biology, chemistry, mathematics, and physics, and our Science faculty are devoted to doing this well. Some of our most famous faculty members, even a few with Nobel Prizes, are some of the best teachers of our first-year undergraduate subjects.

Our science majors are given the very best introduction to their chosen field and the opportunity to participate in leading-edge research. Whether our undergrads choose to start careers in the private or public sector or go on to graduate studies in science or a professional school in an area such as medicine, law, business, or engineering, they will be superbly prepared for their careers after MIT.

Many of our graduate students have pursued distinguished careers in research and education; however, others enjoy equally satisfying careers in business, industry, and government. Combining their PhD degrees in science with medical, law, or business degrees, our graduate students are uniquely capable of making creative contributions to the modern world.

History

Science has been at the core of an MIT education since the Institute’s founding in 1861 by the distinguished natural scientist, William Barton Rogers. The earliest offerings in chemistry, geology, and general science were expanded to include physics, mathematics, and biology, and then consolidated as the School of Science under the leadership of Karl Taylor Compton in 1932. During Compton’s tenure and into the postwar years, the Institute saw vast growth in the physical sciences as federal funding for basic research increased. In 1969, the Geology Department became the Department of Earth and Planetary Sciences, and when it merged with the Department of Meteorology and Physical Oceanography in 1983, it evolved into the present-day Department of Earth, Atmospheric and Planetary Sciences.

As the life sciences attained new prominence in the 1970s and 1980s, the Department of Biology grew with the additions of the Center for Cancer Research (now the Koch Institute for Integrative Cancer Research) and the Whitehead Institute for Biomedical Research. In 1994, the Department of Brain and Cognitive Sciences (BCS) moved from the Whitaker College of Health Sciences and Technology to the School of Science. More recently, BCS was expanded by the creation of the McGovern Institute for Brain Research and the Picower Institute for Learning and Memory, broadening the School-wide resources for research in the neurosciences.

Science Laboratories and Centers

Much of our research in science is carried out in large research laboratories and centers like the Whitehead and Picower institutes, where the kinds of facilities necessary for research are available and collaboration among research groups is encouraged. Laboratories and centers with strong participation by School members include:

- Broad Institute of MIT and Harvard (p. 89)
- Center for Global Change Science (p. 91)
- Koch Institute for Integrative Cancer Research (p. 101)
- Laboratory for Nuclear Science (p. 102)
- McGovern Institute for Brain Research (p. 105)
- MIT Kavli Institute for Astrophysics and Space Research (p. 107)
- Picower Institute for Learning and Memory (p. 111)
- Research Laboratory for Electronics (p. 112)
- Simons Center for the Social Brain (p. 113)
- Whitehead Institute for Biomedical Research (p. 114)

Interdepartmental Educational Programs

MIT is exceptional among major research institutions for its dedication to undergraduate education. Committed to providing undergraduates with a strong science base for studies in their major, the School and its departments participate in and support a variety of programs designed to create more active, student-centered learning environments inside the classroom. For instance, the Department of Physics participates in both the d’Arbeloff Interactive Mathematics Project and the Technology-Enabled Active Learning program, which integrate technology into coursework to help students engage with concepts. Likewise, the Undergraduate Research-Inspired Experimental Chemistry Alternatives curriculum integrates cutting-edge research with core chemistry concepts.
Over the past several years, the School of Science has been working to expand educational and training opportunities for graduate students as well, collaborating with the School of Engineering to create innovative graduate programs in fields in which MIT shows great strength. These programs allow MIT to attract the most talented students in their respective fields and to build cross-disciplinary connections among the Institute’s faculty members, departments, and schools.

- **Biophysics** ([http://biophysics.mit.edu](http://biophysics.mit.edu)). Students in the Biophysics program are trained to work at the intersection of the physical sciences, engineering, and the biology of molecules, cells, and systems. Students participate in MIT’s biophysics research, ranging from molecular-level spectroscopy and imaging to cell and population-level systems biology.

- **Microbiology** ([http://web.mit.edu/microbiology](http://web.mit.edu/microbiology)). With access to a vibrant community of over 50 faculty members across several departments and divisions, Microbiology students receive broad training and in-depth research experience in modern microbial research and engineering.

- **Molecular and Cellular Neuroscience** ([https://mcn.mit.edu](https://mcn.mit.edu)). MCN students work at the forefront of molecular and cellular neuroscience research, with access to a distinguished research community as it strives to understand the biological basis of brain function and neurological disease.

### Degrees Offered in the School of Science

#### Biology (Course 7)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Biology</td>
</tr>
<tr>
<td>PhD</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>PhD</td>
<td>Biological Oceanography (jointly offered with WHOI)</td>
</tr>
<tr>
<td>PhD</td>
<td>Biophysical Chemistry and Molecular Structure</td>
</tr>
<tr>
<td>PhD</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>PhD</td>
<td>Computational and Systems Biology</td>
</tr>
<tr>
<td>PhD</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>PhD</td>
<td>Genetics</td>
</tr>
<tr>
<td>PhD</td>
<td>Immunology</td>
</tr>
<tr>
<td>PhD</td>
<td>Microbiology</td>
</tr>
<tr>
<td>PhD</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>PhD</td>
<td>Neurobiology</td>
</tr>
</tbody>
</table>

#### Brain and Cognitive Sciences (Course 9)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Brain and Cognitive Sciences</td>
</tr>
<tr>
<td>PhD</td>
<td>Cognitive Science</td>
</tr>
<tr>
<td>PhD</td>
<td>Neuroscience</td>
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</table>

#### Chemistry (Course 5)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SB</td>
<td>Chemistry</td>
</tr>
<tr>
<td>SB</td>
<td>Chemistry and Biology</td>
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<tr>
<td>PhD, ScD</td>
<td>Chemistry</td>
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</table>

#### Chemistry and Biology (Course 5-7)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Chemistry and Biology</td>
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#### Computational and Systems Biology (CSB)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>Computational and Systems Biology</td>
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#### Computer Science and Molecular Biology (Course 6-7)

<table>
<thead>
<tr>
<th>Degree</th>
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</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Computer Science and Molecular Biology</td>
</tr>
<tr>
<td>MEng</td>
<td>Computer Science and Molecular Biology</td>
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#### Earth, Atmospheric, and Planetary Sciences (Course 12)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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<tbody>
<tr>
<td>SB</td>
<td>Earth, Atmospheric, and Planetary Sciences</td>
</tr>
<tr>
<td>SM</td>
<td>Atmospheric Science</td>
</tr>
<tr>
<td>SM</td>
<td>Chemical Oceanography (jointly offered with WHOI)</td>
</tr>
<tr>
<td>SM</td>
<td>Climate Science</td>
</tr>
<tr>
<td>SM</td>
<td>Earth and Planetary Sciences</td>
</tr>
<tr>
<td>SM</td>
<td>Marine Geology and Geophysics (jointly offered with WHOI)</td>
</tr>
<tr>
<td>SM</td>
<td>Physical Oceanography (jointly offered with WHOI)</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Atmospheric Chemistry</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Atmospheric Science</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Biological Oceanography (jointly offered with WHOI)</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Chemical Oceanography (jointly offered with WHOI)</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Climate Science</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Geochemistry</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Geology</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Geophysics</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Marine Geology and Geophysics (jointly offered with WHOI)</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Physical Oceanography (jointly offered with WHOI)</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Planetary Sciences</td>
</tr>
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</table>

#### Mathematics (Course 18)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Mathematics</td>
</tr>
<tr>
<td>SB</td>
<td>Mathematics with Computer Science</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Mathematics</td>
</tr>
<tr>
<td>PhD</td>
<td>Mathematics and Statistics</td>
</tr>
</tbody>
</table>

1. Jointly offered with WHOI
Microbiology

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>Microbiology 1</td>
</tr>
</tbody>
</table>

Physics (Course 8)

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Physics</td>
</tr>
<tr>
<td>SM</td>
<td>Physics</td>
</tr>
<tr>
<td>PhD, ScD</td>
<td>Physics</td>
</tr>
</tbody>
</table>

Statistics and Science

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>Mathematics and Statistics 1</td>
</tr>
</tbody>
</table>

Notes

Many departments make it possible for a graduate student to pursue a simultaneous master’s degree.

Several departments also offer undesignated degrees, which lead to the Bachelor of Science without departmental designation. The curricula for these programs offer students opportunities to pursue broader programs of study than can be accommodated within a four-year departmental program.

1 See Interdisciplinary Programs (p. 337).

Admissions

The selection process at MIT is holistic and student centered: each application is evaluated within its unique context. Selection is based on outstanding academic achievement as well as a strong match between the applicant and the Institute.

Undergraduate applicants do not apply to a particular school, department or program and, although the application asks about a preferred field of study, most admitted undergraduates do not declare a major until the second semester of their first year. Admissions information for regular, transfer, and non-degree applicants is provided in the section on Undergraduate Education (p. 31).

Applicants for graduate study apply directly to the particular department or program of interest. See the individual department and program descriptions for specific requirements.

Office of the Dean

Michael Sipser, PhD
Donner Professor of Mathematics
Dean, School of Science

Sarah Brady, MBA
DEPARTMENT OF BIOLOGY

The Department of Biology (https://biology.mit.edu) offers undergraduate, graduate, and postdoctoral training in basic biology, and in a variety of biological fields of specialization. The quantitative aspects of biology, including molecular biology, biochemistry, genetics, and cell biology, represent the core of the program. Students in the department are encouraged to acquire a solid background in the physical sciences not only to master the applications of mathematics, physics, and chemistry to biology, but also to develop an integrated scientific perspective. The various programs, which emphasize practical experimentation, combine a minimum of formal laboratory exercises with ample opportunities for research work both in project-oriented laboratory subjects and in the department’s research laboratories. Students at all levels are encouraged to acquire familiarity with advanced research techniques and to participate in seminar activities.

Undergraduate Study

Bachelor of Science in Biology (Course 7)
The curriculum leading to the Bachelor of Science in Biology (p. 459) is designed to prepare students for a professional career in the area of the biological sciences. Graduates of this program are well prepared for positions in industrial or research institutes. However, experience has shown that many graduates choose to continue their education at a graduate school in order to obtain a PhD in an area such as biochemistry, microbiology, genetics, biophysics, cell biology, or physiology, followed by research or teaching in one of those areas. The undergraduate curriculum is also excellent preparation for students who wish to continue their education toward an MD, particularly if their career plans include laboratory investigations bearing on human disease.

Bachelor of Science in Biology (Course 7-A)
Course 7-A (p. 461) is designed for students who wish to obtain a background in biology as preparation for careers without laboratory research. Course 7-A has the same core requirements as Course 7, but does not require a 30-unit laboratory subject within its Restricted Electives.

Students are encouraged to use their elective subjects for more advanced subjects in their field and for additional study in basic and advanced subjects offered in various departments.

Bachelor of Science in Chemistry and Biology (Course 5-7)
The Departments of Biology and Chemistry jointly offer a Bachelor of Science in Chemistry and Biology (p. 480). A detailed description of the requirements for this degree program can be found in the section on Interdisciplinary Programs (p. 338).

Bachelor of Science in Computer Science and Molecular Biology (Course 6-7)
The Department of Biology jointly offers a Bachelor of Science in Computer Science and Molecular Biology (p. 482) with the Department of Electrical Engineering and Computer Science. A detailed description of the requirements for this degree program can be found in the section on Interdisciplinary Programs (p. 338).

Minor in Biology
The department offers a Minor in Biology; the requirements are as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.12</td>
<td>Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>7.03</td>
<td>Genetics</td>
<td>12</td>
</tr>
<tr>
<td>7.05</td>
<td>General Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>or 5.07[J]</td>
<td>Biological Chemistry I</td>
<td></td>
</tr>
<tr>
<td>Select two of the following:</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>7.02[J]</td>
<td>Introduction to Experimental Biology and Communication</td>
<td></td>
</tr>
<tr>
<td>20.109</td>
<td>Laboratory Fundamentals in Biological Engineering</td>
<td></td>
</tr>
<tr>
<td>7.06</td>
<td>Cell Biology</td>
<td></td>
</tr>
<tr>
<td>7.08[J]</td>
<td>Biological Chemistry II</td>
<td></td>
</tr>
<tr>
<td>7.09</td>
<td>Quantitative and Computational Biology</td>
<td></td>
</tr>
<tr>
<td>7.20[J]</td>
<td>Human Physiology</td>
<td></td>
</tr>
<tr>
<td>7.21</td>
<td>Microbial Physiology</td>
<td></td>
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<tr>
<td>7.22</td>
<td>Developmental Biology</td>
<td></td>
</tr>
<tr>
<td>7.23[J]</td>
<td>Immunology</td>
<td></td>
</tr>
<tr>
<td>7.26</td>
<td>Molecular Basis of Infectious Disease</td>
<td></td>
</tr>
<tr>
<td>7.27</td>
<td>Principles of Human Disease</td>
<td></td>
</tr>
<tr>
<td>7.28</td>
<td>Molecular Biology</td>
<td></td>
</tr>
<tr>
<td>7.29[J]</td>
<td>Cellular and Molecular Neurobiology</td>
<td></td>
</tr>
<tr>
<td>7.31</td>
<td>Current Topics in Mammalian Biology: Medical Implications</td>
<td></td>
</tr>
<tr>
<td>7.32</td>
<td>Systems Biology</td>
<td></td>
</tr>
<tr>
<td>7.37[J]</td>
<td>Molecular and Engineering Aspects of Biotechnology</td>
<td></td>
</tr>
<tr>
<td>or 7.371</td>
<td>Biological and Engineering Principles Underlying Novel Biotherapeutics</td>
<td></td>
</tr>
<tr>
<td>7.41</td>
<td>Principles of Chemical Biology</td>
<td></td>
</tr>
<tr>
<td>7.45</td>
<td>The Hallmarks of Cancer</td>
<td></td>
</tr>
<tr>
<td>7.49[J]</td>
<td>Developmental Neurobiology</td>
<td></td>
</tr>
</tbody>
</table>

Total Units 60
For a general description of the minor program, see Undergraduate Education (p. 35).

**Inquiries**
Additional information regarding undergraduate academic programs and research opportunities may be obtained from the Biology Education Office (undergradbio@mit.edu), Room 68-120, 617-253-4718.

**Graduate Study**
The Department of Biology offers graduate work leading to the Doctor of Philosophy. Students may choose from among the following fields of specialization.

Biochemistry, Biophysics, and Structural Biology focus on improving our understanding of molecular processes central to life. Using in vitro approaches, biochemists and biophysicists analyze the mechanisms of biological information transfer, from maintenance and replication of the genome to protein synthesis, sorting, and processing. Structural biologists elucidate the molecular shapes of biological macromolecules and complexes and determine how structure enables function. Applying principles and tools from chemistry and physics, biochemists and biophysicists elaborate the details of protein and nucleic acid folding and interactions, biomolecular dynamics, catalysis, and macromolecular assembly.

Cancer Biology involves the discovery of genes implicated in cancer, the identification of cell biological processes affected during tumorigenesis, and the development of potential new therapeutic targets. Cancer biologists employ genetic approaches, including classical genetics, to determine the components of growth control pathways in model organisms, cloning of human oncogenes and tumor suppressor genes, and generating mutant mouse strains to study these and other cancer-associated genes. They also perform biochemical and cell biological studies to elucidate the function of cancer genes, the details of proliferation, cell cycle and cell death pathways, the nature of cell-cell and cell-matrix interactions, and the mechanisms of chromosome stability and of DNA repair, replication, and transcription.

Cell Biology is the study of processes carried out by individual cells, such as cell division, organelle inheritance and biogenesis, signal transduction, and motility. These processes are often affected by components in the environment, including nutrients, growth signals, and cell-cell contact. Cell biologists study these processes using single-celled organisms, such as bacteria and yeast; multicellular organisms, such as zebrafish and mice; established mammalian tissue culture lines; and primary cell cultures derived from recombinant animals.

Computational Biology applies quantitative methods to the study of molecular, cellular, and organismal biology. Computational biologists develop and apply models, analyze data, and run simulations to study nucleic acid and protein sequences, biomolecular structures and functions, cellular information processing, tissue morphogenesis, and emergent behaviors.

Genetics is the study of genes, genetic variation, and heredity in living organisms that range in complexity from viruses to single-celled organisms to multicellular organisms, including humans. Geneticists seek to understand the transmission of genes by analyzing DNA replication, DNA repair, chromosome segregation, and cell division. They also use genetic and genomic tools to identify and analyze the genes and gene regulators required for normal biological processes, including development, sex determination, and aging, as well as for the etiology of disease.

Human Disease applies molecular genetics to the problems of human disease. The range of disease areas includes developmental defects, cancer, atherosclerosis and heart disease, neuromuscular diseases, and diseases of other organ systems. Researchers use genetic and genomic strategies to identify, isolate, and characterize genes that cause and contribute to the etiology of human diseases. They explore the mechanisms underlying developmental defects and diseases through the comparison of the genetic pathways in humans and model organisms. They also isolate cells from affected patients to generate novel assay systems to examine gene-function-pathology relationships.

Immunology focuses on the genetic, cellular, and molecular mechanisms by which organisms respond to and eliminate infections by a large number of pathogens. The immune response requires an elaborate collaboration of different cells of the immune system, including macrophages, B lymphocytes, and T lymphocytes. Immunologists study the role of the immune system not just in response to infection but also in a range of human diseases, including cancer.

Microbiology is the study of microscopic organisms, such as bacteria, viruses, archaea, fungi, and protozoa. Exploiting sophisticated genetic, molecular biological, and biochemical systems available for microorganisms, microbiologists obtain high-resolution insights into the fundamental processes necessary for life and explore ways to manipulate microorganisms to achieve particular desired ends. They also determine how aspects of the microbial life cycle and lifestyle enable their survival within particular biological niches and facilitate interactions with their environment.

Neurobiology seeks to understand how the remarkable diversity in neuronal cell types and their connections are established and how changes in them underlie learning and thinking. Neurobiologists identify and characterize the molecules involved in specifying neuronal cell fate in vertebrates and invertebrates, and in guiding axons to their correct targets.

Stem Cell and Developmental Biology explores how a germ line stem cell develops into a multicellular organism, which requires that cells divide, differentiate, and assume their proper positions.
relative to one another as they produce organ systems and entire organisms. Stem cells are unusual cells in the body that retain the capacity to both self-renew and differentiate. Stem cell researchers identify the molecular mechanisms underlying stem cell renewal and differentiation, and use stem cells for disease modeling and regenerative medicine.

Admission Requirements for Graduate Study
In the Department of Biology, the Master of Science is not a prerequisite for a program of study leading to the doctorate.

The department modifies the General Institute Requirements for admission to graduate study as follows: 18.01 Calculus, 18.02 Calculus; one year of college physics; 5.12 Organic Chemistry I; professional subjects including general biochemistry, genetics, and physical chemistry. However, students may make up some deficiencies over the course of their graduate work.

Doctor of Philosophy
The General Degree Requirements for the Doctor of Philosophy are listed under Graduate Education (p. 61). In the departmental program, each graduate student is expected to acquire a solid background in four fundamental areas of biology: biochemistry, genetics, cell biology, and molecular biology. Most students take subjects in these areas during the first year. All students are required to take three subjects:

- **7.50** Method and Logic in Molecular Biology
- **7.51** Principles of Biochemical Analysis
- **7.52** Genetics for Graduate Students

7.50 is a seminar designed specifically to introduce graduate students to in-depth discussion and analysis of topics in molecular biology.

Students have a choice of several elective subjects, which have been designed for the entering graduate student. One of the elective subjects must focus on computational and quantitative approaches to biology. Typically students choose one of the following subjects:

- **7.57** Quantitative Biology for Graduate Students
- **7.81[J]** Systems Biology

In addition to providing a strong formal background in biology, the first-year program serves to familiarize the students with faculty and students in all parts of the department.

Interdisciplinary Programs

Joint Program with the Woods Hole Oceanographic Institution
The Joint Program with the Woods Hole Oceanographic Institution (WHOI) (http://mit.whoi.edu) is intended for students whose primary career objective is oceanography or oceanographic engineering.

Students divide their academic and research efforts between the campuses of MIT and WHOI. Joint Program students are assigned an MIT faculty member as academic advisor; thesis research may be supervised by MIT or WHOI faculty. While in residence at MIT, students follow a program similar to that of other students in their home department. The program is described in more detail under Interdisciplinary Graduate Programs (p. 372).

Master of Engineering in Computer Science and Molecular Biology (Course 6-7P)
The Departments of Biology and Electrical Engineering and Computer Science jointly offer a Master of Engineering in Computer Science and Molecular Biology (6-7P) (p. 489). A detailed description of the program requirements may be found under the section on Interdisciplinary Programs (p. 370).

Financial Support
Students who are accepted into the graduate program are provided with support from departmental training grants, departmental funds for teaching assistants, and research grants. In addition, some students bring National Science Foundation and other competitive fellowships. Through these sources, full tuition plus a stipend for living expenses are provided.

Students are encouraged to apply for outside fellowships for which they are eligible, such as the NSF Fellowships. Information regarding graduate student fellowships is available at most colleges from the career planning office.

Inquiries
Additional information regarding graduate academic programs, research activities, admissions, financial aid, and assistantships may be obtained from the Biology Education Office (gradbio@mit.edu), Room 68-120, 617-253-3717.

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The study of mind, brain, and behavior has grown in recent years with unprecedented speed. New avenues of approach, opened by developments in the biological and computer sciences, raise the hope that human beings, having achieved considerable mastery over the world around them, may also come closer to an understanding of themselves. The goal of the Department of Brain and Cognitive Sciences is to answer fundamental questions concerning intelligent processes and brain organization. To this end, the department focuses on four themes: molecular and cellular neuroscience, systems neuroscience, cognitive science, and computation. Several members of the department's faculty are affiliated with two major research centers: the Picower Institute for Learning and Memory and the McGovern Institute for Brain Research.

Research in cellular neuroscience deals with the biology of neurons, emphasizing the special properties of these cells as encoders, transmitters, and processors of information. Departmental researchers apply techniques of contemporary molecular and cellular biology to problems of neuronal development, structure, and function, resulting in a new understanding of the underlying basic components of the nervous system and their interactions. These studies have profound clinical implications, in part by generating a framework for the treatment of neurological and psychiatric disorders. Primary areas of interest include the development and plasticity of neuronal morphology and connectivity, the cellular and molecular bases of behavior in simple neuronal circuits, neurochemistry, and cellular physiology.

In the area of systems neuroscience, departmental investigators use a number of new approaches ranging from computation through electrophysiology to biophysics. Of major interest are the visual and motor systems where the scientific goals are to understand transduction and encoding of sensory stimuli into nerve messages, organization and development of sensorimotor systems, processing of sensorimotor information, and the sensorimotor performance of organisms. Also of major interest is neuromodulatory regulation, where the scientific goal is to understand the effects of rewarding or stressful environments on brain circuits.

In computation and cognitive science, particularly strong interactions exist between the Department of Brain and Cognitive Sciences, the Computer Science and Artificial Intelligence Laboratory, and the Center for Biological and Computational Learning, providing new intellectual approaches in areas including vision and motor control, and biological and computer learning. Computational theories are developed and tested within the framework of neurophysiological, psychological, and other experimental approaches. In the study of vision and motor control, complementary experimental work includes single-cell and multiple-cell neurophysiological recording as well as functional brain imaging. In the area of learning, which is seen as central to intelligent behavior, departmental researchers are working to develop theories of vision, motor control, neural circuitry, and language within an experimental framework.

In cognitive science, human experimentation is combined with formal and computational analyses to understand complex intelligent processes such as language, reasoning, memory, and visual information processing. There are applications in the fields of education, artificial intelligence, human-machine interaction, and in the treatment of language, cognitive, and other disorders.

Subfields in cognitive science include psycholinguistics, comprising sentence and word processing, language acquisition, and aphasia; visual cognition, including reading, imagery, attention, and perception of complex patterns such as faces, objects, and scenes; spatial cognition; memory; and the nature and development of concepts. Another key field is the study of perception—developmental and processing approaches focus on human and machine vision, and how visual images are encoded, stored, and retrieved, with current topics that include motion analysis, stereopsis, perceptual organization, and perceptual similarity. Other research includes functional brain imaging in normal subjects as well as studies of neurologically impaired patients in an attempt to understand brain mechanisms underlying normal human sensation, perception, cognition, action, and affect.

Undergraduate Study

Bachelor of Science in Brain and Cognitive Sciences (Course 9)
Brain science and cognitive science are complementary and interactive in their research objectives. Both approaches examine perception, performance, and intervening processes in humans and animals. Central issues in the discipline include the interpretation of sensory experience; the reception, manipulation, storage, and retrieval of information within the nervous system; and the planning and execution of motor activity. Higher level functions include the development of formal and informal reasoning skills; and the structure, acquisition, use, and internal representation of human language.

The Bachelor of Science in Brain and Cognitive Sciences (p. 463) prepares students to pursue advanced degrees or careers in artificial intelligence, machine learning, neuroscience, medicine, cognitive science, psychology, linguistics, philosophy, education research and technology, and human-machine interaction.

Methods of inquiry in the brain and cognitive sciences are drawn from molecular, cellular, and systems neuroscience; cognitive and perceptual psychology; computer science and artificial intelligence; linguistics; philosophy of language and mind; and mathematics. The undergraduate program is designed to provide instruction in the relevant aspects of these various disciplines. The program is administered by an Undergraduate Officer and an Undergraduate Administrator, consulting as necessary with faculty members from
these disciplines who also serve as advisors to majors, helping them select a coherent set of subjects from within the requirements, including a research requirement. Members of the faculty are available to guide the research.

The Brain and Cognitive Sciences (BCS) major incorporates programming and computational skills to meet the increasing demands for those skills in both graduate school and the workforce. The major offers a tiered system of subjects with enough flexibility to allow multiple avenues through the Brain and Cognitive Sciences curriculum, meeting the divergent goals of BCS students. Individual guidance regarding career goals is available from faculty and from Career Advising and Professional Development

### Minor in Brain and Cognitive Sciences

The Minor in Brain and Cognitive Sciences consists of six subjects arranged in two levels of study, intended to provide students breadth in the field as a whole and some depth in an area of specialization.

#### Core Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.00</td>
<td>Introduction to Psychological Science</td>
<td>12</td>
</tr>
<tr>
<td>9.01</td>
<td>Introduction to Neuroscience</td>
<td>12</td>
</tr>
<tr>
<td>9.40</td>
<td>Introduction to Neural Computation</td>
<td>12</td>
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</table>

#### Specialized Subjects

Select any combination of three subjects from Tier 2 and/or Tier 3 of the undergraduate degree program:

#### Tier 2 Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.04</td>
<td>Sensory Systems</td>
<td></td>
</tr>
<tr>
<td>9.09[J]</td>
<td>Cellular and Molecular Neurobiology</td>
<td></td>
</tr>
<tr>
<td>9.11</td>
<td>The Human Brain</td>
<td></td>
</tr>
<tr>
<td>9.15</td>
<td>Neural Circuits, Neuromodulatory, and Neuroendocrine Systems</td>
<td></td>
</tr>
<tr>
<td>9.16</td>
<td>Cellular and Synaptic Neurophysiology</td>
<td></td>
</tr>
<tr>
<td>9.18[J]</td>
<td>Developmental Neurobiology</td>
<td></td>
</tr>
<tr>
<td>9.19</td>
<td>Computational Psycholinguistics</td>
<td></td>
</tr>
<tr>
<td>9.21[J]</td>
<td>Cellular Neurophysiology and Computing</td>
<td></td>
</tr>
<tr>
<td>9.31</td>
<td>Neurobiology of Learning and Memory</td>
<td></td>
</tr>
<tr>
<td>9.35</td>
<td>Perceptual Systems</td>
<td></td>
</tr>
<tr>
<td>9.85</td>
<td>Infant and Early Childhood Cognition</td>
<td></td>
</tr>
</tbody>
</table>

#### Tier 3 Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>9.24</td>
<td>Disorders and Diseases of the Nervous System</td>
<td></td>
</tr>
<tr>
<td>9.26[J]</td>
<td>Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience</td>
<td></td>
</tr>
</tbody>
</table>

### Graduate Study

The Department of Brain and Cognitive Sciences offers programs of study leading to the doctoral degree in neuroscience or cognitive science. Areas of research specialization include cellular and molecular neuroscience, systems neuroscience, computation, and cognitive science. The graduate programs are designed to prepare students to pursue careers in research, teaching, or industry.

#### Doctor of Philosophy

The departmental PhD program can normally be completed with four to six years of full-time work, including summers. Institute requirements for the PhD are given in the section on General Degree Requirements (p. 61). Formal coursework, described below, is intended to prepare the student to pass the general examinations and do original thesis research. The written general examinations will be due in August of the second year.

All students start with first-year intensive core subjects that provide an introduction to brain and cognitive studies from the viewpoint of systems neuroscience, molecular and cellular neuroscience, cognition, and computation. Incoming graduate students are required to take at least two of these subjects but encouraged to take all within the first two years of study. Further coursework will be diversified to give each individual the appropriate background for research in his or her own area.

Coursework in cellular and molecular neuroscience emphasizes the current genetic, molecular, and cellular approaches to biological systems that are necessary to generate advances in neuroscience.

Training in systems neuroscience covers neuroanatomy, neurophysiology, and neurotransmitter chemistry, concentrating on the major sensory, motor, memory, and executive systems in the vertebrate brain. Specific ties to molecular neurobiology or computation may be emphasized, depending upon the research interests of the student.

Coursework for students in computation is intended to give both an understanding of empirical approaches to the study of the brain and animal behavior and a theoretical background for analyzing computational aspects of biological information processing.

Candidates studying cognitive science take coursework covering such topics as language processing, language acquisition, cognitive development, natural computation, neural networks, connectionist
models, and visual information processing. Students also choose seminars and coursework in linguistics, philosophy, logic, mathematics, or computer science, depending on the individual student’s research program.

Graduate students begin a research apprenticeship immediately upon arrival with lab rotations in the first year, after which time advisor choices are made based upon a match of interests. These assignments may change as a student’s goals become more focused. At the end of the first year, an advisory committee of two to four faculty members is formed. This committee monitors progress and, with membership changing as necessary, evolves into the thesis committee. Thesis research normally requires 24-48 months of full-time activity after the qualifying examinations have been passed. It is expected that the research embodied in the PhD dissertation be original and significant work, publishable in scientific journals.

Financial Support
Financial assistance is provided to qualified applicants in the form of traineeships, research assistantships, teaching assistantships, and a limited number of fellowships, subject to availability of funds. Prospective students are encouraged to apply for individual fellowships such as those sponsored by the National Science Foundation and the National Defense Science and Engineering Graduate Fellowship Program to cover all or part of the cost of their education. The department’s financial resources for non-US citizens are limited; international students are strongly encouraged to seek financial assistance for all or part of the cost of their education from non-MIT sources.

Inquiries
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DEPARTMENT OF CHEMISTRY

Chemistry is the study of the world of atoms, molecules, and solids. Chemists are both students and architects of this miniature universe, exploring the changes that occur, discovering the principles that govern these chemical changes, and devising ways to create entirely new classes of compounds and materials. Previous triumphs of chemistry include the synthesis of pharmaceuticals and agricultural products, while current challenges include chemical memory, solar cells, superconductors, clean fuels, batteries, and the solution of numerous important problems relating to health and the environment.

The Department of Chemistry (http://chemistry.mit.edu) offers the Bachelor of Science and Doctor of Philosophy degrees. The department’s program of teaching and research spans the breadth of chemistry. General areas covered include biological chemistry, inorganic chemistry, organic chemistry, and physical chemistry. Some of the activities of the department, especially those that involve “translational research” (the application of basic science to practical problems) are carried out in association with interdisciplinary laboratories and centers. See the section on Research and Study (p. 88) for more information.

The Bachelor of Science (p. 312) degree provides rigorous education in the fundamental areas of chemical and biochemical knowledge and experimentation. Undergraduate students are encouraged to participate in the Undergraduate Research Opportunities Program (UROP) (p. 44) and to take graduate-level chemistry classes as well as subjects in other departments at the Institute, Harvard University, or Wellesley College.

The Doctor of Philosophy (p. 313) degree trains students to be world leaders in scientific research and education. In addition to formal coursework, each student undertakes a research problem that forms the core of graduate work. Graduate- and postgraduate-level research is often carried out in collaboration with scientists in other facilities and interdisciplinary laboratories.

Undergraduate Study

Bachelor of Science in Chemistry (Course 5)

Standard Chemistry Option

The Department of Chemistry offers an undergraduate program (p. 465) sufficiently broad as to provide excellent preparation for careers in many different areas of chemistry. Course 5 is designed to provide an education based on science, both for those who intend to go on to graduate study and those who intend to pursue a professional career immediately in either chemistry or an allied field, such as medicine, in which a sound knowledge of chemistry is important. Students receive thorough instruction in the principles of chemistry, supplemented by a strong foundation in mathematics, physics, biology, and the humanities. A Certification in Biochemistry by the American Chemical Society can be received with a bachelor’s degree for students who have concentrated in this area. The Department of Chemistry also teaches courses jointly with the departments of Biology, Chemical Engineering, Biological Engineering, and Materials Science and Engineering. Students at all levels are encouraged to undertake original research under the supervision of a member of the chemistry faculty.

Flexible Chemistry Option

The Flexible Chemistry Option (p. 465), “ChemFlex,” is designed to provide an education both for those who intend to pursue chemistry as a career and for those who plan to go into an allied field, such as biotechnology or scientific consulting, in which a sound knowledge of chemistry is important. Students receive thorough instruction in the principles of chemistry, supplemented by a strong foundation in mathematics, physics, biology, and the humanities. This training can be tailored to the student’s interests by the judicious choice of elective focus subjects that contribute to the major. The Department of Chemistry also teaches courses jointly with the departments of Biology, Chemical Engineering, Biological Engineering, and Materials Science and Engineering. The student’s faculty advisor can offer suggestions for elective subjects that are of value in preparation for specialization in the various broad areas of chemistry. The proper choice of electives is particularly important for students planning to continue their education in a graduate program. Students at all levels are encouraged to undertake original research.

Bachelor of Science in Chemistry and Biology (Course 5-7)

The Departments of Biology and Chemistry jointly offer a Bachelor of Science in Chemistry and Biology (p. 480). A detailed description of the requirements for this degree program can be found in the section on Interdisciplinary Programs (p. 338).

Minor in Chemistry

The requirements for a Minor in Chemistry are as follows:

<table>
<thead>
<tr>
<th>Requirements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5.03 Principles of Inorganic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.12 Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.310 Laboratory Chemistry 1</td>
<td>12</td>
</tr>
<tr>
<td>5.60 Thermodynamics and Kinetics</td>
<td>12</td>
</tr>
<tr>
<td>Select 24 units of the following:</td>
<td>24</td>
</tr>
<tr>
<td>5.04 Principles of Inorganic Chemistry II</td>
<td></td>
</tr>
<tr>
<td>5.07[J] Biological Chemistry I</td>
<td></td>
</tr>
<tr>
<td>5.08[J] Biological Chemistry II</td>
<td></td>
</tr>
<tr>
<td>5.13 Organic Chemistry II</td>
<td></td>
</tr>
<tr>
<td>5.361 Expression and Purification of Enzyme Mutants</td>
<td></td>
</tr>
</tbody>
</table>
5.362 Kinetics of Enzyme Inhibition
5.363 Organic Structure Determination
5.371 Continuous Flow Chemistry: Sustainable Conversion of Reclaimed Vegetable Oil into Biodiesel
5.372 Chemistry of Renewable Energy
5.373 Dinitrogen Cleavage
5.43 Advanced Organic Chemistry
5.61 Physical Chemistry
5.62 Physical Chemistry

Total Units 72

2 The combination of 5.351 Fundamentals of Spectroscopy, 5.352 Synthesis of Coordination Compounds and Kinetics, and 5.353 Macromolecular Prodrugs is an acceptable alternative.

Minor in Atmospheric Chemistry
The Minor in Atmospheric Chemistry (p. 354), offered jointly with the Departments of Earth, Atmospheric, and Planetary Sciences and Civil and Environmental Engineering, blends fundamental science with engineering and policy. For a description of the minor, see Interdisciplinary Programs.

Inquiries
Additional information may be obtained from the Chemistry Education Office, Room 6-205, 617-253-7271.

Graduate Study
The Department of Chemistry offers the Doctor of Philosophy degree. The subjects offered aim to develop a sound knowledge of fundamentals and a familiarity with current progress in the most active and important areas of chemistry. In addition to studying formal subjects, each student undertakes a research problem that forms the core of graduate work. Through the experience of conducting an investigation leading to the doctoral thesis, a student learns general methods of approach and acquires training in some of the specialized techniques of research.

The areas of research (http://chemistry.mit.edu/research/overview) in the department include biological, environmental, inorganic, materials, organic and physical chemistry, broadly defined. Chemical research frequently involves more than one of the traditional subfields. Some research activities of the department are carried out in association with interdisciplinary laboratories and centers as described in Research and Study (p. 88). These interdisciplinary research laboratories provide stimulating interaction among the research programs of several MIT departments and give students opportunities to become familiar with research work in disciplines other than chemistry. The department also participates in the interdisciplinary graduate Program in Polymers and Soft Matter, the Biotechnology Training Program, the Microbiology Program, and the Biophysics Certificate Program.

Admission Requirements for Graduate Study
Students intending to do graduate work in the Chemistry Department should have excellent undergraduate preparation in chemistry. The department is flexible with respect to specific course preparation; the essential requirement is demonstration of ability to progress with advanced study and research in some area of special interest. However, mathematics and physics are important prerequisites for graduate work in physical chemistry or chemical physics, whereas less preparation in these areas is required for work in organic chemistry.

Applicants to the Chemistry Department are required to submit scores from the verbal and quantitative sections of the Graduate Record Examination. Scores on the advanced examinations are optional.

Doctor of Philosophy
The Chemistry Department does not have any formal subject requirements for the doctoral degree. Each student, with the advice of a research supervisor, pursues an individual program of study that is pertinent to the student’s long-range research interests. All students are required to serve as a teaching assistant for two terms, usually during the first year.

During the first term of residence, all graduate students are encouraged to select research supervisors who serve as their advisors for the balance of their graduate careers. In particular, the overall program of graduate subjects is established by each student in consultation with the research supervisor. In planning this program and in establishing the thesis problem, careful consideration is given to the candidate’s academic record and professional experience, as well as to long-range objectives.

Written qualifying examinations are cumulative. Separate examinations in biological, inorganic, organic, and physical chemistry are offered each month from October through May. The examinations demonstrate an understanding of the important principles of each field. Six cumulative examinations must be passed to complete the written major examination. No fixed time limit is set for completion of this requirement; however, progress is reviewed periodically and the department expects a demonstrated passing performance in cumulative exams before a student takes their second-year oral exam. It is normal to have passed at least four cumulative exams by that time. No other written general examinations are required. In particular, no entrance examinations are given.

A comprehensive oral examination in the candidate’s major field of advanced study is held generally in the fourth term of residence. Progress in the student's research is also examined at that time. A final oral presentation on the subject of the doctoral research is
scheduled after the thesis has been submitted and evaluated by a committee of examiners.

**Interdisciplinary Programs**

**Polymers and Soft Matter**
The Program in Polymers and Soft Matter (PPSM) ([http://polymerscience.mit.edu](http://polymerscience.mit.edu)) offers students from participating departments an interdisciplinary core curriculum in polymer science and engineering, exposure to the broader polymer community through seminars, contact with visitors from industry and academia, and interdepartmental collaboration while working towards a PhD or ScD degree.

Research opportunities include functional polymers, controlled drug delivery, nanostructured polymers, polymers at interfaces, biomaterials, molecular modeling, polymer synthesis, biomimetic materials, polymer mechanics and rheology, self-assembly, and polymers in energy. The program is described in more detail under Interdisciplinary Graduate Programs (p. 376).

**Financial Support**
The department usually appoints first-year graduate students as teaching assistants (TAs). TAs are assigned either to laboratory subjects or to discussion sections of lecture subjects. Most students receive appointments to research assistantships after their first year, and departmental fellowships are also available. Financial support after the first academic year is subject to the availability of funds and provided for students who maintain a satisfactory record.

**Inquiries**
Correspondence about the graduate program or appointments should be addressed to the Chemistry Education Office, Room 6-205, 617-253-1851.

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Professor of Chemistry

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Professor Post-Tenure of Toxicology and Biological Engineering  
Professor Post-Tenure of Chemistry

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Technical Instructors

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Peter Mueller, PhD  
Principal Research Scientist of Chemistry

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Research Specialist of Chemistry

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Institute Professor Emeritus  
Professor Emeritus of Chemistry

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Daniel S. Kemp, PhD  
Professor Emeritus of Chemistry

Stephen J. Lippard, PhD  
Arthur Amos Noyes Professor Emeritus  
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JoAnne Stubbe, PhD  
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Professor Emerita of Chemistry  
Professor Emerita of Biology

Gerald N. Wogan, PhD  
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Professor Emeritus of Chemistry
DEPARTMENT OF EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

The Department of Earth, Atmospheric, and Planetary Sciences offers the bachelor’s degree in earth, atmospheric, and planetary sciences, and master’s and doctoral degrees in atmospheric sciences, climate science, geology, geochemistry, geobiology, geophysics, and planetary sciences. The department participates in the MIT-WHOI Joint Program in Oceanography/Applied Ocean Science and Engineering (p. 372) with doctoral degree programs in chemical oceanography, physical oceanography, biological oceanography, and marine geology and geophysics.

Departmental programs apply physics, chemistry, and mathematics to the study of the Earth and planets in order to understand the processes that are active in the Earth’s interior, oceans, and atmosphere, as well as the interiors and atmospheres of other planets. The department also uses the basic sciences to understand the past history of the Earth and planets. By combining the past history with models of present physical, biological, and chemical processes, faculty and students work to develop an understanding of the dynamics of systems as diverse as the global climate system, regional tectonics and deformation, petroleum and geothermal reservoirs, and the solar system.

Research in the department is fundamental in nature, but underpins many of the most pressing societal questions of our time: climate and environmental change; natural hazards; natural resources; the origins of life both on Earth and elsewhere. Much of the research is interdisciplinary, so faculty, researchers, and students commonly cross discipline boundaries. Modern problems in these fields are approached by field measurements, laboratory studies, simulations, and theory. Experimental facilities for training and research are available not only in departmental laboratories such as the Earth Resources Laboratory, but also in MIT’s interdepartmental laboratories such as the Center for Global Change Science, Kavli Institute for Astrophysics and Space Research, Lincoln Laboratory, Haystack Radio Observatory and Millstone Radar facility, and the Wallace Astrophysical and Geophysical Observatories (described in the section on Research and Study (p. 88)), and in cooperating institutions such as the Woods Hole Oceanographic Institution.

Undergraduate Study

Bachelor of Science in Earth, Atmospheric, and Planetary Sciences (Course 12)
The Earth, Atmospheric, and Planetary Sciences Department offers undergraduate preparation for professional careers in a wide range of fields in geoscience (which includes geology, geophysics, geobiology, and geochemistry), atmospheric science, climate science, environmental systems, and planetary science and planetary astronomy.

The curriculum for the Bachelor of Science in Earth, Atmospheric, and Planetary Sciences (p. 467) ensures a fundamental background through general departmental subjects and advanced study in a concentration area chosen by the student. The student and advisor plan an appropriate and relevant selection of electives. Students are also required to take field and/or laboratory subjects, and to complete an independent research project as part of the degree requirements.

Double Major

Studies in physics, chemistry, biology, applied mathematics, and electrical or civil engineering are directly relevant preparation for work in earth, atmospheric, and planetary sciences. Students from these departments can arrange a program of study in Course 12 leading to a second major with subjects that strengthen their undergraduate program.

Five-Year Program

Students with strong academic records from the departments of Earth, Atmospheric, and Planetary Sciences, Chemistry, Physics, Mathematics, Civil and Environmental Engineering, Electrical Engineering and Computer Science, or Chemical Engineering, should be able to complete a Master of Science in Earth and Planetary Sciences, in Atmospheric Sciences, or in Ocean Sciences in one year of additional study, particularly if programs are arranged for this purpose from the beginning of the fourth year.

Applications for graduate enrollment in the department are considered any time after the beginning of the fourth year. Students may receive the Bachelor of Science as soon as the requirements are completed, or may elect to defer the award for simultaneous presentation with the Master of Science.

Minor in Earth, Atmospheric, and Planetary Sciences

The Minor in Earth, Atmospheric, and Planetary Sciences provides an opportunity to complement or expand upon one’s major by exploring in depth the natural processes that govern the structure and evolution of the Earth and planets. Areas of study include planetary surfaces, interiors, atmospheres, oceans, and biospheres. The EAPS Minor requires a solid foundation in two core subjects plus electives that create expertise in a particular area. Opportunities for field work, laboratory work, and independent study are an essential component of the minor.

Core Subjects

<table>
<thead>
<tr>
<th>Select two of the following:</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.001</td>
<td>Introduction to Geology</td>
</tr>
<tr>
<td>12.002</td>
<td>Introduction to Geophysics and Planetary Science</td>
</tr>
<tr>
<td>12.003</td>
<td>Introduction to Atmosphere, Ocean, and Climate Dynamics</td>
</tr>
</tbody>
</table>
Select one of the following:

- 12.007 Geobiology: History of Life on Earth
- 5.60 Thermodynamics and Kinetics
- 18.03 Differential Equations

**Restricted Electives**

Select at least 24 units in Course 12 subjects, approved by the minor advisor, to provide a depth of understanding and expertise in an EAPS discipline.

Select an option from either the Laboratory or Independent Study group:

**Laboratory:**

- 12.115 Field Geology
- 12.119 Analytical Techniques for Studying Environmental and Geologic Samples
- 12.307 Weather and Climate Laboratory
- 12.335 Experimental Atmospheric Chemistry
- 12.410[J] Observational Techniques of Optical Astronomy

**Independent Study:**

- 12.IND Independent Study
- 12.UR Undergraduate Research

**Total Units:** 72-75

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18.03 Differential Equations is also an acceptable option.

**Minor in Astronomy**

The Earth, Atmospheric, and Planetary Sciences Department jointly offers a Minor in Astronomy (p. 353) with the Department of Physics (Course 8). A detailed description and list of requirements for this minor is available under Interdisciplinary Programs.

**Minor in Atmospheric Chemistry**

The department also offers an interdisciplinary Minor in Atmospheric Chemistry (p. 354) with the Departments of Chemistry and Civil and Environmental Engineering. For a description of the minor, see Interdisciplinary Programs.

**Admission Requirements for Graduate Study**

In addition to the general institute requirements for admission listed in the section on Graduate Education (p. 60), the department requires preparation equivalent to the curriculum for the Bachelor of Science in Earth, Atmospheric, and Planetary Sciences at MIT for graduate studies in that field. For atmospheric sciences, climate studies, meteorology, and oceanography, the most essential element is a sound preparation in mathematics and physics, supplemented if possible by some chemistry. Students taking their undergraduate work at other institutions are advised to include in their programs the equivalent of the mathematics and physics contained in the MIT undergraduate curricula. If students are not fully prepared in certain of the fields or required subjects, they usually are asked to extend their studies in these areas while pursuing advanced work. The doctoral program can be entered without a Master of Science as a prerequisite.

**Master of Science in Earth and Planetary Sciences, in Atmospheric Science, or in Climate Physics and Chemistry**

The General Degree Requirements for the degree of Master of Science in Earth and Planetary Science, in Atmospheric Science, or in Climate Physics and Chemistry are described under Graduate...
Education (p. 60). An individual program of study and research is arranged to suit the special background, needs, and goals of each student. The program is worked out in detail by the student with his or her personal faculty advisor and a departmental committee. There are no foreign language requirements for the degree.

**Doctor of Philosophy and Doctor of Science**
A specialized program of study and research is tailored to each student’s background, needs, and goals by the student in consultation with a faculty advisor and a departmental committee. A doctoral candidate’s program should be broad and may include formal study in other departments in addition to the specialized subjects that prepare the candidate for thesis research. There is no foreign language requirement for the degree. Thesis research normally begins immediately after successful completion of the general examination by the end of the second year. The general examination is intended to test the candidate’s aptitude and preparation for independent research.

Thesis research is closely supervised by one or more faculty members interested in and knowledgeable about the research topic, who are chosen by the student and may be members of other departments. The thesis is expected to meet high professional standards, and to be a significant original contribution to the scientific field.

**Interdisciplinary Programs**

**Joint Program with the Woods Hole Oceanographic Institution**
The Joint Program with the Woods Hole Oceanographic Institution (WHOI) (http://mit.whoi.edu) is intended for students whose primary career objective is oceanography or oceanographic engineering. Students divide their academic and research efforts between the campuses of MIT and WHOI. Joint Program students are assigned an MIT faculty member as academic advisor; thesis research may be supervised by MIT or WHOI faculty. While in residence at MIT, students follow a program similar to that of other students in their home department. The program is described in more detail under Interdisciplinary Graduate Programs (p. 372).

**Financial Support**
The department offers a considerable number of research and teaching assistantships each year. Research assistants work on one of the many research projects in the department, often related to the student’s thesis research. Teaching assistants assist in laboratory instruction or in the preparation of teaching materials and the grading of papers.

The department also offers several fellowships beyond normal teaching and research assistantships. Selection of individuals is based on the excellence of the applicant’s record.

**Inquiries**
Additional information regarding academic and current research programs in the department, admission requirements, assistantship appointments, and financial aid may be obtained by writing to the department’s Education Office, Room 54-912, 617-253-3381.

**Research Laboratories and Programs**
The department’s faculty, staff, and students are engaged in a wide variety of research projects in the laboratories of individual faculty members and in the departmental laboratories described below. Many also participate in the activities of interdisciplinary laboratories such as the Center for the Global Change Science and the Joint Program on the Science and Policy of Global Change, described in the section on Research and Study (p. 88).

**Earth Resources Laboratory**
The Earth Resources Laboratory (ERL) (http://erl.mit.edu) is MIT’s primary home for research and education focused on sub-surface energy resources. Through integration across disciplines, departments, and school boundaries, and with support from federal agencies and a consortium of energy companies, ERL addresses questions concerning hydrocarbon exploration and production, geothermal energy, CO₂ sequestration, and near-surface environments.

ERL’s faculty, research staff, and students work with a variety of methodologies (including geophysical imaging, rock physics and chemistry, multiphase flow, geomechanics, microseisms, and remote sensing) to obtain a holistic understanding of sub-surface reservoirs—their structure, the geological materials of which they are made, the fluids that flow through them, and changes that occur in response to production.

Building on a rich tradition, ERL aims to produce tomorrow’s industry leaders through rigorous disciplinary education and broad exposure to the earth sciences, mathematics, and engineering.

Professor Bradford H. Hager is the current director of ERL. For further information, please visit ERL website (http://erl.mit.edu).

**George R. Wallace, Jr., Astrophysical Observatory**
The George R. Wallace, Jr., Astrophysical Observatory (http://web.mit.edu/wallace) is a versatile facility for research and teaching optical astronomy. The observatory located in Westford, MA, has several optical telescopes ranging from 24-in to 8-in diameters and modern instrumentation. The telescopes are used in formal instruction; faculty, staff, and student research projects; and as testbeds for instrumentation to be used with larger telescopes. Further information on the Wallace Observatory may be obtained by contacting Dr. Michael Person (mjperson@mit.edu), 54-418, 617-452-2304.
George R. Wallace, Jr., Geophysical Observatory

The George R. Wallace, Jr., Geophysical Observatory is a unique research facility designed to monitor ground motions and to aid in the development and testing of new seismic and other geophysical instrumentation. It is also a key component of MIT’s five-station seismic network in New England.

Located 35 miles north of Boston in Westford, MA, the observatory has a large, multi-room underground vault and a surface control room. The vault has a controlled temperature environment and instrument piers resting directly on the basement granite. The observatory contains sensitive seismometers and instruments for monitoring ground tilts and the earth’s tidal motions. The surface building houses a work area and control and recording instruments. Data from the observatory are telemetered directly to the Earth Resources Laboratory of the Department of Earth, Atmospheric, and Planetary Sciences. The data from the observatory and the New England Seismic Network are recorded, displayed, and analyzed by three dedicated COMPAQ computers, which are also connected to workstations to facilitate data sharing and transfers. Data from the observatory along with the numerous resources of the department provide a unique facility for undergraduates, graduate students, and staff to pursue research concerning the interior of the earth.

Further information may be obtained by contacting EAPS Headquarters, 54-918, 617-253-2127.

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**Visiting Assistant Professors**
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Lodovica C. Illari, PhD
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Professor Emeritus of Physical Oceanography
DEPARTMENT OF MATHEMATICS

The Department of Mathematics (http://math.mit.edu) offers training at the undergraduate, graduate, and postgraduate levels. Its expertise covers a broad spectrum of fields ranging from the traditional areas of "pure" mathematics, such as analysis, algebra, geometry, and topology, to applied mathematics areas such as combinatorics, computational biology, fluid dynamics, theoretical computer science, and theoretical physics.

Course 18 includes two undergraduate degrees: a Bachelor of Science in Mathematics and a Bachelor of Science in Mathematics with Computer Science. Undergraduate students may choose one of three options leading to the Bachelor of Science in Mathematics: applied mathematics, pure mathematics, or general mathematics. The general mathematics option provides a great deal of flexibility and allows students to design their own programs in conjunction with their advisors. The Mathematics with Computer Science degree is offered for students who want to pursue interests in mathematics and theoretical computer science within a single undergraduate program.

At the graduate level, the Mathematics Department offers the PhD in Mathematics, which culminates in the exposition of original research in a dissertation. Graduate students also receive training and gain experience in the teaching of mathematics.

The CLE Moore instructorships and Applied Mathematics instructorships bring mathematicians at the postdoctoral level to MIT and provide them with training in research and teaching.

Undergraduate Study

An undergraduate degree in mathematics provides an excellent basis for graduate work in mathematics or computer science, or for employment in such fields as finance, business, or consulting. Students’ programs are arranged through consultation with their faculty advisors.

Undergraduates in mathematics are encouraged to elect an undergraduate seminar during their junior or senior year. The experience gained from active participation in a seminar conducted by a research mathematician has proven to be valuable for students planning to pursue graduate work as well as for those going on to other careers. These seminars also provide training in the verbal and written communication of mathematics and may be used to fulfill the Communication Requirement.

Many mathematics majors take 18.821 Project Laboratory in Mathematics, which fulfills the Institute’s Laboratory Requirement and counts toward the Communication Requirement.

Bachelor of Science in Mathematics (Course 18)

General Mathematics Option

In addition to the General Institute Requirements, the requirements consist of Differential Equations, plus eight additional 12-unit subjects in Course 18 of essentially different content, including at least six advanced subjects (first decimal digit one or higher). One of these eight subjects must be Linear Algebra. This leaves available 84 units of unrestricted electives. The requirements are flexible in order to accommodate students who pursue programs that combine mathematics with a related field (such as physics, economics, or management) as well as students who are interested in both pure and applied mathematics. More details can be found on the degree chart (p. 470).

Applied Mathematics Option

Applied mathematics focuses on the mathematical concepts and techniques applied in science, engineering, and computer science. Particular attention is given to the following principles and their mathematical formulations: propagation, equilibrium, stability, optimization, computation, statistics, and random processes.

Sophomores interested in applied mathematics typically enroll in 18.200 Principles of Discrete Applied Mathematics and 18.300 Principles of Continuum Applied Mathematics. Subject 18.200 is devoted to the discrete aspects of applied mathematics and may be taken concurrently with 18.03 Differential Equations. Subject 18.300, offered in the spring term, is devoted to continuous aspects and makes considerable use of differential equations.

The subjects in Group I of the program correspond roughly to those areas of applied mathematics that make heavy use of discrete mathematics, while Group II emphasizes those subjects that deal mainly with continuous processes. Some subjects, such as probability or numerical analysis, have both discrete and continuous aspects.

Students planning to go on to graduate work in applied mathematics should also take some basic subjects in analysis and algebra.

More detail on the Applied Mathematics option can be found on the degree chart (p. 471).

Pure Mathematics Option

Pure (or “theoretical”) mathematics is the study of the basic concepts and structure of mathematics. Its goal is to arrive at a deeper understanding and an expanded knowledge of mathematics itself.

Traditionally, pure mathematics has been classified into three general fields: analysis, which deals with continuous aspects of mathematics; algebra, which deals with discrete aspects; and geometry. The undergraduate program is designed so that students become familiar with each of these areas. Students also may wish to
explore other topics such as logic, number theory, complex analysis, and subjects within applied mathematics.

The subjects 18.701 Algebra I and 18.901 Introduction to Topology are more advanced and should not be elected until a student has had experience with proofs, as in Real Analysis (18.100A, 18.100B, 18.100P or 18.100Q) or 18.700 Linear Algebra.

For more details, see the degree chart (p. 473).

**Bachelor of Science in Mathematics with Computer Science (Course 18-C)**

Mathematics and computer science are closely related fields. Problems in computer science are often formalized and solved with mathematical methods. It is likely that many important problems currently facing computer scientists will be solved by researchers skilled in algebra, analysis, combinatorics, logic and/or probability theory, as well as computer science.

The purpose of this program is to allow students to study a combination of these mathematical areas and potential areas of application in computer science. Required subjects include linear algebra (18.06 or 18.700) because it is so broadly used, and discrete mathematics (18.062[J] or 18.200) to give experience with proofs and the necessary tools for analyzing algorithms. The required subjects covering complexity (18.404 Theory of Computation or 18.400[J] Automata, Computability, and Complexity) and algorithms (18.410[J] Design and Analysis of Algorithms) provide an introduction to the most theoretical aspects of computer science. We also require exposure to other areas of computer science (6.031, 6.033, 6.034, or 6.036) where mathematical issues may also arise. More details can be found on the degree chart (p. 473).

Some flexibility is allowed in this program. In particular, students may substitute the more advanced subject 18.701 Algebra I for 18.06 Linear Algebra, and, if they already have strong theorem-proving skills, may substitute 18.211 Combinatorial Analysis or 18.212 Algebraic Combinatorics for 18.062[J] Mathematics for Computer Science or 18.200 Principles of Discrete Applied Mathematics.

**Minor in Mathematics**

The requirements for a Minor in Mathematics are as follows: six 12-unit subjects in mathematics, beyond the Institute’s Mathematics Requirement, of essentially different content, including at least three advanced subjects (first decimal digit one or higher).

See the Undergraduate Section for a general description of the minor program (p. 35).

**Inquiries**

For further information, see the department’s website ([http://math.mit.edu/academics/undergrad](http://math.mit.edu/academics/undergrad)) or contact Math Academic Services, 617-253-2416.

**Graduate Study**

The Mathematics Department offers programs covering a broad range of topics leading to the Doctor of Philosophy or Doctor of Science degree. Candidates are admitted to either the Pure or Applied Mathematics programs but are free to pursue interests in both groups. Of the roughly 120-130 doctoral students, about two thirds are in Pure Mathematics, one third in Applied Mathematics.

The programs in Pure and Applied Mathematics offer basic and advanced classes in analysis, algebra, geometry, Lie theory, logic, number theory, probability, statistics, topology, astrophysics, combinatorics, fluid dynamics, numerical analysis, theoretical physics, and the theory of computation. In addition, many mathematically oriented subjects are offered by other departments. Students in Applied Mathematics are especially encouraged to take subjects in engineering and scientific subjects related to their research.

All students pursue research under the supervision of the faculty and are encouraged to take advantage of the many seminars and colloquia at MIT and in the Boston area.

**Doctor of Philosophy or Doctor of Science**

The requirements for these degrees are described on the department’s website ([http://math.mit.edu/academics/grad/timeline](http://math.mit.edu/academics/grad/timeline)). In outline, they consist of a language requirement, an oral qualifying examination, a thesis proposal, completion of a minimum of 132 units (11 graduate subjects), and a thesis containing original research in mathematics.

**Interdisciplinary Programs**

**Computational Science and Engineering**

Students with primary interest in computational science may also consider applying to the interdisciplinary Computational Science and Engineering (CSE) program, with which the Mathematics Department is affiliated. For more information, see the CSE website ([http://gradadmissions.mit.edu/programs/cse](http://gradadmissions.mit.edu/programs/cse)).

**Mathematics and Statistics**

The Interdisciplinary Doctoral Program in Statistics provides training in statistics, including classical statistics and probability as well as computation and data analysis, to students who wish to integrate these valuable skills into their primary academic program. The program is administered jointly by the departments of Aeronautics and Astronautics, Economics, Mathematics, and Political Science, and the Statistics and Data Science Center within the Institute for Data, Systems, and Society. It is open to current doctoral students in participating departments, who may apply to enroll in the program at any time after the end of their first year. For more information, see the full program description (p. 376) under Interdisciplinary Graduate Programs.
Financial Support
Financial support is guaranteed for up to five years to students making satisfactory academic progress. Financial aid after the first year is usually in the form of a teaching or research assistantship.

Inquiries
For further information, see the department’s website (http://math.mit.edu/academics/grad) or contact Math Academic Services, 617-253-2416.

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DEPARTMENT OF PHYSICS

The Department of Physics offers undergraduate, graduate, and postgraduate training, with a wide range of options for specialization.

The emphasis of both the undergraduate curriculum and the graduate program is on understanding the fundamental principles that appear to govern the behavior of the physical world, including space and time and matter and energy in all its forms, from the subatomic to the cosmological and from the elementary to the complex.

The Department of Physics strives to be at the forefront of many areas where new physics can be found. Consequently, the department works on problems where extreme conditions may reveal new behavior: from clusters of galaxies or the entire universe to elementary particles or the strings that may be the substructure of these particles; from collisions of nuclei at relativistic velocities that make droplets of matter hotter than anything since the Big Bang to laser-cooled atoms so cold that their wave functions overlap, resulting in a macroscopic collective state, the Bose-Einstein condensate; and from individual atoms to unusual materials, such as high-temperature superconductors and those that are important in biology. Pushing the limits provides the opportunity to observe new general principles and test theories of the structure and behavior of matter and energy.

Undergraduate Study

Bachelor of Science in Physics (Course 8)

An undergraduate degree in physics provides an excellent basis not only for graduate study in physics and related fields, but also for professional work in such fields as astrophysics, biophysics, engineering and applied physics, geophysics, management, law, or medicine. The undergraduate curriculum offers students the opportunity to acquire a deep conceptual understanding of fundamental physics. The core departmental requirements begin this process. The student then chooses one of two options to complete the degree: the focused option (p. 477) is designed for students who plan to pursue physics as a career, and is an excellent choice for students who want to experience as deep an engagement as possible with physics; the flexible option (p. 478) also provides a very strong physics framework, and gives students who may want to pursue additional academic interests the flexibility to do so. Both programs prepare students very well for graduate studies in physics, as well as for a variety of academic or research-related careers. Either option provides a considerable amount of time for exploration through electives. Students proceed at the pace and degree of specialization best suited to their individual capacities.

Both options lead to the same degree: the Bachelor of Science in Physics.

Physics: Focused Option

This option—which includes three terms of quantum mechanics, 36 units of laboratory experience, and a thesis—is ideal preparation for a career in physics.

In the second year, students take:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.03</td>
<td>Physics III</td>
<td>12</td>
</tr>
<tr>
<td>8.033</td>
<td>Relativity</td>
<td>12</td>
</tr>
<tr>
<td>8.04</td>
<td>Quantum Physics I</td>
<td>12</td>
</tr>
<tr>
<td>8.044</td>
<td>Statistical Physics I</td>
<td>12</td>
</tr>
<tr>
<td>8.223</td>
<td>Classical Mechanics II</td>
<td>6</td>
</tr>
</tbody>
</table>

Important skills for experimentation in physics may be acquired by starting an Undergraduate Research Opportunities Program (UROP) (p. 44) project.

In the third year, students normally take laboratory subjects:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.13</td>
<td>Experimental Physics I</td>
<td>12</td>
</tr>
<tr>
<td>&amp; 8.14</td>
<td>and Experimental Physics II</td>
<td>24</td>
</tr>
<tr>
<td>8.05</td>
<td>Quantum Physics II</td>
<td>12</td>
</tr>
<tr>
<td>&amp; 8.06</td>
<td>and Quantum Physics III</td>
<td>24</td>
</tr>
</tbody>
</table>

Students should also begin to take the restricted elective subjects, one in mathematics and at least two in physics. The mathematics subjects 18.04 Complex Variables with Applications, 18.075 Methods for Scientists and Engineers, and 18.06 Linear Algebra are particularly popular with physics majors. Topical elective subjects in astrophysics, biological physics, condensed matter, plasma, and nuclear and particle physics allow students to gain an appreciation of the forefronts of modern physics. Students intending to go on to graduate school in physics are encouraged to take the theoretical physics sequence:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.07</td>
<td>Electromagnetism II</td>
<td>12</td>
</tr>
<tr>
<td>8.08</td>
<td>Statistical Physics II</td>
<td>12</td>
</tr>
<tr>
<td>8.09</td>
<td>Classical Mechanics III</td>
<td>12</td>
</tr>
</tbody>
</table>

An important component of this option is the thesis, which is a physics research project carried out under the guidance of a faculty member. Many thesis projects grow naturally out of UROP projects. Students should have some idea of a thesis topic by the middle of the junior year. A thesis proposal must be submitted before registering for thesis units and no later than Add Date of the fall term of the senior year.

A relatively large amount of elective time usually becomes available during the fourth year and can be used either to deepen one’s background in physics or to explore other disciplines.
Physics: Flexible Option

This option is designed for students who wish to develop a strong background in the fundamentals of physics and then build on this foundation as they prepare for career paths that may or may not involve a graduate degree in physics. Many students find an understanding of the basic concepts of physics and an appreciation of the physicist's approach to problem solving an excellent preparation for the growing spectrum of nontraditional, technology-related career opportunities, as well as for careers in business, law, medicine, or engineering. Additionally, the flexible option makes it more possible for students with diverse intellectual interests to pursue a second major in another department.

The option begins with the core subjects:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.01</td>
<td>Physics I</td>
<td>12</td>
</tr>
<tr>
<td>8.02</td>
<td>Physics II</td>
<td>12</td>
</tr>
<tr>
<td>8.03</td>
<td>Physics III</td>
<td>12</td>
</tr>
<tr>
<td>8.04</td>
<td>Quantum Physics I</td>
<td>12</td>
</tr>
<tr>
<td>8.044</td>
<td>Statistical Physics I</td>
<td>12</td>
</tr>
<tr>
<td>8.21</td>
<td>Physics of Energy</td>
<td>12</td>
</tr>
<tr>
<td>or 8.223</td>
<td>Classical Mechanics II</td>
<td>12</td>
</tr>
</tbody>
</table>

Students round out their foundation material with either an additional quantum mechanics subject (8.05 Quantum Physics II) or a subject in relativity (8.13 Introduction to Special Relativity or 8.033 Relativity). There is an experimental requirement of 8.13 Experimental Physics I or, with the approval of the department, a laboratory subject of similar intensity in another department, an experimental research project or senior thesis, or an experimentally oriented summer externship. An exploration requirement consists of one elective subject in physics. Students can satisfy the departmental portion of the Communication Requirement by taking two of the following subjects:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.06</td>
<td>Quantum Physics III</td>
<td>12</td>
</tr>
<tr>
<td>8.13</td>
<td>Experimental Physics I</td>
<td>18</td>
</tr>
<tr>
<td>8.14</td>
<td>Experimental Physics II</td>
<td>18</td>
</tr>
<tr>
<td>8.225[J]</td>
<td>Einstein, Oppenheimer, Feynman: Physics in the 20th Century</td>
<td>12</td>
</tr>
<tr>
<td>8.226</td>
<td>Forty-three Orders of Magnitude</td>
<td>12</td>
</tr>
<tr>
<td>8.287[J]</td>
<td>Observational Techniques of Optical Astronomy</td>
<td>15</td>
</tr>
</tbody>
</table>

The department and the Subcommittee on the Communication Requirement may accept substitution of one of the department's two required CI-M subjects with a CI-M subject in another department if it forms a natural part of the student's physics program.

Students following this option must also complete a focus requirement—three subjects forming one intellectually coherent unit in some area (not necessarily physics), subject to the approval of the department and separate from those used by the student to satisfy the HASS requirement. Areas of focus chosen by students have included astronomy, biology, computational physics, theoretical physics, nanotechnology, history of science, science and technology policy, philosophy, and science teaching. Some students may choose to satisfy their experimental and exploration requirements in the same area as their focus; others may opt for greater breadth by choosing other fields to fulfill these requirements.

Although students may choose this option at any time in their undergraduate career, many decide on the flexible major during their sophomore year in order to have enough time to craft a program that best suits their individual needs. Specific subject choices for the experimental and focus requirements require the written approval of the Flexible Program coordinator, Dr. Sean P. Robinson.

Minor in Physics

The Minor in Physics provides a solid foundation for the pursuit of a broad range of professional activities in science and engineering. The requirements for a Minor in Physics are as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03</td>
<td>Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>Select five Course 8 subjects beyond the General Institute Requirements</td>
<td>57-60</td>
<td></td>
</tr>
</tbody>
</table>

Total Units: 69-72

Students should submit a completed Minor Application Form to Physics Academic Programs, Room 4-315. The Physics Department's minor coordinator is Catherine Modica. See Undergraduate Education for more information on minor programs (p. 35).

Minor in Astronomy

The Minor in Astronomy (p. 353), offered jointly with the Department of Earth, Atmospheric, and Planetary Sciences, covers the observational and theoretical foundations of astronomy. For a description of the minor, see Interdisciplinary Programs.

Inquiries

Additional information concerning degree programs and research activities may be obtained by contacting the department office (physics-undergrad@mit.edu), Room 4-315, 617-253-4841.

Graduate Study

The Physics Department offers programs leading to the degrees of Master of Science in Physics and Doctor of Philosophy.

Admission Requirements for Graduate Study

Students intending to pursue graduate work in physics should have as a background the equivalent of the requirements for the Bachelor
of Science in Physics from MIT. However, students may make up some deficiencies over the course of their graduate work.

**Master of Science in Physics**
The normal degree program in the department leads to a PhD in Physics. Admission to a master’s degree program in Physics is available only in special cases (e.g., US military officers). The requirements for the Master of Science in Physics are the same as the General Degree Requirements (p. 61) listed under Graduate Education. A master's thesis must represent a piece of independent research work in any of the fields described below, and must be carried out under the supervision of a department faculty member. No fixed time is set for the completion of a master’s program; two years of work is a rough guideline. There is no language requirement for this degree.

**Doctor of Philosophy**
Candidates for the Doctor of Philosophy or Doctor of Science are expected to enroll in those basic graduate subjects that prepare them for the general examination, which must be passed no later than in the seventh term after initial enrollment. No specific subjects of study are prescribed, except for the requirement of two subjects in the candidate's doctoral research area and two subjects outside the candidate's field of specialization (breadth requirement). Half of the breadth requirement may be satisfied through a departmentally approved industrial internship. The doctoral thesis must represent a substantial piece of original research, carried out under the supervision of a department faculty member.

The Physics Department faculty members offer subjects of instruction and are engaged in research in a variety of fields in experimental and theoretical physics. This broad spectrum of activities is organized in the divisional structure of the department, presented below. Graduate students are encouraged to contact faculty members in the division of their choice to inquire about opportunities for research, and to pass through an apprenticeship (by signing up for Pre-Thesis Research) as a first step toward an engagement in independent research for a doctoral thesis.

**Research Divisions**
Faculty and students in the Department of Physics are generally affiliated with one of several research divisions:

- Astrophysics
- Experimental Nuclear and Particle Physics
- Atomic Physics, Biophysics, Condensed Matter Physics, and Plasma Physics
- Theoretical Nuclear and Particle Physics

Much of the research in the department is carried out as part of the work of various interdisciplinary laboratories and centers, including the Center for Materials Science and Engineering, Francis Bitter Magnet Laboratory, Haystack Observatory, Laboratory for Nuclear Science, Microsystems Technology Laboratories, MIT Kavli Institute for Astrophysics and Space Research, Plasma Science and Fusion Center, Research Laboratory of Electronics, and Spectroscopy Laboratory. Additional information can be found under Research and Study (p. 88). These facilities provide close relationships among the research activities of a number of MIT departments and give students opportunities for contact with research carried out in disciplines other than physics.

**Inquiries**
Additional information on degree programs, research activities, admissions, financial aid, teaching and research assistantships may be obtained by contacting the department office (physics-grad@mit.edu), Room 4-315, 617-253-4851.

**Faculty and Teaching Staff**

- Peter H. Fisher, PhD
  Professor of Physics
  Head, Department of Physics

- Nergis Mavalvala, PhD
  Curtis (1963) and Kathleen Marble Professor
  Professor of Physics
  Associate Head, Department of Physics

- Raymond Ashoori, PhD
  Professor of Physics

- John Winston Belcher, PhD
  Class of 1922 Professor
  Professor of Physics

- Edmund Bertschinger, PhD
  Professor of Physics
  (On sabbatical)

- Wit Busza, PhD
  Professor of Physics

- Claude R. Canizares, PhD
  Bruno B. Rossi Distinguished Professor in Experimental Physics

- Deepto Chakrabarty, PhD
  Professor of Physics

- Arup K. Chakraborty, PhD
  Robert T. Haslam (1911) Professor
  Core Faculty, Institute for Medical Engineering and Science
  Professor of Chemical Engineering
  Professor of Biological Engineering
  Professor of Chemistry
  (On leave, fall)
Min Chen, PhD
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Professor of Physics

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Professor of Physics

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Miklos Porkolab, PhD
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Liang Fu, PhD
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Professor of the Practice of Physics

Adjunct Professors
William A. Barletta, PhD
Adjunct Professor of Physics

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Senior Lecturer in Physics

George S. F. Stephans, PhD
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Technical Instructor of Physics

Michelle Tomasik, PhD
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Lauren Dana, BS
Technical Instructor of Physics

Kay Lowdon, BS
Technical Instructor of Physics

Andy Neely, BS
Technical Instructor of Physics

Gladys Velez Caideco, BS
Technical Instructor of Physics

Joshua Wolfe, BS
Technical Instructor of Physics

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Jagadeesh Moodera, PhD
Senior Research Scientist of Physics

Richard J. Temkin, PhD
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Alfred H. Caspary Professor Emeritus of Physics
Professor Emeritus of Biological Physics

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Aron M. Bernstein, PhD
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Professor Emeritus of Physics

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Lee Grodzins, PhD
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Erich P. Ippen, PhD
Elihu Thomson Professor Emeritus
Professor Emeritus of Physics
Professor Emeritus of Electrical Engineering

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Jerrold Zacharias Professor Emeritus of Physics
Professor Emeritus of Physics

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Professor Emeritus of Engineering Systems

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Saul A. Rappaport, PhD
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Lawrence Rosenson, PhD
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Paul L. Schechter, PhD
William A. M. Burden Professor Emeritus in Astrophysics

Rainer Weiss, PhD
Professor Emeritus of Physics

James E. Young, PhD
Professor Emeritus of Physics
INTERDISCIPLINARY PROGRAMS

Undergraduate Programs

Undergraduate Degrees
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• Computer Science and Molecular Biology (Course 6-7) (p. 338)
• Computer Science, Economics, and Data Science (Course 6-14) (p. 339)
• Humanities (Course 21) (p. 339)
• Humanities and Engineering (Course 21E) (p. 347)
• Humanities and Science (Course 21S) (p. 347)
• Urban Science and Planning with Computer Science (Course 11-6) (p. 348)

Undergraduate Minors
• African and African Diaspora Studies (p. 349)
• Ancient and Medieval Studies (p. 350)
• Applied International Studies (p. 351)
• Asian and Asian Diaspora Studies (p. 352)
• Astronomy (p. 353)
• Atmospheric Chemistry (p. 354)
• Biomedical Engineering (p. 354)
• Energy Studies (p. 355)
• Entrepreneurship and Innovation (p. 356)
• Environment and Sustainability (p. 358)
• Latin American and Latino/a Studies (p. 360)
• Middle Eastern Studies (p. 361)
• Polymers and Soft Matter (p. 362)
• Public Policy (p. 363)
• Russian and Eurasian Studies (p. 363)
• Statistics and Data Science (p. 364)
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• Computation for Design and Optimization (p. 368)
• Computational and Systems Biology (p. 368)
• Computational Science and Engineering (p. 370)
• Computer Science and Molecular Biology (p. 370)
• Design and Management (Integrated Design and Management & System Design and Management) (p. 371)
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• Supply Chain Management (p. 376)
• Technology and Policy (p. 377)
• Transportation (p. 377)
INTERDISCIPLINARY UNDERGRADUATE DEGREES

MIT offers seven interdisciplinary undergraduate degrees:

- **Chemistry and Biology** (p. 338), a joint program offered by the Departments of Chemistry and Biology (School of Science).
- **Computer Science and Molecular Biology** (p. 338), a joint program offered by the Department of Electrical Engineering and Computer Science (School of Engineering) and the Department of Biology (School of Science).
- **Computer Science, Economics, and Data Science** (p. 339), a joint program offered by the Department of Electrical Engineering and Computer Science (School of Engineering) and the Department of Economics (School of Arts, Humanities, and Social Sciences).
- **Humanities** (p. 339), a program offered by the Department of Humanities that encompasses six fields of interdisciplinary study.
- **Humanities and Engineering** (p. 347), a joint program in which a student combines coursework from a degree program in the School of Engineering and one of 17 programs in the School of Humanities, Arts, and Social Sciences.
- **Humanities and Science** (p. 347), a joint program in which a student combines coursework from a degree program in the School of Science and one of 17 programs in the School of Humanities, Arts, and Social Sciences.
- **Urban Science and Planning with Computer Science** (Course 11-6), a joint program offered by the Department of Urban Studies and Planning (School of Architecture and Planning) and the Department of Electrical Engineering and Computer Science (School of Engineering).

### Interdisciplinary Undergraduate Degrees

**Chemistry and Biology (Course 5-7)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Chemistry and Biology</td>
</tr>
</tbody>
</table>

**Computer Science and Molecular Biology**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Computer Science and Molecular Biology 1</td>
</tr>
</tbody>
</table>

**Computer Science, Economics, and Data Science (Course 6-14)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Computer Science, Economics, and Data Science 1</td>
</tr>
</tbody>
</table>

**Humanities (Course 21)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Humanities</td>
</tr>
<tr>
<td>SB</td>
<td>Humanities and Engineering</td>
</tr>
<tr>
<td>SB</td>
<td>Humanities and Science</td>
</tr>
</tbody>
</table>

**Urban Science and Planning with Computer Science (Course 11-6)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>Urban Science and Planning with Computer Science 1</td>
</tr>
</tbody>
</table>

1. See Interdisciplinary Programs (p. 337).

2. Students majoring in one of the designated interdisciplinary major fields within SHASS receive the generic SB degree in Course 21, Humanities.

### CHEMISTRY AND BIOLOGY

**Bachelor of Science in Chemistry and Biology (Course 5-7)**

The Department of Biology (p. 301) and the Department of Chemistry (p. 312) offer a joint curriculum leading to a Bachelor of Science in Chemistry and Biology (p. 480) that focuses on the intersection of these two subject areas, encompassing biochemistry and chemical biology. The curriculum provides strong foundations in both biology and chemistry, with flexibility in elective subjects that enable students to tailor their major program to their specific interests within the broad interface of biology and chemistry. Students in the program are full members of both departments, with one academic advisor from each department.

The Bachelor of Science in Chemistry and Biology prepares students for careers that involve applications of both subjects, including the pharmaceutical and biotechnology industries, as well as further graduate study in biochemistry, molecular biology, and chemical biology. The interdepartmental major program also provides a strong foundation for the study of clinical and research careers in medicine and related health professions.

### COMPUTER SCIENCE AND MOLECULAR BIOLOGY

**Bachelor of Science in Computer Science and Molecular Biology (Course 6-7)**

The Department of Biology (p. 301) and the Department of Electrical Engineering and Computer Science (EECS) (p. 188) offer a joint curriculum leading to a Bachelor of Science in Computer Science and Molecular Biology (p. 482) that focuses on the emerging field of computational and molecular biology. The curriculum provides strong foundations in both biology and computer science and
features innovative, integrative, capstone, and elective subjects. The goal is to produce an entirely new cadre of graduates who are uniquely qualified to address the challenges and opportunities at the interface of computational and molecular biology. Students in the program are full members of both departments and of two schools, Science and Engineering, with one academic advisor from each department.

The Bachelor of Science in Computer Science and Molecular Biology prepares students for careers that leverage computational biology (e.g., pharmaceuticals, bioinformatics, medicine, etc.) as well as further graduate study in biology, in computer science, and in emerging programs at the interface. Students in this program who have a strong academic record will be offered an opportunity to continue through the five-year master’s program, leading to the Master of Engineering in Computer Science and Molecular Biology (p. 370).

Inquiries
Information about these programs is available from the EECS Undergraduate Office (http://www.eecs.mit.edu), Room 38-476, 617-253-4654, and the Biology Undergraduate Office (https://biology.mit.edu), Room 68-120, 617-253-4718.

COMPUTER SCIENCE, ECONOMICS, AND DATA SCIENCE

Bachelor of Science in Computer Science, Economics, and Data Science (Course 6-14)

Contemporary electronically mediated platforms for market-level and individual exchange combine complex human decisions with intensive computation and data processing, all interacting within an engineered economic environment. Examples include: online markets, crowdsourcing platforms, spectrum auctions, financial platforms, crypto currencies, and large scale matching/Allocation systems such as kidney exchange and public school choice systems. These platforms encompass a growing slice of economic activity and are shifting the scope and efficiency of market and non-market exchanges. Some forms of exchange that were simply infeasible due to coordination or information frictions (centralized kidney exchange, vehicle sharing) are suddenly available and important. Other market activities that were previously thought to require centralization and oversight, can now be decentralized and self-regulated (crypto-currency being the leading example). Moreover, the technology enabling that decentralization (so-called blockchain) is likely to have many further applications.

The Bachelor of Science in Computer Science, Economics and Data Science (Course 6-14) (p. 428) is aimed at educating students at this intellectual nexus and equipping them with a foundational knowledge of economic analysis, computing, optimization and data science, as well as hands-on experience with empirical analysis of economic data, to identify, analyze and solve real-world challenges in real and virtual settings.

HUMANITIES

The Bachelor of Science in Humanities (Course 21) (p. 428) offers students six interdisciplinary areas of study from which to choose:

- American Studies
- Ancient and Medieval Studies
- Asian and Asian Diaspora Studies
- Latin American and Latino/a Studies
- Russian and Eurasian Studies
- Women's and Gender Studies

All options for this major are by special arrangement and must be approved by the Dean of the School of Humanities, Arts, and Social Sciences. Students must file a proposal that identifies all the subjects to be taken in the chosen program. Contact information for each program is included in its description.

American Studies

American Studies at MIT offers students the opportunity to organize subjects from various fields (e.g., history, anthropology, literature, political science, music, art, architecture, and urban planning) into personally constructed interdisciplinary programs as a way of gaining an integrated understanding of American society and culture. Students can focus on any of several areas of interest, such as American literature; folklore and popular culture; black history and culture; women’s studies; American history, politics, or law; the history of science and technology; and American art, architecture, or music. Thus, a program in American Studies is ideal for preparing students for further work not only in the various humanistic fields, but also in law, urban planning, management, architecture, engineering, medicine, teaching, and the media.

The program has three primary objectives:

- To understand the underlying system of beliefs that informs every aspect of American culture—its myths, institutions, politics and literature, its characteristic dreams and rituals.
- To understand the uses and limits of different methods and intellectual disciplines as tools for exploring the complexities of a culture.
- To understand the American present in relation to the American past.

As noted in the degree chart (p. 428), the program includes a pre-thesis tutorial (21.THT), a thesis (21.THU), and a minimum of nine restricted electives (108 units) selected from at least two of the following three disciplinary areas:
• Area I: Humanities and the Arts
• Area II: Social Sciences; Science, Technology, and Society
• Area III: Historical Studies

Up to six subjects (72 units) may be used for both the major and the GIRs, but the units from those subjects may not count toward the 180 units required beyond the GIRs. No more than one subject that counts toward the distribution component of the HASS Requirement may also be counted toward American Studies requirements. In addition, at least eight of the subjects required for the program cannot count toward any other major or minor.

The list of restrictive electives below is not exhaustive. Additional information can be obtained from the American Studies advisor, Professor Christopher Capozzola (capozzol@mit.edu), E51-284, 617-452-4960, or from the SHASS academic administrator, Andrea Wirth (awirth@mit.edu), 4-240, 617-253-4441.

**Restricted Electives**

Select 9-12 subjects from at least two of the following areas:

**Area I: Humanities and the Arts**
- 21L.006 American Literature
- 21L.011 The Film Experience
- 21L.432 Understanding Television
- 21L.487 Modern Poetry
- 21L.501 The American Novel
- 21L.504[J] Race and Identity in American Literature
- 21L.512 American Authors
- 21M.215 Music of the Americas
- 21M.226 Jazz
- 21M.283 The Musical
- 21M.284 Film Music
- 21M.295 American Popular Music
- 21W.742[J] Writing about Race

**Area II: Social Sciences; Science, Technology, and Society**
- 17.20 Introduction to the American Political Process
- 17.251 Congress and the American Political System I
- 17.261 Congress and the American Political System II
- 17.263 Electoral Politics, Public Opinion, and Democracy
- 17.265 Public Opinion and American Democracy
- 17.267 Democracy in America
- 17.269 Race, Ethnicity, and American Politics
- 17.317 US Social Policy
- 17.40 American Foreign Policy: Past, Present, and Future
- 17.483 US Military Power
- 21A.120 American Dream: Exploring Class in the US
- STS.001 Technology in American History
- STS.026 History of Manufacturing in America
- STS.048 African Americans in Science, Technology, and Medicine
- STS.049 The Long War Against Cancer
- STS.050 The History of MIT
- WGS.225[J] The Science of Race, Sex, and Gender

**Area III: Historical Studies**
- 11.014[J] History of the Built Environment in the US
- 21G.043[J] Introduction to Asian American Studies: Historical and Contemporary Issues
- 21H.101 American History to 1865
- 21H.102 American History since 1865
- 21H.201 The American Revolution
- 21H.211 The United States in the Nuclear Age
- 21H.214 War and American Society
- 21H.226[J] Riots, Strikes, and Conspiracies in American History
- 21H.227 Constitutional Law in US History
- 21H.228 American Classics
- 21H.229 The Black Radical Tradition in America
- 21H.315 American Consumer Culture
- 21H.319 Race, Crime, and Citizenship in American Law
- 21H.320[J] Gender and the Law in US History
- 21H.321[J] Downtown
21H.322 Christianity in America

STS.027[J] The Civil War and the Emergence of Modern America: 1861-1890

Counts as Area II or III, but not both.

Ancient and Medieval Studies

Through a wide variety of subjects drawn from a number of disciplines, this program provides a curricular framework for exploring topics in ancient and medieval studies which range from the history of ideas and institutions to that of material artifacts, literature and certain of the original languages. The chronological span of the program includes some 6,500 years between 5000 BC and 1500 AD.

The goal of this program is to develop knowledge and understanding of the more distant past both for itself, in its uniqueness, and as an object of specifically modern questions and methods of inquiry. We are interested in the structure of institutions and social systems, and in relationships between the social order and learned traditions, values, ideologies and ideas. Ancient and medieval studies derive a special claim to our interest from the fact that the record is so full and multiform and that much of it is of exceptionally high quality at once in substance and form.

The program in Ancient and Medieval Studies is designed for students who are seeking a fuller understanding of the forces which shaped the ancient and medieval world. The geographical and chronological scope of the program is broadly conceived and is intended to be comparative. Subjects range in content from Classical Greece and Rome, and the ancient societies of Asia and South America, to medieval Europe and Japan. Students will be required to demonstrate intermediate level language proficiency in either Greek, Latin or a medieval vernacular, but they need not concentrate their other subjects on the area associated with that language. Students are also expected to have some distribution across the ancient and medieval time periods. We expect that students will consult closely with the program advisor in order to devise a coherent program of study.

As noted in the degree chart (p. 428), the program includes a minimum of nine subjects (108 units) beyond the pre-thesis tutorial (21.THT) and thesis (21.THU). The nine subjects must include one language subject in Area I (or equivalent proficiency); the eight remaining subjects must be selected from at least two of the three other disciplinary areas (Areas II–IV), with at least one subject in both Ancient and Medieval periods. To satisfy the communication-intensive (CI-M) component of the program, students may select two subjects from among 3.990 Seminar in Archaeological Method and Theory, 21H.331 Julius Caesar and the Fall of the Roman Republic, 21H.240 The World of Charlemagne, 21H.390 Theories and Methods in the Study of History, or any Literature seminar (21L.715-21L.715) with an ancient or medieval focus.

- Area I: Languages
- Area II: Arts and Architecture
- Area III: Literary Studies
- Area IV: Material and Historical Studies

Up to six subjects (72 units) may be used for both the major and the GIRs, but the units from those subjects may not count toward the 180 units required beyond the GIRs. No more than one subject that counts toward the distribution component of the HASS Requirement may also be counted toward the requirements of the Ancient and Medieval Studies program. In addition, at least eight of the subjects required for the program cannot count toward any other major or minor.

The list of restricted electives below is not exhaustive. Additional information can be obtained from the advisors for the program, Professor Eric Goldberg (egoldber@mit.edu), E51-290, 617-324-2420, and Professor Stephanie Frampton (sframpton@mit.edu), 14N-434, 617-253-4452, or from the History Office, E51-255, 617-324-5134.

Restricted Electives

Area I: Languages

<table>
<thead>
<tr>
<th>Select one of the following for a total of 12 units:</th>
</tr>
</thead>
<tbody>
<tr>
<td>21L.601[J] Old English and Beowulf 3</td>
</tr>
<tr>
<td>21L.611 Latin I &amp; 21L.612 and Latin II</td>
</tr>
<tr>
<td>21L.607 Greek I &amp; 21L.608 and Greek II</td>
</tr>
<tr>
<td>21L.613 Latin Readings &amp; 21L.614 and Advanced Latin Readings 3</td>
</tr>
<tr>
<td>Two intermediate-level subjects in Greek, Latin, Italian, Norse, or Arabic 4</td>
</tr>
</tbody>
</table>

Select eight subjects from at least two of the following disciplinary areas. At least one subject must be taken in both the Ancient and Medieval periods:

Area II: Arts and Architecture

<table>
<thead>
<tr>
<th>Ancient</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.605 A Global History of Architecture 5</td>
</tr>
<tr>
<td>21H.237 The City of Athens in the Age of Pericles</td>
</tr>
<tr>
<td>21H.239 The City of Rome in the Age of the Caesars</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medieval</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.614 Building Islam</td>
</tr>
<tr>
<td>4.635 Early Modern Architecture and Art</td>
</tr>
<tr>
<td>21M.220 Medieval and Renaissance Music (CI-M)</td>
</tr>
</tbody>
</table>
Area III: Literary Studies

**Ancient**

- 21L.001 Foundations of Western Literature: Homer to Dante
- 21L.021 Comedy
- 21L.455 Ancient Authors
- 21L.458 The Bible
- 21L.613 Latin Readings & 21L.614 Advanced Latin Readings
- 24.200 Ancient Philosophy

**Medieval**

- 21L.460 Arthurian Literature
- 21L.601 Old English and Beowulf

Area IV: Material and Historical Studies

**Ancient**

- 3.981 Communities of the Living and the Dead: the Archaeology of Ancient Egypt
- 3.982 The Ancient Andean World
- 3.983 Ancient Mesoamerican Civilization
- 3.986 The Human Past: Introduction to Archaeology
- 3.987 Human Evolution: Data from Palaeontology, Archaeology, and Materials Science
- 3.993 Archaeology of the Middle East
- 21H.007 Introduction to Ancient and Medieval Studies
- 21H.130 The Ancient World: Greece
- 21H.132 The Ancient World: Rome
- 21H.230 Barbarians, Saints, and Emperors
- 21H.331 Julius Caesar and the Fall of the Roman Republic (CI-M)
- 21H.333 Early Christianity
- 21H.336 The Making of a Roman Emperor
- CC.117 Humane Warfare: Ancient and Medieval Perspectives on Ethics in War

**Medieval**

- 21H.133 The Medieval World
- 21H.134 Medieval Economic History in Comparative Perspective
- 21H.160 Islam, the Middle East, and the West
- 21H.238 The Vikings
- 21H.240 The World of Charlemagne (CI-M)
- 21H.383 Technology and the Global Economy, 1000-2000

CC.116 How to Rule the World: The Promises and Pitfalls of Politics, War, and Empire

1. Students are required to take at least 12 units in a pre-modern language. Two six-unit subjects in a pre-modern language may be combined to satisfy this requirement (e.g., Latin I and II or, for students who enter with strong Latin from high school, two different iterations of 21L.6xx Latin Readings). Greek, Latin and Old English are currently offered at MIT, but students may substitute another pre-modern language taken elsewhere.

2. Students with equivalent proficiency in a pre-modern language may substitute the Area I requirement with one more subject from areas II–IV.

3. Counts as Area I or III, but not both.

4. MIT does not offer these languages; consult with advisor concerning appropriate coursework at Harvard University or Wellesley College. Arabic is required for students proposing a specialty in the medieval Islamic world.

5. Counts as either Ancient or Medieval, but not both.

6. Any seminar-tier subject in Literature with a substantially ancient and/or medieval focus counts toward Area III and satisfies a CI-M.

### Asian and Asian Diaspora Studies

This program is designed for students interested in serious intensive research on the languages, history, politics, and cultures of Asia and/or the Asian diasporas. The geographic region of Asia includes countries such as Bangladesh, China, India, Japan, Korea, Mongolia, Pakistan, the Philippines, Taiwan, and Vietnam. In consultation with the program advisor, students may focus their coursework on a sub-region of Asia, on one of the Asian diasporas, or design their program to offer a comparative study across different regions and/or cultural groups. The goal of the program is to provide balanced coverage of language, humanistic and social science offerings on the region and to expose students to some comparative perspectives within the region. The MIT Departments of Global Studies and Languages, History, and Political Science offer a substantial number of subjects related to Asia and the Asian diasporas.

As noted in the degree chart (p. 428), the program includes a minimum of nine subjects (108 units) beyond the pre-thesis tutorial (21.THT) and thesis (21.THU). The nine subjects must include two language subjects in Area I (or equivalent proficiency); the seven remaining subjects must be selected from at least two of the three disciplinary areas (Areas II–IV).

- Area I: Language
- Area II: Humanities and the Arts
- Area III: Social Sciences
- Area IV: Historical Studies

For the thesis requirement, students choose a topic in consultation with an MIT faculty member whose specialty falls within Asian Studies; the thesis research may include knowledge of an Asian language.
Up to six subjects (72 units) may be used for both the major and the GIRs, but the units from those subjects may not count toward the 180 units required beyond the GIRs. No more than one subject that counts toward the distribution component of the HASS Requirement may also be counted toward the requirements of the Asian and Asian Diaspora Studies program. In addition, at least eight of the subjects required for the program cannot count toward any other major or minor.

The language requirement can be satisfied by taking two intermediate (Levels III and IV) subjects in an Asian language. Students with proficiency at this level in the spoken and written language can either take two more advanced language subjects (highly recommended), or two more courses from Areas II, III and IV. Chinese and Japanese are taught at MIT. Subjects about Asia and the Asian diaspora, as well as subjects in Asian languages, are also available from Harvard University and Wellesley College through cross-registration. Students must receive permission from the advisor prior to registering for a class at another institution.

The list of restricted electives below is not exhaustive. Additional information can be obtained from the advisor for the program, Professor Hiromu Nagahara (nagahara@mit.edu), E51-255G, 617-324-4977, or from the SHASS academic administrator, Andrea Wirth (awirth@mit.edu), 4-240, 617-253-4441.

### Restricted Electives

Select two subjects in the same language from Area I and seven subjects from at least two of Areas II, III or IV.  

#### Area I: Language

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.103</td>
<td>Chinese III (Regular)</td>
</tr>
<tr>
<td>21G.104</td>
<td>Chinese IV (Regular)</td>
</tr>
<tr>
<td>21G.105</td>
<td>Chinese V (Regular): Discovering Chinese Cultures and Societies</td>
</tr>
<tr>
<td>21G.106</td>
<td>Chinese VI (Regular): Discovering Chinese Cultures and Societies</td>
</tr>
<tr>
<td>21G.109</td>
<td>Chinese III (Streamlined)</td>
</tr>
<tr>
<td>21G.110</td>
<td>Chinese IV (Streamlined)</td>
</tr>
<tr>
<td>21G.113</td>
<td>Chinese V (Streamlined)</td>
</tr>
<tr>
<td>21G.120</td>
<td>Business Chinese</td>
</tr>
<tr>
<td>21G.503</td>
<td>Japanese III</td>
</tr>
<tr>
<td>21G.504</td>
<td>Japanese IV</td>
</tr>
<tr>
<td>21G.505</td>
<td>Japanese V</td>
</tr>
<tr>
<td>21G.506</td>
<td>Japanese VI</td>
</tr>
<tr>
<td>21G.903</td>
<td>Korean III (Regular)</td>
</tr>
<tr>
<td>21G.904</td>
<td>Korean IV (Regular)</td>
</tr>
</tbody>
</table>

Two intermediate-level subjects in another Asian language

#### Area II: Humanities and the Arts

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.011</td>
<td>Topics in Indian Popular Culture</td>
</tr>
</tbody>
</table>

### Area II: Social Sciences

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.407</td>
<td>Chinese Foreign Policy</td>
</tr>
<tr>
<td>17.433</td>
<td>International Relations of East Asia</td>
</tr>
<tr>
<td>17.486</td>
<td>Japan and East Asian Security</td>
</tr>
<tr>
<td>17.53</td>
<td>The Rise of Asia</td>
</tr>
<tr>
<td>17.537</td>
<td>Politics and Policy in Contemporary Japan</td>
</tr>
<tr>
<td>21A.140[J]</td>
<td>Cultures of East Asia</td>
</tr>
<tr>
<td>21A.141[J]</td>
<td>Images of Asian Women: Dragon Ladies and Lotus Blossoms</td>
</tr>
</tbody>
</table>

### Area IV: Historical Studies

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.043[J]</td>
<td>Introduction to Asian American Studies: Historical and Contemporary Issues</td>
</tr>
<tr>
<td>21G.045</td>
<td>Global Chinese Food</td>
</tr>
</tbody>
</table>
Latin American and Latino/a Studies

This program is designed for students interested in the language, history, politics, and culture of Latin America and of Hispanics living in the US. Students are encouraged to develop a program that is both international and comparative in perspective and that takes into account the heterogeneous cultural experiences of people living in the vast territory encompassed by the term Latin America, as well as of those people living in the United States who identify themselves as Latino/a.

As noted in the degree chart (p. 428), the program includes a minimum of eight subjects (96 units) beyond the introductory course (17.55[J] Introduction to Latin American Studies), the pre-thesis tutorial (21.TH), and thesis (21.THU). The eight subjects must include two language subjects in Area I (or equivalent proficiency); the six remaining subjects must be selected from at least two of the three other disciplinary areas (Areas II–IV).

- Area I: Language
- Area II: Humanities and the Arts
- Area III: Social Sciences
- Area IV: Historical Studies

Up to six subjects (72 units) may be used for both the major and the GiRs, but the units from those subjects may not count toward the 180 units required beyond the GiRs. No more than one subject that counts toward the distribution component of the HASS Requirement may also be counted toward the requirements of the Latin American and Latino/a Studies program. In addition, at least eight of the subjects required for the program cannot count toward any other major or minor.

Subjects in Latin American and Latino Studies are also available from Harvard University and Wellesley College through cross-registration. Students must receive permission from the program advisor prior to registering for a class at another institution.

The list of restricted electives below is not exhaustive. Additional information may be obtained from the advisor for the program, Professor Tanalís Padilla (tanalis@mit.edu), E51-293, 617-324-7544, or from the SHASS Academic Administrator, Andrea Wirth (awirth@mit.edu), 4-240, 617-253-4441.

Restricted Electives

Area I: Language

Select two subjects in the same language from among the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.703</td>
<td>Spanish III</td>
</tr>
<tr>
<td>21G.704</td>
<td>Spanish IV</td>
</tr>
<tr>
<td>21G.710</td>
<td>Advanced Communication in Spanish: Topics in Language and Culture</td>
</tr>
<tr>
<td>21G.711</td>
<td>Advanced Spanish Conversation and Composition: Perspectives on Technology and Culture</td>
</tr>
<tr>
<td>21G.712</td>
<td>Spanish Conversation and Composition</td>
</tr>
<tr>
<td>21G.713</td>
<td>Spanish through Film: Mexico, Chile, Argentina, and Spain</td>
</tr>
<tr>
<td>21G.714</td>
<td>Spanish for Heritage Learners</td>
</tr>
<tr>
<td>21G.715</td>
<td>Topics in Heritage Learnings in the Hispanic World</td>
</tr>
<tr>
<td>21G.803</td>
<td>Portuguese III</td>
</tr>
<tr>
<td>21G.804</td>
<td>Portuguese IV</td>
</tr>
</tbody>
</table>
Select seven subjects, including 17.55[J], from at least two of the following disciplinary areas: 2

**Area II: Humanities and the Arts**

**Subjects taught in English:**
- 21G.070 Latin America and the Global Sixties: Counterculture and Revolution
- 21G.072 The New Latin American Novel
- 21G.074 Topics in Portuguese Popular Culture
- 21L.019 Introduction to European and Latin American Fiction

**Subjects taught in Spanish:**
- 21G.731[J] Creation of a Continent: Representations of Hispanic America, 1492-1898, in Literature and Film
- 21G.732 The Making of the Latin American City: Culture, Gender, and Citizenship
- 21G.735 Advanced Topics in Hispanic Literature and Film
- 21G.736 The Short Story in Spain and Hispanic America
- 21L.636[J] Introduction to Contemporary Hispanic Literature and Film
- 21L.637[J] Introduction to Hispanic Culture
- 21L.638[J] Literature and Social Conflict: Perspectives on the Hispanic World

**Subjects taught in Portuguese:**
- 21G.820 Topics in Modern Portuguese Literature and Culture
- 21G.821 The Beat of Brazil: Portuguese Language and Brazilian Society Through its Music

**Area III: Social Studies**

- 17.55[J] Introduction to Latin American Studies (Required)

**Additional options:**
- 3.982 The Ancient Andean World
- 3.983 Ancient Mesoamerican Civilization
- 17.56 The Politics of Crime and Policing
- 21A.506 The Anthropology of Politics

**Area IV: Historical Studies**

- 21H.171 Latin America: Revolution, Dictatorship, and Democracy, 1850 to Present
- 21H.172[J] Latin America Through Film (Latin America Through Film)
- 21H.273 From Coca to Cocaine: Drug Economies in Latin America

Appropriate subjects offered at Harvard or Wellesley

1 Two language subjects beginning at Levels III and IV, either in Spanish or Portuguese, satisfy the Area I language requirement. MIT offers Levels III and IV of Spanish every semester and offers Level III of Portuguese every fall semester and Level IV every spring semester. Students who demonstrate competence beyond Level IV may either take two advanced language subjects (highly recommended) or two more subjects from Areas II, III, and IV.

2 Students who are not required to take Area I subjects and opt not to take advanced language subjects (see footnote 1 above) must take all subjects from Areas II, III, and IV, with at least one subject from each area.

**Russian and Eurasian Studies**

This program is intended for students seeking an interdisciplinary program of study centered on Russia and Eurasia. The program is regional in spirit, meaning that students can take courses in a wide range of countries of East/Central Europe, the Slavic states, and Central Asia.

As noted in the degree chart (p. 428), the program includes a minimum of nine subjects (108 units) beyond the pre-thesis tutorial (21.THT) and thesis (21.THU). The nine subjects must include two language subjects in Area I (or equivalent proficiency); the seven remaining subjects must be selected from at least two of the three other disciplinary areas (Areas II–IV). At least six subjects must be MIT subjects or subjects taken at Harvard or Wellesley under cross-registration. (Students must receive permission from the program advisor prior to registering for a class at another institution.) The program includes four areas of study:

- **Area I: Language**
- **Area II: Humanities and the Arts**
- **Area III: Social Sciences**
- **Area IV: Historical Studies**

Up to six subjects (72 units) may be used for both the major and the GIRs, but the units from those subjects may not count toward the 180 units required beyond the GIRs. No more than one subject that counts toward the distribution component of the HASS Requirement may also be counted toward the requirements of the Russian and Eurasian Studies program. In addition, at least eight of the subjects required for the program cannot count toward any other major or minor.

The list of restricted electives below is not exhaustive. Additional information may be obtained from the advisor for the program, Professor Elizabeth Wood (elizwood@mit.edu), E51-282,
Restricted Electives

Area I: Language

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.613</td>
<td>Russian III (Regular)</td>
</tr>
<tr>
<td>21G.614</td>
<td>Russian IV (Regular)</td>
</tr>
</tbody>
</table>

Select seven subjects from at least two of the following areas: 

Area II: Humanities and the Arts

- 21G.077[J] Introduction to the Classics of Russian Literature
- or 21G.618 Introduction to the Classics of Russian Literature - Russian Language Option

Appropriate subjects offered at Harvard or Wellesley

Area III: Social Sciences

- 17.569 Russia's Foreign Policy: Toward the Post-Soviet States and Beyond

Appropriate subjects offered at Harvard or Wellesley

Area IV: Historical Studies

- 21H.244[J] Imperial and Revolutionary Russia: Culture and Politics, 1700-1917

Appropriate subjects offered at Harvard or Wellesley

Women's and Gender Studies

This program (p. 428) offers students an academic framework for the study of women, gender, and sexuality using the analytical tools and methodologies of a variety of disciplines in the humanities, arts, and social sciences. It includes a minimum of seven subjects (84 units) beyond WGS.101 Introduction to Women's and Gender Studies, WGS.301[J] Feminist Thought, the pre-thesis tutorial (21.THT), and thesis (21.THT). However, students may request a two-class substitution for the pre-thesis/thesis requirement for a total of 11 courses in that case.

Up to six subjects (72 units) may be used for both the major and the GIRs, but the units from those subjects may not count toward the 180 units required beyond the GIRs. No more than one subject that counts toward the distribution component of the HASS Requirement may also be counted toward the requirements of the Women's and Gender Studies program. In addition, at least eight of the subjects required for the program cannot count toward any other major or minor.

The list of restricted electives below is not exhaustive. Students interested in this interdisciplinary program should consult with the Women's and Gender Studies program manager, Emily Neill (wgs@mit.edu), Room 14E-316, 617-253-2642, and then arrange a meeting with the current director, Professor Elizabeth Wood (elizwood@mit.edu).

Restricted Electives

Tier I

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WGS.101</td>
<td>Introduction to Women's and Gender Studies (Required)</td>
</tr>
</tbody>
</table>

Tier II

Select seven subjects, including at least one from each category below:

Humanities (HASS-H) and Arts (HASS-A) subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WGS.109</td>
<td>Women and Global Activism in Media and Politics</td>
</tr>
<tr>
<td>WGS.110[J]</td>
<td>Sexual and Gender Identities</td>
</tr>
<tr>
<td>WGS.111[J]</td>
<td>Gender and Media Studies</td>
</tr>
<tr>
<td>WGS.115</td>
<td>Gender and Technology</td>
</tr>
<tr>
<td>WGS.140[J]</td>
<td>Race and Identity in American Literature</td>
</tr>
<tr>
<td>WGS.141[J]</td>
<td>International Women’s Voices</td>
</tr>
<tr>
<td>WGS.142</td>
<td>Narrative and Identity: Writing and Film by Contemporary Women of Color</td>
</tr>
<tr>
<td>WGS.145[J]</td>
<td>Globalization: The Good, the Bad and the In-Between</td>
</tr>
<tr>
<td>WGS.154[J]</td>
<td>Gender and Japanese Popular Culture</td>
</tr>
<tr>
<td>WGS.161[J]</td>
<td>Gender and the Law in US History</td>
</tr>
<tr>
<td>WGS.181</td>
<td>Queer Cinema and Visual Culture</td>
</tr>
<tr>
<td>WGS.190[J]</td>
<td>Black Matters: Introduction to Black Studies</td>
</tr>
<tr>
<td>WGS.220[J]</td>
<td>Women and Gender in the Middle East and North Africa</td>
</tr>
<tr>
<td>WGS.226[J]</td>
<td>Science, Gender and Social Inequality in the Developing World</td>
</tr>
<tr>
<td>WGS.231[J]</td>
<td>Writing about Race</td>
</tr>
</tbody>
</table>
WGS.233[J] New Culture of Gender: Queer France
WGS.234[J] The Invention of French Theory: A History of Transatlantic Intellectual Life since 1945
WGS.235[J] Classics of Chinese Literature in Translation
WGS.236[J] Introduction to East Asian Cultures: From Zen to K-Pop
WGS.240[J] Jane Austen
WGS.245[J] Identities and Intersections: Queer Literatures

Social Science (HASS-S) subjects
WGS.125[J] Games and Culture
WGS.151 Gender, Health, and Society
WGS.155[J] Global Sexualities
WGS.172[J] For Love and Money: Rethinking the Family
WGS.221 Women in the Developing World
WGS.222[J] Women and War
WGS.224 Race, Gender and Social Inequality: Reproductive Health Care in the United States
WGS.225[J] The Science of Race, Sex, and Gender
WGS.228 Psychology of Sex and Gender
WGS.229 Race, Culture, and Gender in the US and Beyond: A Psychological Perspective
WGS.270[J] Violence, Human Rights, and Justice
WGS.271[J] Dilemmas in Biomedical Ethics: Playing God or Doing Good?
WGS.274[J] Images of Asian Women: Dragon Ladies and Lotus Blossoms
WGS.275[J] Gender in Science, Technology, and Environment
WGS.276[J] Cultures of Computing
WGS.321 French Feminist Literature: Yesterday and Today

Tier III
WGS.301[J] Feminist Thought (Required)

1 One of the Tier II subjects may be taken at Harvard or Wellesley with the permission of the director.
2 Subjects 21L.430, 21L.460, 21L.512, 21L.702, 21L.704, 21L.705, 21L.715, and 21W.745 may be taken for credit as a Women's and Gender Studies subject when their content meets WGS criteria. For more information, consult the program office (wgs@mit.edu).
3 With the permission of the director, an advanced Women's and Gender Studies subject may be substituted for WGS.301[J].

HUMANITIES AND ENGINEERING

Bachelor of Science in Humanities and Engineering (Course 21E)

This joint degree program (p. 430) draws from both humanistic and engineering studies, providing students with a basic command of each mode of inquiry. One component is selected from the undergraduate degree curriculum of an engineering department (p. 142), which is approved by a faculty member in the field. The other component consists of subjects in a humanities field, chosen by the student in consultation with an advisor from the appropriate humanities faculty. This unique arrangement yields a humanities program of considerable depth while allowing for continued serious commitment to an engineering interest. In most cases, a senior thesis or sequence of advanced seminars is also required.

Available humanities fields include:

- American Studies
- Ancient and Medieval Studies
- Anthropology
- Asian and Asian Diaspora Studies
- Comparative Media Studies
- Global Studies and Languages (in French, German, or Spanish)
- History
- Latin American and Latino/a Studies
- Literature
- Music
- Russian and Eurasian Studies
- Science, Technology, and Society
- Theater Arts
- Women's and Gender Studies
- Writing (Creative, Digital Media, or Science Writing)

For more information about this degree, contact Andrea Wirth (awirth@mit.edu), academic administrator, School of Humanities, Arts, and Social Sciences.

HUMANITIES AND SCIENCE

Bachelor of Science in Humanities and Science (Course 21S)

This joint degree program (p. 434) draws from both humanistic and scientific studies, providing students with a basic command of each mode of inquiry. One component is selected from the undergraduate degree curriculum of a science department (p. 298), which is approved by a faculty member in the field. The other
Component consists of subjects in a humanities field, chosen by the student in consultation with an advisor from the appropriate humanities faculty. This arrangement yields a humanities program of considerable depth while allowing for continued serious commitment to a scientific interest. In most cases, a senior thesis or sequence of advanced seminars is also required.

Available humanities fields include:

- American Studies
- Ancient and Medieval Studies
- Anthropology
- Asian and Asian Diaspora Studies
- Comparative Media Studies
- Global Studies and Languages (in French, German, or Spanish)
- History
- Latin American and Latino/a Studies
- Literature
- Music
- Russian and Eurasian Studies
- Science, Technology, and Society
- Theater Arts
- Women’s and Gender Studies
- Writing (Creative, Digital Media, or Science Writing)

For more information about this program, contact Andrea Wirth (awirth@mit.edu), academic administrator, School of Arts, Humanities, and Social Sciences.

URBAN SCIENCE AND PLANNING WITH COMPUTER SCIENCE

Bachelor of Science in Urban Science and Planning with Computer Science (Course 11-6)

Urban settlements and technology around the world are rapidly co-evolving as flows of population, finance, and politics are reshaping the very identity of cities and nations globally. We already see rapid and profound change, especially in megacities, including pervasive sensing, the growth and availability of continuous data streams, advanced analytics, interactive communications and social networks, and distributed intelligence. Examples of new technologies facilitated by or requiring big data and new informatics concentrated in urban areas include, but are not limited to, autonomous vehicles, sensor-enabled self-management of natural resources, cybersecurity for critical infrastructure biometric identity, the sharing or gig-economy, and continuous public engagement opportunities through social networks and data and visualization.

The Bachelor of Science in Urban Science and Planning with Computer Science (Course 11-6) (p. 486) emphasizes the development of fundamental skills in urban planning and policy, including ethics and justice; statistics, data science, geospatial analysis, and visualization; and computer science, robotics, and machine learning. The Course 11-6 program provides numerous opportunities for field-based problem-solving experience through labs, UROP assignments and client-based courses in which students synthesize and empirically integrate what they are learning about theory and practice at the intersection of computer and urban science. Students also have the opportunity to specialize though the selection of a customized concentration of upper-level electives in data visualization, applied spatial analysis, design, and public policy. Students in the program are full members of both departments and of two schools, Architecture and Planning and Engineering.

For more information, email (duspinfo@mit.edu) or call 617-253-9403.

MINORS

The objective of any minor is to provide a depth of understanding and expertise in an area outside of, or complementary to, a student’s major. This depth and expertise must be sufficient to enable the student to appreciate the complexities and issues that are central to the minor, and to perform at a level sufficient to solve realistic problems and/or to make a contribution to the field.

In order to be designated as an interdisciplinary minor at MIT, the content and working skills associated with the program must, in addition, be sufficiently broadly based that they cannot be reasonably addressed by a minor within a single department. Thus, interdisciplinary minors at MIT represent collaborative efforts among distinct academic units, a characteristic that distinguishes them from departmental minors. Interdisciplinary minors may be organized among departments within a School or among departments in different Schools. The interdisciplinary minors offered at MIT are as follows:

- African and African Diaspora Studies (p. 349)
- Ancient and Medieval Studies (p. 350)
- Applied International Studies (p. 351)
- Asian and Asian Diaspora Studies (p. 352)
- Astronomy (p. 353)
- Atmospheric Chemistry (p. 354)
- Biomedical Engineering (p. 354)
- Energy Studies (p. 355)
- Entrepreneurship and Innovation (p. 356)
- Environment and Sustainability (p. 358)
- Latin American and Latino/a Studies (p. 360)
- Middle Eastern Studies (p. 361)
- Polymers and Soft Matter (p. 362)

For more information, visit the MIT Bulletin website or contact the appropriate department.
• Public Policy (p. 363)
• Russian and Eurasian Studies (p. 363)
• Statistics and Data Science (p. 364)
• Women’s and Gender Studies (p. 365)

See the Undergraduate Education section for general information about minor programs (p. 35).

MINOR IN AFRICAN AND AFRICAN DIASPORA STUDIES

The Minor in African and African Diaspora Studies is designed for students interested in the cultures and experiences of the peoples of African descent on the continent and elsewhere. The goal of the minor program is to emphasize the importance of Africa and people of African descent in world cultural, economic, and social developments, and to provide a balance between language, humanistic, historical, and contemporary study. The minor includes study of economic and political systems as they reflect the African continent and areas of the African diaspora, and the histories, languages, and literatures of Africans and peoples of African descent elsewhere.

All of Africa falls within the geographical scope of the minor. A student may concentrate on a particular region or on any of the broad groupings of African cultures, such as Arabic-speaking, Anglophone, Francophone, or Lusophone Africa. Equally, a student choosing to focus on the African diaspora may concentrate on any group of African-descended populations in the Americas. Students focusing on either principal area (Africa or the African diaspora) must also take at least one subject which deals with the other area or with interactions between them.

The minor consists of six subjects (at least three of which must be MIT subjects), arranged in four areas of study:

• Area I: Language
• Area II: Humanities and the Arts
• Area III: Social Sciences
• Area IV: Historical Studies

Subjects about Africa and the African diaspora, as well as subjects in indigenous African languages, are also available from Harvard University and Wellesley College through cross-registration. Students must receive permission from the minor advisor prior to registering for a class at another institution.

Five of the six subjects taken for the minor may be counted toward the eight-subject HASS Requirement. Of these five, at most one may count toward the distribution component of the HASS Requirement. Of the six subjects required for the minor, at least four cannot be counted toward a major or another minor.

Area I: Language

Select one of the following:

Area II: Humanities and the Arts

Select from among the following:

Area III: Social Sciences

Select from among the following:

Area IV: Historical Studies

Select from among the following:

Two intermediate-level subjects in an indigenous African language, or other official language of the region of study

Select four subjects from at least two of the following areas

Area II: Humanities and the Arts

Select from among the following:

Area III: Social Sciences

Select from among the following:

Area IV: Historical Studies

Select from among the following:

21G.303 & 21G.304 French III and French IV
21G.703 & 21G.704 Spanish III and Spanish IV
21G.803 & 21G.804 Portuguese III and Portuguese IV

Two intermediate-level subjects in an indigenous African language, or other official language of the region of study

Select four subjects from at least two of the following areas

Area II: Humanities and the Arts

Select from among the following:

Area III: Social Sciences

Select from among the following:

Area IV: Historical Studies

Select from among the following:
The goal of this program is to develop knowledge and understanding of the more distant past both for itself, in its uniqueness, and as an object of specifically modern questions and methods of inquiry. The program has an interest in the structure of institutions and social systems, and in relationships between the social order and learned traditions, values, ideologies, and ideas. Ancient and medieval studies derive a special claim to our interest from the fact that the record is so full and multiform and that much of it is of exceptionally high quality at once in substance and form.

The minor is designed for students who, in addition to the focus of their major program of study, are seeking a fuller understanding of the forces which shaped the ancient and medieval world. The geographical and chronological scope of the minor program is broadly conceived and is intended to be comparative. Subjects range in content from Classical Greece and Rome, and the ancient societies of Asia and South America, to medieval Europe and Japan. Students will be required to demonstrate intermediate level language proficiency in either Greek, Latin, or a medieval vernacular, but they need not concentrate their other subjects on the area associated with that language. Students are also expected to have some distribution across the ancient and medieval time periods. Students are expected to consult closely with the minor advisor in order to devise a coherent program of study.

The minor consists of six subjects (at least three of which must be MIT subjects), arranged in four primary areas of study:

- Area I: Languages
- Area II: Arts and Architecture
- Area III: Literary Studies
- Area IV: Material and Historical Studies

Subjects in Ancient and Medieval Studies are also available from Harvard University and Wellesley College through cross-registration. Students must receive permission from the minor advisor prior to registering for a class at another institution.

Five of the six minor subjects may be counted toward the eight-subject Institute HASS Requirement. Of these five, at most one shall count toward satisfaction of the HASS Distribution Requirement. Of the six subjects required for the minor, at least four cannot be counted toward a major or another minor.

**MINOR IN ANCIENT AND MEDIEVAL STUDIES**

Through a wide variety of subjects drawn from a number of disciplines, this program provides a curricular framework for exploring topics in ancient and medieval studies which range from the history of ideas and institutions to that of material artifacts, literature, and certain of the original languages. The chronological span of the program includes some 6,500 years between 5000 BC and 1500 AD.

The subject list above is not exhaustive. Additional information can be obtained from the minor advisor, Professor D. Fox Harrell (fox.harrell@mit.edu), Room E15-326, 617-254-4278, or from the SHASS academic administrator, Andrea Wirth (awirth@mit.edu), 4-240, 617-253-4441.

### Area I: Language

Select one of the following for a total of 12 units:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21L.601[J]</td>
<td>Old English and Beowulf</td>
</tr>
<tr>
<td>21L.611</td>
<td>Latin I</td>
</tr>
<tr>
<td>&amp; 21L.612</td>
<td>and Latin II</td>
</tr>
<tr>
<td>21L.607</td>
<td>Greek I</td>
</tr>
<tr>
<td>&amp; 21L.608</td>
<td>and Greek II</td>
</tr>
<tr>
<td>21L.613</td>
<td>Latin Readings</td>
</tr>
<tr>
<td>&amp; 21L.614</td>
<td>and Advanced Latin Readings</td>
</tr>
</tbody>
</table>

An intermediate-level subject in Greek, Latin, Italian, Norse, or Arabic

Select five subjects from at least two of the following areas. At least one subject must be taken in both the Ancient and Medieval periods:

### Area II: Arts and Architecture

Ancient
MINOR IN APPLIED INTERNATIONAL STUDIES

The Minor in Applied International Studies is designed to help students integrate a practical, applied international experience into a coherent course of study. The minor is built around four key components:

- Local understanding with a global perspective
- Theory combined with in-the-field experience
- Cross-cultural communication skills
- Independent research

The result is a comprehensive plan of study that allows students to combine academic work with foreign experience to gain the skills and perspective necessary for a productive, sustainable career in the global economy.

Students are required to take at least 12 units in a pre-modern language. Two six-unit subjects in a pre-modern language may be combined to satisfy this requirement (e.g., Latin I and II or, for students who enter with strong Latin from high school, two different iterations of 21L.6xx Latin Readings). Greek, Latin, and Old English are currently offered at MIT, but students may substitute another pre-modern language taken elsewhere.

Students with equivalent proficiency in a pre-modern language may substitute the Area I requirement with one more subject from Areas II–IV.

Counts as either Ancient or Medieval, but not both.

MIT does not offer these languages; consult with advisor concerning appropriate coursework at Harvard University or Wellesley College. Arabic is required for students proposing a specialty in the medieval Islamic world.

Counts as Area I or III, but not both.

Any seminar-tier subject in Literature with a substantially ancient and/or medieval focus counts toward Area III.

The subject list above is not exhaustive. Additional information can be obtained from the minor advisors, Professor Eric Goldberg (egoldber@mit.edu), E51-290, 617-254-2420, Professor Stephanie Frampton (sframpton@mit.edu), 14N-434, 617-253-4452, or from the History Office, E51-255, 617-253-4965.

The Minor in Applied International Studies is designed to help students integrate a practical, applied international experience into a coherent course of study. The minor is built around four key components:

- Local understanding with a global perspective
- Theory combined with in-the-field experience
- Cross-cultural communication skills
- Independent research

The result is a comprehensive plan of study that allows students to combine academic work with foreign experience to gain the skills and perspective necessary for a productive, sustainable career in the global economy.

**Total Units:** 72

**Area I: Pre-Modern Languages**

- 21L.001 Foundations of Western Literature: Homer to Dante
- 21L.210 Comedy
- 21L.455 Ancient Authors
- 21L.458 The Bible
- 21L.613 Latin Readings
- 21L.614 & 21L.614 Advanced Latin Readings
- 24.200 Ancient Philosophy

**Area II: Literary Studies**

- 21H.133 The Medieval World
- 21H.134 Medieval Economic History in Comparative Perspective
- 21H.160 Islam, the Middle East, and the West
- 21H.238 The Vikings
- 21H.240 The World of Charlemagne
- 21H.383 Technology and the Global Economy, 1000-2000
- CC.116 How to Rule the World: The Promises and Pitfalls of Politics, War, and Empire

**Area III: Literary Studies**

- 21L.601 Old English and Beowulf

**Area IV: Material and Historical Studies**

- 3.981 Communities of the Living and the Dead: the Archaeology of Ancient Egypt
- 3.982 The Ancient Andean World
- 3.983 Ancient Mesoamerican Civilization
- 3.986 The Human Past: Introduction to Archaeology
- 3.987 Human Evolution: Data from Palaeontology, Archaeology, and Materials Science
- 3.993 Archaeology of the Middle East
- 21H.007 Introduction to Ancient and Medieval Studies
- 21H.130 The Ancient World: Greece
- 21H.132 The Ancient World: Rome
- 21H.230 Barbarians, Saints, and Emperors
- 21H.331 Julius Caesar and the Fall of the Roman Republic
- 21H.333 Early Christianity
- 21H.336 The Making of a Roman Emperor
- CC.117 Humane Warfare: Ancient and Medieval Perspectives on Ethics in War

**MINOR IN APPLIED INTERNATIONAL STUDIES**

The Minor in Applied International Studies is designed to help students integrate a practical, applied international experience into a coherent course of study. The minor is built around four key components:

- Local understanding with a global perspective
- Theory combined with in-the-field experience
- Cross-cultural communication skills
- Independent research

The result is a comprehensive plan of study that allows students to combine academic work with foreign experience to gain the skills and perspective necessary for a productive, sustainable career in the global economy.
The Minor in Applied International Studies consists of six internationally-oriented subjects from any program in the School of Humanities, Art, and Social Sciences, including:

- At least two subjects focused on one area of the world, including at least one in the social sciences. Qualifying subjects will be determined with the help of the minor advisor.
- The equivalent of four semesters of college language training related to the student's geographical specialization. Upper-level language subjects (beyond first-year subjects) may count toward the six-subject total.
- An intensive international experience (MISTI, D-Lab, or other experience for at least two months).
- A research seminar in international studies and social science, 17.591 Research Seminar in Applied International Studies. In consultation with the instructor, students pick a topic for extensive independent research and, over the course of the semester, complete a lengthy term paper.

Students seeking additional information or wishing to plan their minor should contact Tobie Weiner (iguanawt@mit.edu), E53-483, 617-253-3649, or minor advisor Professor Ben Schneider (brs@mit.edu).

MINOR IN ASIAN AND ASIAN DIASPORA STUDIES

The Minor in Asian and Asian Diaspora Studies is designed for students interested in the language, history, politics, and culture of Asia and/or the Asian diasporas. In consultation with the minor advisor, students may focus their coursework on a subregion of Asia, on one of the Asian diasporas, or design their program to offer a comparative study across different regions and/or cultural groups. The goal of the minor program is to provide balanced coverage of language, humanistic and social science offerings on the region, and to expose students to comparative perspectives.

The minor consists of six subjects (at least three of which must be MIT subjects), arranged in four areas of study:

- Area I: Language
- Area II: Humanities and the Arts
- Area III: Social Sciences
- Area IV: Historical Studies

Subjects about Asia and the Asian diaspora, as well as subjects in Asian languages, are also available from Harvard University and Wellesley College through cross-registration. Students must receive permission from the minor advisor prior to registering for a class at another institution.

Five of the six subjects taken for the minor may be counted toward the eight-subject HASS Requirement. Of these five, at most one may count toward the distribution component of the HASS Requirement.

Of the six subjects required for the minor, at least four cannot be counted toward a major or another minor.

<table>
<thead>
<tr>
<th>Area I: Language 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Select from among the following:</td>
<td>21-24</td>
</tr>
<tr>
<td>21G.103 Chinese III (Regular)</td>
<td></td>
</tr>
<tr>
<td>21G.104 Chinese IV (Regular)</td>
<td></td>
</tr>
<tr>
<td>21G.105 Chinese V (Regular): Discovering Chinese Cultures and Societies</td>
<td></td>
</tr>
<tr>
<td>21G.106 Chinese VI (Regular): Discovering Chinese Cultures and Societies</td>
<td></td>
</tr>
<tr>
<td>21G.109 Chinese III (Streamlined)</td>
<td></td>
</tr>
<tr>
<td>21G.110 Chinese IV (Streamlined)</td>
<td></td>
</tr>
<tr>
<td>21G.113 Chinese V (Streamlined)</td>
<td></td>
</tr>
<tr>
<td>21G.120 Business Chinese</td>
<td></td>
</tr>
<tr>
<td>21G.503 Japanese III</td>
<td></td>
</tr>
<tr>
<td>21G.504 Japanese IV</td>
<td></td>
</tr>
<tr>
<td>21G.505 Japanese V</td>
<td></td>
</tr>
<tr>
<td>21G.506 Japanese VI</td>
<td></td>
</tr>
<tr>
<td>21G.903 Korean III (Regular)</td>
<td></td>
</tr>
<tr>
<td>21G.904 Korean IV (Regular)</td>
<td></td>
</tr>
</tbody>
</table>

Two intermediate-level subjects in another Asian language 2

Select four subjects from at least two of the following areas: 3

| Area II: Humanities and the Arts | 48 |
| Select from among the following: | |
| 21G.011 Topics in Indian Popular Culture | |
| 21G.027[J] Visualizing Japan in the Modern World | |
| 21G.030[J] Introduction to East Asian Cultures: From Zen to K-Pop | |
| 21G.036[J] Advertising and Media: Comparative Perspectives | |
| 21G.038 China in the News: The Untold Stories | |
| 21G.039[J] Gender and Japanese Popular Culture | |
| 21G.040 A Passage to India: Introduction to Modern Indian Culture and Society | |
| 21G.046 Modern Chinese Fiction and Cinema | |
| 21G.063 Anime: Transnational Media and Culture | |
| 21G.064 Introduction to Japanese Culture | |
| 21G.065 Japanese Literature and Cinema | |
| 21G.067 Digital Media in Japan and Korea | |
The Minor in Astronomy, offered jointly by the Department of Earth, Atmospheric, and Planetary Sciences (p. 317) and the Department of Physics (p. 330), covers the observational and theoretical foundations of astronomy. The minor requires seven subjects as follows:

**Astronomy, Mathematics, and Physics**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.03</td>
<td>Physics III</td>
<td>12</td>
</tr>
<tr>
<td>8.282</td>
<td>Introduction to Astronomy</td>
<td>9</td>
</tr>
<tr>
<td>18.03</td>
<td>Differential Equations</td>
<td>12</td>
</tr>
</tbody>
</table>

**Astrophysics**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.284</td>
<td>Modern Astrophysics</td>
<td>12</td>
</tr>
<tr>
<td>or 8.286</td>
<td>The Early Universe</td>
<td></td>
</tr>
</tbody>
</table>

**Planetary Astronomy**

Select one of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.400</td>
<td>The Solar System</td>
<td>12</td>
</tr>
<tr>
<td>12.420</td>
<td>Physics and Chemistry of the Solar System</td>
<td></td>
</tr>
<tr>
<td>12.425</td>
<td>Extrasolar Planets: Physics and Detection Techniques</td>
<td></td>
</tr>
</tbody>
</table>
MINOR IN ATMOSPHERIC CHEMISTRY

Atmospheric Chemistry is an interdisciplinary field that blends fundamental science with engineering and policy. It is a domain that is growing in scope, complexity, and demand as society grapples with burgeoning global, regional, and local challenges, including those in energy and public health. The minor is offered by the Departments of Earth, Atmospheric, and Planetary Sciences (p. 317), Civil and Environmental Engineering (p. 174), Chemistry (p. 312), and Aeronautics and Astronautics (p. 147), and the Institute for Data, Systems, and Society (p. 181). The minor requires five subjects. The core of the minor consists of three required subjects spanning thermodynamics and kinetics, atmospheric and ocean dynamics, air pollution, and atmospheric physics and chemistry, complemented by (at least) one subject in observations/applications, and one subject in the links of atmospheric chemistry to policy.

**Chemistry, Dynamics, and the Atmosphere**

**Required Subjects**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.085[J]</td>
<td>Air Pollution</td>
</tr>
<tr>
<td>or 12.306</td>
<td>Atmospheric Physics and Chemistry</td>
</tr>
<tr>
<td>5.60</td>
<td>Thermodynamics and Kinetics</td>
</tr>
<tr>
<td>12.003</td>
<td>Introduction to Atmosphere, Ocean, and Climate Dynamics</td>
</tr>
</tbody>
</table>

**Observations/Applications**

Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.080A &amp; 1.080B</td>
<td>Environmental Chemistry I and Environmental Chemistry II</td>
</tr>
</tbody>
</table>

**Linkages of Atmospheric Chemistry to Policy**

Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.301</td>
<td>Climate Science</td>
</tr>
<tr>
<td>12.346[J]</td>
<td>Global Environmental Negotiations</td>
</tr>
<tr>
<td>12.385</td>
<td>Science, Politics, and Environmental Policy</td>
</tr>
</tbody>
</table>

Total Units: 57-60

A minimum of four subjects taken for the atmospheric chemistry minor cannot also count toward a major or another minor.

Further information on the minor may be obtained from Professor Susan Solomon (solos@mit.edu), or from Dr. Megan Jordan (mkjordan@mit.edu), EAPS Academic Program Administrator, 54-910, 617-253-3380.

MINOR IN BIOMEDICAL ENGINEERING

The Biomedical Engineering Minor (BME) program requires a total of seven subjects selected from a series of categories as outlined below.

**Programming and Computational Modeling Core**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0001</td>
<td>Introduction to Computer Science Programming in Python</td>
</tr>
<tr>
<td>6.0002</td>
<td>Introduction to Computational Thinking and Data Science</td>
</tr>
</tbody>
</table>

**Mathematics Core**

Select two of the following options:

1. **Option A**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.016</td>
<td>Computational Methods for Materials Scientists and Engineers</td>
</tr>
<tr>
<td>or 18.03</td>
<td>Differential Equations</td>
</tr>
</tbody>
</table>

2. **Option B**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.06</td>
<td>Linear Algebra</td>
</tr>
</tbody>
</table>

3. **Option C**

Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.010</td>
<td>Introduction to Probability and Statistics in Engineering</td>
</tr>
<tr>
<td>6.041A &amp; 6.041B</td>
<td>Introduction to Probability I and Introduction to Probability II</td>
</tr>
<tr>
<td>9.07</td>
<td>Statistics for Brain and Cognitive Science</td>
</tr>
</tbody>
</table>
Human Physiology Core
Select one of the following: 12
- 6.022[J] Quantitative Systems Physiology
- 7.20[J] Human Physiology 2
- 9.01 Introduction to Neuroscience

Biomedical Engineering and Applications
Select three of the following: 3, 4 30-36
- 2.184 Biomechanics and Neural Control of Movement 2
- 2.750[J] Medical Device Design 2
- 3.052 Nanomechanics of Materials and Biomaterials 2
- 3.054 Cellular Solids: Structure, Properties, Applications 2
- 3.055[J] Biomaterials Science and Engineering 2
- 6.021[J] Cellular Neurophysiology and Computing
- 6.811[J] Principles and Practice of Assistive Technology 2
- 7.37[J] Molecular and Engineering Aspects of Biotechnology 2
- 9.17 Systems Neuroscience Laboratory 2
- 9.24 Disorders and Diseases of the Nervous System 2
- 9.26[J] Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience 2
- 9.35 Perceptual Systems
- 9.40 Introduction to Neural Computation 2
- 10.424 Pharmaceutical Engineering 2
- 10.443 Future Medicine: Drug Delivery, Therapeutics, and Diagnostics 2
- 10.495 Molecular Design and Bioprocess Development of Immunotherapies 2
- 20.310[J] Molecular, Cellular, and Tissue Biomechanics 2
- 20.345[J] Bioinstrumentation Project Lab 2
- 20.352 Principles of Neuroengineering

Total Units 72-84

A minimum of four subjects taken for the biomedical engineering minor cannot also count toward a major or another minor.

1 Contact minor advisor for additional 6–12 unit subjects that satisfy requirement.

2 Subject has prerequisites that are outside of the program.

3 At least one of the subjects must be taken outside the student's major. See the BME Minor website (https://be.mit.edu/academic-programs/current-undergraduate/minor-programs/minor-program-biomedical-engineering) for potential substitutions.

4 Approved biomedical engineering UROPs with sufficient medical focus, carried out by students with junior or senior standing with prior approval, may be substituted for up to 12 units.

Students should consult with their departmental BME minor advisor, preferably in sophomore year and no later than the end of the fall term of junior year, to choose a course of study, which must be approved in advance by the BME minor advisor. For the list of BME minor advisors and other information, please visit the Biological Engineering website (http://web.mit.edu/be) or contact the BE Academic Office, Room 56-651, 617-253-1712.

MINOR IN ENERGY STUDIES

Energy is a fundamentally multidisciplinary topic. Transforming the world’s energy systems requires combining expertise from numerous fields in engineering and technology, natural and social science, and policy. A diversity of disciplinary perspectives is necessary to equip students to work in this complex, evolving field.

The Energy Studies Minor for undergraduates is an Institute-wide program that complements the deep expertise obtained in any major with a broad understanding of the interlinked realms of science, technology, and social sciences as they relate to energy and associated environmental challenges. The minor curriculum integrates these three domains in a thoroughly multidisciplinary program. The Energy Minor Oversight Committee, including faculty representatives from all five Schools, oversees the Energy Studies Minor program.

The Energy Studies curriculum has two components. The first is a core that provides an integrated perspective on energy and associated environmental challenges in three domains, each with a primary focus: Science Foundations (fundamental laws and principles that govern energy sources, conversion, and uses), Social Science Foundations (social scientific perspectives and tools that explain human behavior in the energy context), and Technology/Engineering in Context (the application of laws and principles to a specific energy context). The second component is a customized program of electives that is selected by each student in close consultation with his or her Energy Studies Minor faculty advisor.

Core Curriculum
Science Foundations 12-27

Option 1
- 8.21 Physics of Energy

Option 2 - Select two subjects from one of the following groups:

Group A
6.007
2.005 Thermal-Fluids Engineering I
or 3.012 Fundamentals of Materials Science and Engineering

Group B
5.60 Thermodynamics and Kinetics
12.021 Earth Science, Energy, and the Environment
or 12.340

Social Science Foundations 33-36
14.01 Principles of Microeconomics
or 15.011 Economic Analysis for Business Decisions

Select one of the following options:
Option 1
or 15.031

Option 2 - Select one subject from each of the following groups:
Group A
14.42 Environmental Policy and Economics

Group B
1.801[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control
11.162 Politics of Energy and the Environment
22.04[J] Social Problems of Nuclear Energy

Technology/Engineering in Context 12
Select one of the following:
2.60[J] Fundamentals of Advanced Energy Conversion
4.42
22.081[J] Introduction to Sustainable Energy

Electives 24
Select 24 units from the following: 1,2
1.071[J] Global Change Science
2.006 Thermal-Fluids Engineering II
2.612 Marine Power and Propulsion
2.627 Fundamentals of Photovoltaics
2.813 Energy, Materials, and Manufacturing

3.003 Principles of Engineering Practice (9 units)
3.004 Principles of Engineering Practice
3.18 Materials Science and Engineering of Clean Energy

4.401 Environmental Technologies in Buildings
6.131 Power Electronics Laboratory
6.701 Introduction to Nanoelectronics
8.044 Statistical Physics I
10.04 A Philosophical History of Energy
10.213 Chemical and Biological Engineering Thermodynamics
10.27 Energy Engineering Projects Laboratory (15 units)
10.28 Chemical-Biological Engineering Laboratory (15 units)
10.426 Electrochemical Energy Systems (15 units)
11.142 Geography of the Global Economy
11.165 Urban Energy Systems and Policy
12.213 Alternate Energy Sources (6 units)
12.346[J] Global Environmental Negotiations (6 units)
17.051 Ethics of Energy Policy
22.033 Nuclear Systems Design Project
22.06 Engineering of Nuclear Systems
EC.711[J] D-Lab: Energy I
STS.032 Energy, Environment, and Society

Total Units 81-99

1 See the Energy Studies Minor website (http://energy.mit.edu/minor) for potential elective and core subject substitutions or additions.
2 All subjects are 12-unit subjects unless otherwise noted.

Students who take more than the required subjects from any of the core curriculum subject lists may count the additional coursework toward the elective requirement. Contact Rachel Shulman (rshulman@mit.edu), academic coordinator, MIT Energy Initiative Education Office, Room E19-370D, 617-324-7236, or visit the Energy Studies Minor website (http://energy.mit.edu/minor) for more information.

MINOR IN ENTREPRENEURSHIP AND INNOVATION

The Minor in Entrepreneurship and Innovation (E&I Minor) educates students to serve as leaders in the innovation economy with the knowledge, skills, and confidence to develop, scale, and deliver breakthrough solutions to real-world problems. They will be prepared to do so within a range of organizational contexts: an entrepreneurial start-up of their own, as key members of a founding team, or as an entrepreneurial member of a large organization.

Jointly offered by the Schools of Engineering and Management, the minor is designed as an interdisciplinary program with a coherent
combination of conceptual and practical elements that draws on a wealth of prior educational activities in this domain.

Students who complete the E&I Minor will have developed knowledge and skills in:

- The innovation process from the conception of an initial invention and the problem it may solve to the refinement of the solution, to the considerations needed in the scale-up and delivery of the solution, to the launch of an appropriately funded entity.
- Communication, teamwork, decision making and leadership skills as well as the integrity and character that are necessary to engage with stakeholders and develop the invention into a real-world product or process.
- Strategies and methods to engage in rigorous iterations to identify and deeply understand societal needs/problems and develop robust, scalable solutions.
- Types of organizational models and designs for the delivery of innovations to the world.
- A range of global contexts for entrepreneurship and innovation, including variations in the interface with key stakeholders whose interests may enable or limit the potential effectiveness of innovation and entrepreneurship.

The minor requires five courses: a core curriculum of two E&I Foundations subjects and an elective subject in each of the three domains—E&I in Context, Leadership of Teams and Organizations, and E&I Experiential.

### Core Curriculum

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.359[J]</td>
<td>Innovation Engineering: Moving Ideas to Impact</td>
</tr>
<tr>
<td>15.373[J]</td>
<td>Venture Engineering</td>
</tr>
</tbody>
</table>

### Electives

#### E&I in Context

Select one of the following: 9-12

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.086</td>
<td>Innovation and Commercialization of Materials Technology</td>
</tr>
<tr>
<td>11.005</td>
<td>Introduction to International Development</td>
</tr>
<tr>
<td>11.123</td>
<td>Big Plans and Mega-Urban Landscapes</td>
</tr>
<tr>
<td>11.142</td>
<td>Geography of the Global Economy</td>
</tr>
<tr>
<td>11.165</td>
<td>Urban Energy Systems and Policy</td>
</tr>
<tr>
<td>14.46</td>
<td>Innovation Policy and the Economy</td>
</tr>
<tr>
<td>15.3641</td>
<td>Regional Entrepreneurship Acceleration Leaders (REAL)</td>
</tr>
<tr>
<td>17.307</td>
<td>American Public Policy for Washington Interns</td>
</tr>
<tr>
<td>17.309[J]</td>
<td>Science, Technology, and Public Policy</td>
</tr>
<tr>
<td>17.315</td>
<td>Health Policy</td>
</tr>
<tr>
<td>STS.002</td>
<td>Finance and Society</td>
</tr>
<tr>
<td>STS.004</td>
<td>Intersections: Science, Technology, and the World</td>
</tr>
<tr>
<td>STS.011</td>
<td>Engineering Life: Biotechnology and Society</td>
</tr>
<tr>
<td>STS.032</td>
<td>Energy, Environment, and Society</td>
</tr>
<tr>
<td>STS.081[J]</td>
<td>Innovation Systems for Science, Technology, Energy, Manufacturing, and Health</td>
</tr>
<tr>
<td>STS.088</td>
<td>Africa for Engineers</td>
</tr>
<tr>
<td>EC.701[J]</td>
<td>D-Lab: Development</td>
</tr>
</tbody>
</table>

#### Leadership of Teams and Organizations

Select one of the following: 9-12

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.96</td>
<td>Management in Engineering</td>
</tr>
<tr>
<td>6.915[J]</td>
<td>Leading Innovation in Teams</td>
</tr>
<tr>
<td>10.02</td>
<td>Foundations of Entrepreneurship for Engineers</td>
</tr>
<tr>
<td>15.301</td>
<td>People, Teams, and Organizations Laboratory</td>
</tr>
<tr>
<td>15.3941</td>
<td>Entrepreneurial Founding and Teams</td>
</tr>
</tbody>
</table>

#### E&I Experiential

Select one of the following: 9-12

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>2.009</td>
<td>The Product Engineering Process</td>
</tr>
<tr>
<td>2.750[J]</td>
<td>Medical Device Design</td>
</tr>
<tr>
<td>2.752</td>
<td>Development of Mechanical Products</td>
</tr>
<tr>
<td>2.760</td>
<td>Global Engineering</td>
</tr>
<tr>
<td>3.042</td>
<td>Materials Project Laboratory</td>
</tr>
<tr>
<td>6.170</td>
<td>Software Studio</td>
</tr>
<tr>
<td>6.811[J]</td>
<td>Principles and Practice of Assistive Technology</td>
</tr>
<tr>
<td>6.813</td>
<td>User Interface Design and Implementation</td>
</tr>
<tr>
<td>10.807[J]</td>
<td>Innovation Teams</td>
</tr>
<tr>
<td>11.127[J]</td>
<td>Design and Development of Games for Learning</td>
</tr>
<tr>
<td>15.3781</td>
<td>Building an Entrepreneurial Venture: Advanced Tools and Techniques</td>
</tr>
<tr>
<td>15.3901</td>
<td>New Enterprises</td>
</tr>
<tr>
<td>15.3991</td>
<td>Entrepreneurship Lab</td>
</tr>
<tr>
<td>CMS.339</td>
<td>Virtual Reality and Immersive Media Production</td>
</tr>
<tr>
<td>CMS.610</td>
<td>Media Industries and Systems: The Art, Science and Business of Games</td>
</tr>
<tr>
<td>CMS.611[J]</td>
<td>Creating Video Games</td>
</tr>
</tbody>
</table>
MINOR IN ENVIRONMENT AND SUSTAINABILITY

The Environment and Sustainability Minor (E&S Minor) provides an integrative foundation in the scientific, engineering, social, and humanistic dimensions of humanity's interaction with the environment. The minor will equip students with knowledge and experience that will make it possible to understand, diagnose, and develop solutions to complex problems faced by society as it strives for social and environmental sustainability. Students who complete the minor will be prepared to apply the principles of sustainability in diverse workplace contexts, including business/industry, government, civil society, and academia.

The E&S Minor combines a wide range of fields of inquiry to directly engage environmental and climate challenges facing ecosystems and populations around the globe. Fundamentally, these challenges affect both human systems and the earth systems on which we depend: people and the planet. Planetary challenges include global changes in the climate and oceans, degradation to both biodiversity and material resources, and fundamental transformations of biogeochemical cycles. Challenges facing society include (but are not limited to) widespread and intransigent environmental injustice, expanding urban and agricultural pollution, technological and economic lock-in of infrastructure and all manner of production and consumption systems, and a global dependence on carbon intensive energy.

The minor prioritizes integrative, interdisciplinary learning that is critical for effectively understanding and addressing the complexities of environmental issues today and in the future, and is structured on four pillars: Earth Systems and Climate Science, Environmental Governance, Environmental Histories and Cultures, and Engineering for Sustainability.

### Requirements

**Curriculum**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.387[J]</td>
<td>People and the Planet: Environmental Governance and Science</td>
<td>9</td>
</tr>
<tr>
<td>11.004[J]</td>
<td>People and the Planet: Environmental Histories and Engineering</td>
<td>12</td>
</tr>
</tbody>
</table>

In consultation with the minor advisor, select a minimum of 36 units from the list of electives

| Total Units | 57-60 |

**Electives**

**Earth Systems and Climate Science**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.078</td>
<td>Soil and Environmental Biogeochemistry</td>
<td>12</td>
</tr>
<tr>
<td>1.080A</td>
<td>Environmental Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>&amp; 1.080B</td>
<td>Environmental Chemistry II</td>
<td>12</td>
</tr>
<tr>
<td>1.089</td>
<td>Environmental Microbiology</td>
<td>6-12</td>
</tr>
<tr>
<td>or 1.089A</td>
<td>Environmental Microbiology I</td>
<td>12</td>
</tr>
<tr>
<td>2.981</td>
<td>New England Coastal Ecology</td>
<td>3</td>
</tr>
<tr>
<td>3.982</td>
<td>The Ancient Andean World</td>
<td>9</td>
</tr>
<tr>
<td>8.21</td>
<td>Physics of Energy</td>
<td>12</td>
</tr>
<tr>
<td>12.000</td>
<td>Solving Complex Problems</td>
<td>9</td>
</tr>
<tr>
<td>12.001</td>
<td>Introduction to Geology</td>
<td>12</td>
</tr>
<tr>
<td>12.002</td>
<td>Introduction to Geophysics and Planetary Science</td>
<td>12</td>
</tr>
<tr>
<td>12.003</td>
<td>Introduction to Atmosphere, Ocean, and Climate Dynamics</td>
<td>12</td>
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<tr>
<td>12.007</td>
<td>Geobiology: History of Life on Earth</td>
<td>12</td>
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<tr>
<td>12.021</td>
<td>Earth Science, Energy, and the Environment</td>
<td>12</td>
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<tr>
<td>12.102</td>
<td>Environmental Earth Science</td>
<td>12</td>
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<tr>
<td>12.104</td>
<td>Geochemistry of Natural Waters</td>
<td>12</td>
</tr>
<tr>
<td>12.120</td>
<td>Environmental Earth Science Field Course</td>
<td>6</td>
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<tr>
<td>12.170</td>
<td>Essentials of Geology</td>
<td>12</td>
</tr>
<tr>
<td>12.174</td>
<td>Biogeochemistry of Natural and Perturbed Systems</td>
<td>12</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>12.307</td>
<td>Weather and Climate Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>12.335</td>
<td>Experimental Atmospheric Chemistry</td>
<td>12</td>
</tr>
<tr>
<td>12.349</td>
<td>Mechanisms and Models of the Global Carbon Cycle</td>
<td>12</td>
</tr>
<tr>
<td>12.385</td>
<td>Science, Politics, and Environmental Policy</td>
<td>9</td>
</tr>
<tr>
<td>20.106[J]</td>
<td>Systems Microbiology</td>
<td>12</td>
</tr>
<tr>
<td>EC.714</td>
<td>D-Lab: Earth</td>
<td>6</td>
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</tbody>
</table>

**Environmental Governance**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.801[J]</td>
<td>Environmental Law, Policy, and Economics: Pollution Prevention and Control</td>
<td>12</td>
</tr>
<tr>
<td>1.802[J]</td>
<td>Regulation of Chemicals, Radiation, and Biotechnology</td>
<td>12</td>
</tr>
<tr>
<td>11.123</td>
<td>Big Plans and Mega-Urban Landscapes</td>
<td>9</td>
</tr>
<tr>
<td>11.142</td>
<td>Geography of the Global Economy</td>
<td>12</td>
</tr>
<tr>
<td>11.148</td>
<td>Environmental Justice: Law and Policy</td>
<td>12</td>
</tr>
<tr>
<td>11.162</td>
<td>Politics of Energy and the Environment</td>
<td>12</td>
</tr>
<tr>
<td>12.385</td>
<td>Science, Politics, and Environmental Policy</td>
<td>9</td>
</tr>
<tr>
<td>17.181</td>
<td>Sustainability: Political Economy, Science, and Policy</td>
<td>12</td>
</tr>
<tr>
<td>17.309[J]</td>
<td>Science, Technology, and Public Policy</td>
<td>12</td>
</tr>
<tr>
<td>17.411</td>
<td>Globalization, Migration, and International Relations</td>
<td>12</td>
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<tr>
<td>21A.410</td>
<td>Environmental Struggles</td>
<td>12</td>
</tr>
<tr>
<td>EC.701[J]</td>
<td>D-Lab: Development</td>
<td>12</td>
</tr>
<tr>
<td>EC.711[J]</td>
<td>D-Lab: Energy</td>
<td>12</td>
</tr>
<tr>
<td>EC.714</td>
<td>D-Lab: Earth</td>
<td>6</td>
</tr>
<tr>
<td>EC.715</td>
<td>D-Lab: Water, Sanitation and Hygiene</td>
<td>12</td>
</tr>
<tr>
<td>EC.716</td>
<td>D-Lab: Waste</td>
<td>9</td>
</tr>
<tr>
<td>EC.733[J]</td>
<td>D-Lab: Supply Chains</td>
<td>12</td>
</tr>
<tr>
<td>IDS.062[J]</td>
<td>Global Environmental Negotiations</td>
<td>6</td>
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</table>

**Environmental Histories and Cultures**

<table>
<thead>
<tr>
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<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.094</td>
<td>Materials in Human Experience</td>
<td>9</td>
</tr>
<tr>
<td>3.982</td>
<td>The Ancient Andean World</td>
<td>9</td>
</tr>
<tr>
<td>3.983</td>
<td>Ancient Mesoamerican Civilization</td>
<td>9</td>
</tr>
<tr>
<td>4.622</td>
<td>Islamic Gardens and Geographies</td>
<td>12</td>
</tr>
<tr>
<td>10.04</td>
<td>A Philosophical History of Energy</td>
<td>12</td>
</tr>
<tr>
<td>10.05</td>
<td>Foundational Analyses of Problems in Energy and the Environment</td>
<td>12</td>
</tr>
<tr>
<td>11.016[J]</td>
<td>The Once and Future City</td>
<td>12</td>
</tr>
<tr>
<td>17.051</td>
<td>Ethics of Energy Policy</td>
<td>12</td>
</tr>
<tr>
<td>24.03</td>
<td>Good Food: The Ethics and Politics of Food</td>
<td>12</td>
</tr>
<tr>
<td>21A.155</td>
<td>Food, Culture, and Politics</td>
<td>12</td>
</tr>
<tr>
<td>21A.303[J]</td>
<td>The Anthropology of Biology</td>
<td>12</td>
</tr>
<tr>
<td>21G.417</td>
<td>Cultural Geographies of Germany: Nature, Culture, and Politics</td>
<td>12</td>
</tr>
<tr>
<td>21H.185[J]</td>
<td>Environment and History</td>
<td>12</td>
</tr>
<tr>
<td>21H.380[J]</td>
<td>People and Other Animals</td>
<td>12</td>
</tr>
<tr>
<td>21H.383</td>
<td>Technology and the Global Economy, 1000-2000</td>
<td>12</td>
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<tr>
<td>21L.449</td>
<td>The Wilds of Literature</td>
<td>12</td>
</tr>
<tr>
<td>21W.012</td>
<td>Writing and Rhetoric: Food for Thought</td>
<td>12</td>
</tr>
<tr>
<td>21W.036</td>
<td>Science Writing and New Media: Writing and the Environment</td>
<td>12</td>
</tr>
<tr>
<td>21W.775</td>
<td>Writing about Nature and Environmental Issues</td>
<td>12</td>
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<tr>
<td>EC.701[J]</td>
<td>D-Lab: Development</td>
<td>12</td>
</tr>
<tr>
<td>EC.715</td>
<td>D-Lab: Water, Sanitation and Hygiene</td>
<td>12</td>
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<tr>
<td>SP.360</td>
<td>Terrascope Radio</td>
<td>12</td>
</tr>
<tr>
<td>STS.009</td>
<td>Evolution and Society</td>
<td>12</td>
</tr>
<tr>
<td>STS.032</td>
<td>Energy, Environment, and Society</td>
<td>12</td>
</tr>
</tbody>
</table>

**Engineering for Sustainability**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.007</td>
<td>Big Engineering: Small Solutions with a Large Impact</td>
<td>6</td>
</tr>
<tr>
<td>1.011</td>
<td>Project Evaluation and Management</td>
<td>12</td>
</tr>
<tr>
<td>2.00A</td>
<td>Fundamentals of Engineering Design: Explore Space, Sea and Earth</td>
<td>9</td>
</tr>
<tr>
<td>2.627</td>
<td>Fundamentals of Photovoltaics</td>
<td>12</td>
</tr>
<tr>
<td>3.094</td>
<td>Materials in Human Experience</td>
<td>9</td>
</tr>
<tr>
<td>3.983</td>
<td>Ancient Mesoamerican Civilization</td>
<td>9</td>
</tr>
<tr>
<td>4.401</td>
<td>Environmental Technologies in Buildings</td>
<td>12</td>
</tr>
<tr>
<td>4.411[J]</td>
<td>D-Lab Schools: Building Technology Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>4.432</td>
<td>Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods</td>
<td>12</td>
</tr>
<tr>
<td>12.000</td>
<td>Solving Complex Problems</td>
<td>9</td>
</tr>
<tr>
<td>12.213</td>
<td>Alternate Energy Sources</td>
<td>6</td>
</tr>
</tbody>
</table>
Of the six subjects required for the minor, at least four cannot be counted toward a major or another minor.

Area I: Language

Select two from among the following:

<table>
<thead>
<tr>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.703</td>
</tr>
<tr>
<td>21G.793</td>
</tr>
<tr>
<td>21G.704</td>
</tr>
<tr>
<td>21G.710</td>
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<tr>
<td>21G.711</td>
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<tr>
<td>21G.712</td>
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<tr>
<td>21G.713</td>
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<td>21G.714</td>
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<tr>
<td>21G.715</td>
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<tr>
<td>21G.795</td>
</tr>
<tr>
<td>21G.803</td>
</tr>
<tr>
<td>21G.804</td>
</tr>
</tbody>
</table>

Select four subjects, including 17.55[J], from at least two of the following areas:

Area II: Humanities and the Arts

Subjects taught in English:

<table>
<thead>
<tr>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.070</td>
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<tr>
<td>21G.072</td>
</tr>
<tr>
<td>21G.074</td>
</tr>
<tr>
<td>21L.019</td>
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</tbody>
</table>

Subjects taught in Spanish:

<table>
<thead>
<tr>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.731[J]</td>
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<tr>
<td>21G.732</td>
</tr>
<tr>
<td>21G.735</td>
</tr>
<tr>
<td>21G.736</td>
</tr>
<tr>
<td>21L.636[J]</td>
</tr>
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</table>
MINOR IN MIDDLE EASTERN STUDIES

Middle Eastern Studies at MIT offers students the opportunity to explore the connections among culture, society, politics, economics, technology, and environment in the Middle East, including North Africa. MIT offers a number of subjects open to undergraduates that provide a variety of perspectives on the ancient, Islamic, and modern Middle East. The goal of the HASS Minor Program in Middle Eastern Studies is to lead the student from the basic language into survey subjects and then into more focused studies of individual countries or specific historical periods, and to encourage analysis of the main methodological and conceptual issues in Middle Eastern Studies.

The minor consists of six subjects (at least three of which must be MIT subjects), arranged in four areas of study:

- **Area I: Language**
- **Area II: Humanities and the Arts**
- **Area III: Social Sciences**
- **Area IV: Historical Studies**

Subjects in Middle Eastern Studies are also available from Harvard University and Wellesley College through cross-registration. Students must receive permission from the minor advisor prior to registering for a class at another institution.

Five of the six subjects taken for the minor may be counted toward the eight-subject HASS Requirement. Of these five, at most one may count toward the distribution component of the HASS Requirement. Of the six subjects required for the minor, at least four cannot be counted toward a major or another minor.

**Area I: Language**

Two intermediate (Levels III and IV) subjects in one of the following Middle Eastern languages are required: Arabic, Hebrew, Persian, Turkish.

**Select four subjects from at least two of the following areas:**

- **Area II: Humanities and the Arts**
- **Area III: Social Sciences**
- **Area IV: Historical Studies**

**Select from among the following:**

- 4.614 Building Islam
- 4.622 Islamic Gardens and Geographies
- WGS.220[J] Women and Gender in the Middle East and North Africa

**Area III: Social Sciences**

Select from among the following:

- 3.993 Archaeology of the Middle East
- 17.565 Israel: History, Politics, Culture, and Identity
  or 17.567 Israel: History, Politics, Culture, and Identity

---

The subject list above is not exhaustive. Additional information can be obtained from the minor advisor, Professor Tanalís Padilla (tanalis@mit.edu), 617-254-7544, or from the SHASS academic administrator, Andrea Wirth (awirth@mit.edu), 4-240, 617-253-4441.
**MINOR IN POLYMERS AND SOFT MATTER**

Polymers and soft materials are critical components of existing and next-generation technologies. The Minor in Polymers and Soft Matter (MPSM) is designed to equip students with the basic knowledge of polymer science and engineering required to solve problems in this diverse and essential field. Students pursuing the Minor complete four foundational subjects focusing on organic chemistry, polymer physics, and polymer engineering; a half-subject (6 units) on the basics of ethical guidelines for research; and one elective subject or approved UROP experience. Only one subject taken for the Minor in Polymers and Soft Matter can also count toward a student’s major or other minor.

### Required Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.016</td>
<td>Computational Methods for Materials Scientists and Engineers</td>
<td>12</td>
</tr>
<tr>
<td>or 18.03</td>
<td>Differential Equations</td>
<td></td>
</tr>
</tbody>
</table>

### Total Units

63-72

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**MINOR IN POLYMERS AND SOFT MATTER**

Polymers and soft materials are critical components of existing and next-generation technologies. The Minor in Polymers and Soft Matter (MPSM) is designed to equip students with the basic knowledge of polymer science and engineering required to solve problems in this diverse and essential field. Students pursuing the Minor complete four foundational subjects focusing on organic chemistry, polymer physics, and polymer engineering; a half-subject (6 units) on the basics of ethical guidelines for research; and one elective subject or approved UROP experience. Only one subject taken for the Minor in Polymers and Soft Matter can also count toward a student’s major or other minor.

### Required Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>3.063</td>
<td>Polymer Physics</td>
<td>12</td>
</tr>
<tr>
<td>5.12</td>
<td>Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>10.01</td>
<td>Ethics for Engineers</td>
<td>6</td>
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Select one of the following:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.001</td>
<td>Mechanics and Materials I</td>
<td>12-15</td>
</tr>
<tr>
<td>3.012</td>
<td>Fundamentals of Materials Science and Engineering</td>
<td></td>
</tr>
<tr>
<td>5.60</td>
<td>Thermodynamics and Kinetics</td>
<td></td>
</tr>
<tr>
<td>10.10</td>
<td>Introduction to Chemical Engineering</td>
<td></td>
</tr>
<tr>
<td>20.110[J]</td>
<td>Thermodynamics of Biomolecular Systems</td>
<td></td>
</tr>
</tbody>
</table>

### Electives

Select one of the following:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.001</td>
<td>Mechanics and Materials I</td>
<td>1</td>
</tr>
<tr>
<td>2.627</td>
<td>Fundamentals of Photovoltaics</td>
<td></td>
</tr>
<tr>
<td>3.012</td>
<td>Fundamentals of Materials Science and Engineering</td>
<td></td>
</tr>
<tr>
<td>3.032</td>
<td>Mechanical Behavior of Materials</td>
<td></td>
</tr>
<tr>
<td>3.034</td>
<td>Organic and Biomaterials Chemistry</td>
<td></td>
</tr>
<tr>
<td>3.055[J]</td>
<td>Biomaterials Science and Engineering</td>
<td></td>
</tr>
<tr>
<td>5.07[J]</td>
<td>Biological Chemistry I</td>
<td></td>
</tr>
<tr>
<td>5.13</td>
<td>Organic Chemistry II</td>
<td></td>
</tr>
<tr>
<td>5.43</td>
<td>Advanced Organic Chemistry</td>
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</tr>
<tr>
<td>5.60</td>
<td>Thermodynamics and Kinetics</td>
<td></td>
</tr>
<tr>
<td>10.00</td>
<td>Molecule Builders</td>
<td></td>
</tr>
<tr>
<td>10.10</td>
<td>Introduction to Chemical Engineering</td>
<td></td>
</tr>
<tr>
<td>10.443</td>
<td>Future Medicine: Drug Delivery, Therapeutics, and Diagnostics</td>
<td></td>
</tr>
<tr>
<td>20.110[J]</td>
<td>Thermodynamics of Biomolecular Systems</td>
<td></td>
</tr>
</tbody>
</table>

### Total Units

63-72

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1. These subjects can count as part of the required subjects or as restricted electives, but not both. Students majoring in Course 2, 2-A, or 2-OE may not count 2.001 toward the minor. Students majoring in Course 3, 3-A, or 3-C may not count 3.012 toward the minor. Students majoring in Course 5 may not count 5.60 toward the minor. Students majoring in Course 10, 10-B, 10-C, or 10-ENG may not count 10.10 toward the minor. Students majoring in Course 20 may not count 20.110[J] toward the minor.

2. Students must select an elective subject that is outside of the major field of study as approved by their minor advisor. As a general guideline, the elective should be from outside of the student’s major department.

3. Students may substitute a one-semester UROP (12 units) in an area of research relevant to polymers and soft matter science or engineering. UROP must be approved by minor advisor.

Further information on the minor can be obtained from Professor Jeremiah A. Johnson (jaj2109@mit.edu), Room 18-296, 617-253-1819.
MINOR IN PUBLIC POLICY

Some of the most far-reaching decisions about science, technology, and enterprise are made in the public policy arena. The interdisciplinary minor in Public Policy enables students from across the Institute to develop their understanding of public problems and how governments attempt to address them, with emphasis on the process and outcomes of policymaking.

Students benefit from increased engagement with and understanding of emerging real-world issues that affect society’s greatest challenges, including energy, globalization, health care, conflict resolution, science and technology policy, and public-private collaboration.

The six-subject minor is a three-tiered program. The first tier provides foundational knowledge of public and private institutions where public policy decisions are made and implemented, as well as an introduction to the rationales for government action and the policymaking process. The second tier explores qualitative and quantitative methods of analyzing and assessing the impacts of policy change. In the third tier, students choose an in-depth, three-subject program of study in a substantive field of policymaking. All minors specialize in an area of public policy, such as science and technology policy, and take three subjects within that specialty. Students may also do an internship (17.901) to fulfill one part of the three-subject requirement.

Students majoring in Planning (Course 11) are not permitted to minor in Public Policy. Political Science (Course 17) majors can minor in Public Policy, but subjects being used to fulfill their major cannot be used toward the minor.

Tier I: Introduction to Markets, Politics, and Public Policy

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01</td>
<td>Principles of Microeconomics</td>
<td>12</td>
</tr>
</tbody>
</table>

Tier II: Policy Analysis

<table>
<thead>
<tr>
<th>Subject</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.003[J]</td>
<td>Methods of Policy Analysis</td>
<td>12</td>
</tr>
<tr>
<td>or 14.03</td>
<td>Microeconomic Theory and Public Policy</td>
<td></td>
</tr>
</tbody>
</table>

Tier III: Policy Concentration

Select three subjects in one of the following tracks: 1

- Social and Educational Policy
- Environmental Policy
- Infrastructure Policy
- Science and Technology Policy
- Labor and Industrial Policy
- International Development Policy
- Security and Defense Policy

Total Units: 72

1 Students may propose their own track for approval by their minor advisor; students may also register for the subject 17.901 Political Science Internship and Research and do an internship in their chosen field for one subject, with the approval of their minor advisor. See the minor’s website (http://web.mit.edu/polisci/undergraduate/minor/pp.html) for a list of approved public policy subjects by track.

Students can obtain additional information from the minor’s website (http://web.mit.edu/polisci/undergraduate/minor/pp.html); Ellen Rushman (erushman@mit.edu), undergraduate administrator in Urban Studies and Planning, Room 9-413, 617-253-9403; or Tobie Weiner (iguanatw@mit.edu), undergraduate administrator in Political Science, Room E53-483, 617-253-3649.

MINOR IN RUSSIAN AND EURASIAN STUDIES

The Minor in Russian and Eurasian Studies is intended for students seeking an interdisciplinary program of study centered on Russia and Eurasia. The program is regional in spirit, meaning that students can take subjects about a wide range of countries of Eastern/Central Europe, the Slavic states, and Central Asia.

The minor consists of six subjects (at least three of which must be MIT subjects or subjects taken at Harvard University or Wellesley College through cross-registration), arranged in four areas of study:

- Area I: Language
- Area II: Humanities and the Arts
- Area III: Social Sciences
- Area IV: Historical Studies

Students must receive permission from the minor advisor prior to registering for a class at another institution.

Five of the six subjects taken for the minor may be counted toward the eight-subject HASS Requirement. Of these five, at most one may count toward the distribution component of the HASS Requirement. Of the six subjects required for the minor, at least four cannot be counted toward a major or another minor.

Area I: Language 1

Select from among the following: 24

- 21G.613 Russian III (Regular)
- 21G.614 Russian IV (Regular)

Select four subjects from at least two of the following areas: 1

Area II: Humanities and the Arts

- 21G.077[J] Introduction to the Classics of Russian Literature 3

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MINOR IN STATISTICS AND DATA SCIENCE

Statistics, the science of making inferences and decisions under uncertainty, is becoming increasingly relevant in the modern world due to the widespread availability of and access to unprecedented amounts of data and computational resources. Unlike classical statistics, the need to process and manage massive amounts of data has become a key feature of modern statistics. This aspect of managing and processing data is popularly referred to as “data science.”

Through six required subjects, the Minor in Statistics and Data Science provides students with a working knowledge base in statistics, probability, and computation, along with an ability to perform data analysis.

Foundation
Select one of the following: 6–12

| 2.087 | Engineering Mathematics: Linear Algebra and ODEs |
| 6.00  | Introduction to Computer Science and Programming |
| 6.01  | Introduction to EECS via Robotics |
| 18.03 | Differential Equations |
| 18.06 | Linear Algebra |

Statistics 1
Select one of the following: 12

| 1.010 | Introduction to Probability and Statistics in Engineering |
| 6.041A & 6.041B | Introduction to Probability I and Introduction to Probability II |
| 9.07  | Statistics for Brain and Cognitive Science |
| 14.30 | Introduction to Statistical Methods in Economics |
| 15.0791 | Introduction to Applied Probability |
| 16.09 | Statistics and Probability |
| 18.600 | Probability and Random Variables |

Statistics 2
Select one of the following: 12

| 14.32 | Econometric Data Science |
| 15.075[J] | Statistical Thinking and Data Analysis |

Computation & Data Analysis
Select two of the following: 24

| 1.00 | Engineering Computation and Data Science |
| 2.086 | Numerical Computation for Mechanical Engineers |
| 6.008 | Introduction to Inference |
| 6.036 | Introduction to Machine Learning |
| 6.802[J] | Foundations of Computational and Systems Biology |
| 6.819 | Advances in Computer Vision |
| 14.36 | Advanced Econometrics |
| 15.053 | Optimization Methods in Business Analytics |
| 16.90 | Computational Modeling and Data Analysis in Aerospace Engineering |
| 18.642 | Topics in Mathematics with Applications in Finance |

MINOR IN STATISTICS AND DATA SCIENCE

or 21G.618 Introduction to the Classics of Russian Literature - Russian Language Option

Appropriate subjects offered at Harvard or Wellesley

Area III: Social Sciences
Select from among the following:

17.569 | Russia’s Foreign Policy: Toward the Post-Soviet States and Beyond |
21H.245[J] | Soviet and Post-Soviet Politics and Society: 1917 to the Present |

Appropriate subjects offered at Harvard or Wellesley

Area IV: Historical Studies
Select from among the following:

21H.244[J] | Imperial and Revolutionary Russia: Culture and Politics, 1700-1917 |

Appropriate subjects offered at Harvard or Wellesley

Total Units: 72

2 Two intermediate (Levels III and IV) subjects in the Russian language are required to satisfy Area I. Students with the equivalent proficiency, but who are not native speakers, can either take two advanced language subjects beyond Level IV (highly recommended) or two additional subjects from Areas II, III, or IV. Native speakers may substitute other subjects, with the permission of the minor advisor.

2 Students who are not required to take Area I subjects must take all six subjects for the minor from Areas II, III, and IV, with at least one subject from each area.

3 Students may choose either subject but it is preferred that they take 21G.618 Introduction to the Classics of Russian Literature - Russian Language Option.

The subject list above is not exhaustive. Additional information can be obtained from the minor advisor, Professor Elizabeth Wood (elizwood@mit.edu), Room E51-282, 617-253-3255, or from the SHASS academic administrator, Andrea Wirth (awirth@mit.edu), 4-240, 617-253-4441.
MINOR IN WOMEN’S AND GENDER STUDIES

The interdisciplinary Women's and Gender Studies Minor offers students an academic framework for the study of women, gender, and sexuality using the analytical tools and methodologies of a variety of disciplines in the humanities, arts, and social sciences. The minor program consists of six Women's and Gender Studies subjects, arranged into three levels of study as follows:

**Tier I**
- WGS.101 Introduction to Women's and Gender Studies 12

**Tier II**
Select four subjects, including at least one from each category below: ²

**Humanities (HASS-H) and Arts (HASS-S) subjects** ²
- WGS.109 Women and Global Activism in Media and Politics
- WGS.110[J] Sexual and Gender Identities
- WGS.111[J] Gender and Media Studies
- WGS.115 Gender and Technology
- WGS.140[J] Race and Identity in American Literature
- WGS.141[J] International Women's Voices
- WGS.142 Narrative and Identity: Writing and Film by Contemporary Women of Color
- WGS.145[J] Globalization: The Good, the Bad and the In-Between
- WGS.154[J] Gender and Japanese Popular Culture
- WGS.161[J] Gender and the Law in US History
- WGS.181 Queer Cinema and Visual Culture
- WGS.190[J] Black Matters: Introduction to Black Studies

**Social Science (HASS-S) subjects**
- WGS.125[J] Games and Culture
- WGS.151 Gender, Health, and Society
- WGS.155[J] Global Sexualities
- WGS.172[J] For Love and Money: Rethinking the Family
- WGS.221 Women in the Developing World
- WGS.222[J] Women and War
- WGS.224 Race, Gender and Social Inequality: Reproductive Health Care in the United States
- WGS.225[J] The Science of Race, Sex, and Gender
- WGS.228 Psychology of Sex and Gender
- WGS.229 Race, Culture, and Gender in the US and Beyond: A Psychological Perspective
- WGS.270[J] Violence, Human Rights, and Justice
- WGS.271[J] Dilemmas in Biomedical Ethics: Playing God or Doing Good?
- WGS.274[J] Images of Asian Women: Dragon Ladies and Lotus Blossoms
- WGS.275[J] Gender in Science, Technology, and Environment
- WGS.276[J] Cultures of Computing

**Tier III**
- WGS.301[J] Feminist Thought ³

Total Units 72

³ One of the Tier II subjects may be taken at Harvard or Wellesley with the permission of the director.

Consult minor advisor about potential substitutions.

Subject has prerequisites that are outside of the program.

A minimum of four subjects taken for the Statistics and Data Science Minor cannot also count toward a major or another minor.

See the Statistics and Data Science Minor webpage (http://idss.mit.edu/academics) for additional information. Inquiries about the undergraduate program may be directed to the IDSS Academic Office (idss_academic_office@mit.edu).

Capstone Subject
IDS.012[J] Statistics, Computation and Applications 12

One of the Tier II subjects may be taken at Harvard or Wellesley with the permission of the director.
MINOR IN WOMEN’S AND GENDER STUDIES

Subjects 21L.430, 21L.460, 21L.512, 21L.701, 21L.702, 21L.704, 21L.705, 21L.707, 21L.715, and 21W.745 may be taken for credit as a Women’s and Gender Studies subject when their content meets WGS criteria. For more information, consult the program office (wgs@mit.edu).

With the permission of the director, an advanced Women’s and Gender Studies subject may be substituted for WGS.301[J].

For more information, contact the program manager, Emily Neill (wgs@mit.edu), Women’s and Gender Studies, Room 14E-316, 617-253-2642, or visit the WGS website (https://wgs.mit.edu).
GRADUATE PROGRAMS

At MIT, students and faculty from different fields work together in a variety of collaborative programs that extend beyond departmental or school boundaries. The programs listed in this section offer a number of interdisciplinary graduate degrees.

- Computation for Design and Optimization (p. 368)
- Computational and Systems Biology (p. 368)
- Computational Science and Engineering (p. 370)
- Computer Science and Molecular Biology (p. 370)
- Harvard-MIT Health Sciences and Technology (p. 372)
- Integrated Design and Management (p. 371)
- Joint Program with Woods Hole Oceanographic Institution (p. 372)
- Leaders for Global Operations (p. 373)
- Microbiology (p. 374)
- Operations Research (p. 375)
- Polymers and Soft Matter (p. 376)
- Social and Engineering Systems (p. 376)
- Statistics (p. 376)
- Supply Chain Management (p. 376)
- System Design and Management (p. 371)
- Technology and Policy (p. 377)
- Transportation (p. 377)

Interdisciplinary Graduate Degrees

**Computation for Design and Optimization**
Degree | Program
---|---
SM | Computation for Design and Optimization

**Computational and Systems Biology (CSB)**
Degree | Program
---|---
PhD | Computational and Systems Biology

**Computational Science and Engineering**
Degree | Program
---|---
PhD, ScD | Computational Science and Engineering

**Computer Science and Molecular Biology (Course 6-7)**
Degree | Program
---|---
MEng | Computer Science and Molecular Biology

**Design and Management (Integrated Design and Management & System Design and Management)**
Degree | Program
---|---
SM | Engineering and Management

**Health Sciences and Technology (HST)**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>Health Sciences and Technology</td>
</tr>
<tr>
<td>MD</td>
<td>Medical Sciences (degree from Harvard Medical School)</td>
</tr>
<tr>
<td>ScD, PhD</td>
<td>Health Sciences and Technology</td>
</tr>
<tr>
<td>ScD, PhD</td>
<td>Health Sciences and Technology—Bioastronautics</td>
</tr>
<tr>
<td>ScD, PhD</td>
<td>Health Sciences and Technology—Bioinformatics and Integrative Genomics</td>
</tr>
<tr>
<td>ScD, PhD</td>
<td>Health Sciences and Technology—Medical Engineering and Medical Physics</td>
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**Oceanography and Applied Ocean Science and Engineering**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Program</th>
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</table>
| SM | Oceanographic Engineering
| ScD, PhD | Applied Ocean Science and Engineering |
| ScD, PhD | Biological Oceanography |
| ScD, PhD | Chemical Oceanography |
| ScD, PhD | Marine Geology and Geophysics |
| ScD, PhD | Physical Oceanography |

**Leaders for Global Operations**

<table>
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<th>Degree</th>
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</table>
| SM/MBA | Engineering/Management

**Microbiology**

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<tr>
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</table>
| PhD | Microbiology

**Operations Research**

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<th>Program</th>
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</thead>
</table>
| SM | Operations Research
| PhD | Operations Research

**Polymers and Soft Matter**

<table>
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<tr>
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<th>Program</th>
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</table>
| PhD, ScD | Polymers and Soft Matter

**Statistics**

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<td>PhD</td>
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<td>PhD</td>
<td>Mathematics and Statistics</td>
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<tr>
<td>PhD</td>
<td>Political Science and Statistics</td>
</tr>
<tr>
<td>PhD</td>
<td>Social and Engineering Systems and Statistics</td>
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**Supply Chain Management**

<table>
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<th>Degree</th>
<th>Program</th>
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| MASc | Supply Chain Management
COMPUTATION FOR DESIGN AND OPTIMIZATION

MEng Supply Chain Management

Technology and Policy

<table>
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<td>SM</td>
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Transportation

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<td>Transportation</td>
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<tr>
<td>PhD, ScD</td>
<td>Transportation</td>
</tr>
</tbody>
</table>

1 See Interdisciplinary Programs (p. 337).

2 With the exception of engineering, the SM is only available as an interim degree for doctoral candidates or for those who leave the program before the completion of the doctoral degree.

COMPUTATION FOR DESIGN AND OPTIMIZATION

Computation for Design and Optimization (CDO) is an interdisciplinary master’s degree program that provides students with a strong foundation in computational methods for the study, design, and operation of complex engineered and scientific systems. The CDO program is administered by the Center for Computational Engineering (p. 90).

The CDO SM program educates students in the formulation, analysis, implementation, and application of computational approaches in science and engineering. The curriculum’s common core serves all science and engineering disciplines, while an elective component focuses on particular applications. The program emphasizes:

- Breadth through introductory courses in numerical analysis and simulation, and optimization
- Depth in optimization methods and numerical methods for partial differential equations
- Multidisciplinary aspects of computation
- Hands-on experience through projects, assignments, and a master’s thesis

Participating faculty come from the Schools of Engineering, Science, and Management, including the Departments of Aeronautics and Astronautics, Biological Engineering, Chemical Engineering, Civil and Environmental Engineering, Electrical Engineering and Computer Science, Mathematics, Mechanical Engineering, and Nuclear Science and Engineering.

The research interests of CDO faculty cover a great variety of computationally intensive areas in engineering, science, and mathematics. Recent research has included such far-ranging topics as micromachined devices, guidance/control systems, imaging systems, distribution networks, telecommunications systems, and transportation systems. CDO faculty research encompasses applications in areas such as aircraft design, materials design, manufacturing operations scheduling, and applied optimization in operations and industrial engineering.

Inquiries

For more information about the CDO program, contact Kate Nelson (cdo_info@mit.edu), Room 35-434, 617-253-3725; or visit the website (http://computationalengineering.mit.edu/education).

COMPUTATIONAL AND SYSTEMS BIOLOGY

The field of computational and systems biology represents a synthesis of ideas and approaches from the life sciences, physical sciences, computer science, and engineering. Recent advances in biology, including the human genome project and massively parallel approaches to probing biological samples, have created new opportunities to understand biological problems from a systems perspective. Systems modeling and design are well established in engineering disciplines but are newer in biology. Advances in computational and systems biology require multidisciplinary teams with skill in applying principles and tools from engineering and computer science to solve problems in biology and medicine. To provide education in this emerging field, the Computational and Systems Biology (CSB) program integrates MIT’s world-renowned disciplines in biology, engineering, mathematics, and computer science. Graduates of the program are uniquely prepared to make novel discoveries, develop new methods, and establish new paradigms. They are also well-positioned to assume critical leadership roles in both academia and industry, where this field is becoming increasingly important.

Computational and systems biology, as practiced at MIT, is organized around “the 3 Ds” of description, distillation, and design. In many research programs, systematic data collection is used to create detailed molecular- or cellular-level descriptions of a system in one or more defined states. Given the complexity of biological systems and the number of interacting components and parameters, system modeling is often conducted with the aim of distilling the essential or most important subsystems, components, and parameters, and of obtaining simplified models that retain the ability to accurately predict system behavior under a wide range of conditions. Distillation of the system can increase the interpretability of the models in relation to evolutionary and engineering principles such as robustness, modularity, and evolvability. The resulting models may also serve to facilitate rational design of perturbations to test understanding of the system or to change system behavior (e.g., for therapeutic intervention), as well as efforts to design related systems or systems composed of similar biological components.

More than 70 faculty members at the Institute participate in MIT’s Computational and Systems Biology Initiative (CSBI). These investigators span nearly all departments in the School of Science and the School of Engineering, providing CSB students...
the opportunity to pursue thesis research in a wide variety of different MIT laboratories. It is also possible for students to arrange collaborative thesis projects with joint supervision by faculty members with different areas of expertise. Areas of active research include behavioral genetics and genomics; bioengineering and neuroengineering; biological networks and machine learning; cancer systems biology; cellular biophysics; chemical biology and metabolomics; epigenomics; evolutionary and computational biology; microbiology and systems ecology; molecular biophysics and structural biology; precision medicine and medical genomics; quantitative imaging; regulatory genomics and proteomics; single cell manipulations and measurement; stem cell and developmental systems biology; and synthetic biology and biological design.

The CSB PhD program is an Institute-wide program that has been jointly developed by the Departments of Biology, Biological Engineering, and Electrical Engineering and Computer Science. The program integrates biology, engineering, and computation to address complex problems in biological systems, and CSB PhD students have the opportunity to work with CSBi faculty from across the Institute. The curriculum has a strong emphasis on foundational material to encourage students to become creators of future tools and technologies, rather than merely practitioners of current approaches. Applicants must have an undergraduate degree in biology (or a related field), bioinformatics, chemistry, computer science, mathematics, statistics, physics, or an engineering discipline, with dual-emphasis degrees encouraged.

All students pursue a core curriculum that includes classes in biology and computational biology, along with a class in computational and systems biology based on the scientific literature. Advanced electives in science and engineering enhance both the breadth and depth of each student’s education. During their first year, in addition to coursework, students carry out rotations in multiple research groups to gain a broader exposure to work at the frontier of this field, and to identify a suitable laboratory in which to conduct thesis research. CSB students also serve as teaching assistants during one semester in the second year to further develop their teaching and communication skills and facilitate their interactions across disciplines. Students also participate in training in the responsible conduct of research to expose them to a range of research activities in computation and systems biology, and to assist them in choosing a lab. Students are encouraged to gain experience in experimental and computational approaches taken across different disciplines at MIT.

Curriculum

The CSB curriculum has two components. The first is a core that provides foundational knowledge of both biology and computational biology. The second is a customized program of electives that is selected by each student in consultation with members of the CSB graduate committee. The goal is to allow students broad latitude in defining their individual area of interest, while at the same time providing oversight and guidance to ensure that training is rigorous and thorough.

Core Curriculum

The core curriculum consists of three classroom subjects plus a set of three research rotations in different research groups. The classroom subjects fall into three areas described below.

<table>
<thead>
<tr>
<th>Modern Biology</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational Biology</td>
<td>12</td>
</tr>
<tr>
<td>Computational and Systems Biology</td>
<td>12</td>
</tr>
</tbody>
</table>

Research Group Rotations

Students participate in three research rotations of one to two months’ duration during their first year to expose them to a range of research activities in computation and systems biology, and to assist them in choosing a lab. Students are encouraged to gain experience in experimental and computational approaches taken across different disciplines at MIT.

Advanced Electives

To develop breadth and depth, add to the base of the diversified core, and contribute strength in areas related to their interest and research direction, students must take four advanced electives. Each student designs a program of advanced electives that satisfies the distribution and area requirements in close consultation with members of the graduate committee.

| Two subjects in the student’s research area or department |
|----------------|----|
| One subject in engineering |
| One subject in science |

Additional Subjects

CSB PhD students may take classes beyond the required diversified core and advanced electives described above. These additional subjects can be used to add breadth or depth to the proposed curriculum, and might be useful to explore advanced topics relevant to the student’s thesis research in later years. The CSB Graduate Committee works with each graduate student to develop a path through the curriculum appropriate for his or her background and research interests.
COMPUTATIONAL SCIENCE AND ENGINEERING

Training in the Responsible Conduct of Research
Throughout the program, students will be expected to attend workshops and other activities that provide training in the ethical conduct of research. This is particularly important in interdisciplinary fields such as computational and systems biology, where different disciplines often have very different philosophies and conventions. By the end of the fourth year, students will have had about 16 hours of training in the responsible conduct of research.

Qualifying Exams
In addition to coursework and a research thesis, each student must pass a written and an oral qualifying examination at the end of the second year or the beginning of the third year. The written examination involves preparing a research proposal based on the student’s thesis research, and presenting the proposal to the examination committee. This process provides a strong foundation for the thesis research, incorporating new research ideas and refinement of the scope of the research project. The oral examination is based on the coursework taken and on related published literature. The qualifying exams are designed to develop and demonstrate depth in a selected area (the area of the thesis research) as well as breadth of knowledge across the field of computational and systems biology.

Thesis Research
Research will be performed under the supervision of a CSBI faculty member, culminating in the submission of a written thesis and its oral defense before the community and thesis defense committee. By the second year, a student will have formed a thesis advisory committee that they will meet with on an annual basis.

COMPUTATIONAL SCIENCE AND ENGINEERING
Computational Science and Engineering (CSE) (https://computationalengineering.mit.edu/cse) allows students to specialize at the doctoral level in a computation-related field of their choice via focused coursework and a doctoral thesis through a number of participating host departments, including Aeronautics and Astronautics, Chemical Engineering, Civil and Environmental Engineering, Mechanical Engineering, Mathematics, and Nuclear Science and Engineering. The emphasis of thesis research activities is the development of new computational methods and/or the innovative application of computational techniques to important problems in engineering and science.

The CSE program is administered jointly by the Center for Computational Engineering (CCE) and the host departments. Students must submit an online application (https://gradapply.mit.edu/cse/apply/login/?next=/cse) to the CSE PhD program, indicating the department they wish to be hosted in. To gain admission, CSE program applicants must receive approval from both the host department graduate admission committee and the CCE graduate admission committee. See the website (http://computationalengineering.mit.edu/cseadmission) for more information about the application process, requirements, and relevant deadlines.

Once admitted, doctoral degree candidates are expected to complete the host department’s degree requirements (including qualifying exam) with CSE deviations relating to coursework, thesis committee composition and thesis submission that are specific to the CSE program and are discussed in more detail on the CSE website (http://computationalengineering.mit.edu/education/cse-overview).

Inquiries
For more information about the CSE program, contact Kate Nelson (cse_info@mit.edu), Room 35-434, 617-253-3725, or visit the program website (https://computationalengineering.mit.edu/cse).

COMPUTER SCIENCE AND MOLECULAR BIOLOGY

Master of Engineering in Computer Science and Molecular Biology (Course 6-7P)
The Department of Biology (p. 301) and the Department of Electrical Engineering and Computer Science (EECS) (p. 188) offer a joint curriculum that focuses on the emerging field of computational and molecular biology. The curriculum provides strong foundations in both biology and computer science and features innovative, integrative, capstone, and elective subjects. The goal is to produce an entirely new cadre of graduates who are uniquely qualified to address the challenges and opportunities at the interface of computational and molecular biology. Students in the program are full members of both departments and of two schools, Science and Engineering, with one academic advisor from each department.

The Master of Engineering in Computer Science and Molecular Biology (p. 489) program builds on the Bachelor of Science in Computer Science and Molecular Biology program (Course 6-7) (p. 482), which prepares students for careers that leverage computational biology (e.g., pharmaceuticals, bioinformatics, medicine, etc.) as well as further graduate study in biology, in computer science, and in emerging programs at the interface of these fields. The master’s program provides additional depth in computational and/or molecular biology through coursework and a substantial thesis. The student selects (with departmental review and approval) 42 units of advanced graduate subjects, which include two concentration subjects in biology and/or computational biology plus a third subject in electrical engineering and computer science and/or biology. A further 24 units of electives are chosen from a restricted departmental list of math electives.
The Master of Engineering degree also requires 24 units of thesis credit. While a student may register for more than this number of thesis units, only 24 units count toward the degree requirement.

Recipients of a Master of Engineering degree normally receive a Bachelor of Science degree simultaneously. No thesis is explicitly required for the Bachelor of Science degree. However, every program must include a major project experience at an advanced level, culminating in written and oral reports. Normally, the thesis for the Master of Engineering degree will provide this experience for students receiving both degrees simultaneously.

Programs leading to the five-year Master of Engineering degree or to the four-year Bachelor of Science degree can be arranged to be identical through the junior year. At the end of the junior year, students with a strong academic record will be offered the opportunity to continue through the five-year master's program. A student in the Master of Engineering program must be registered as a graduate student for at least one regular (non-summer) term. To remain in the program and to receive the Master of Engineering degree, students will be expected to maintain a strong academic record. Admission to the Master of Engineering program is open only to undergraduate students who have completed their junior year in the Course 6-7 Bachelor of Science program.

Financial Support

The fifth year of study toward the Master of Engineering degree can be supported by a combination of personal funds, an award such as a National Science Foundation Fellowship, a fellowship, or a graduate assistantship. Assistantships require participation in research or teaching in the department or in one of the associated laboratories. Full-time assistants may register for no more than two scheduled classroom or laboratory subjects during the term, but may receive academic credit for their participation in the teaching or research program. Support through an assistantship may extend the period required to complete the Master of Engineering program by an additional term or two. Support is granted competitively to graduate students and will not be available for all of those admitted to the Master of Engineering program. If provided, department support for Master of Engineering candidates is normally limited to the first three terms as a graduate student, unless the Master of Engineering thesis has been completed or the student has served as a teaching assistant or has been admitted to the doctoral program, in which cases a fourth term of support may be permitted.

Inquiries

Information about these programs is available from the EECS Undergraduate Office (http://www.eecs.mit.edu), Room 38-476, 617-253-4654, and the Biology Undergraduate Office (https://biology.mit.edu), Room 68-120, 617-253-4718.

DESIGN AND MANAGEMENT

Integrated Design and Management

The Integrated Design and Management (IDM) (https://idm.mit.edu) program, leading to a master's degree in engineering and management, is dedicated to enabling the learning and development of extraordinary, innovative leaders who will bring new levels of creativity, vision, and integrity to business and society. The curriculum combines the inspired, intuitive methods taught in the world's best design schools with the systematic, analytical methods of the world's best engineering and business schools.

To achieve balance, the backgrounds of IDM's student body and faculty are composed of equal parts engineering, business, and design. Through exposure and interaction of these different backgrounds, students learn to appreciate and integrate the value of the other disciplines in their activities. This balanced, integrated approach has been demonstrated time and again to produce new business paradigms, great products, and the creative courage to solve complex, hard-to-define problems.

IDM's core curriculum is taught in the Integrated Design Lab (ID Lab), a design studio environment, where interdisciplinary teams have dedicated team space to practice the human-centered design process, complete with state-of-the-art tools ranging from 3D printers to robotic arms. In this action-based environment, empathy is generated, trial and error is encouraged, failure is celebrated, and the potential for success is realized.

IDM is a track within the System Design and Management Program.

System Design and Management

MIT's System Design and Management (SDM) (http://sdm.mit.edu) program, offered jointly by the MIT Sloan School of Management and School of Engineering, is a master's program for experienced engineers and product development professionals who seek to build upon their technical background and advance to positions of leadership in their careers. Program applicants have significant engineering and/or managerial experience, in addition to a scientific or engineering education. On average, SDM student-fellows have about 10 years of work experience. Program participants come from both private and government institutions, either as company-sponsored or self-sponsored students. Most SDM students have advanced degrees in other fields, and over half come from countries other than the United States.

The SDM program leads to a Master of Science in Engineering and Management. The program focuses on developing competencies in the areas of systems thinking, management skills, leadership, and an end-to-end understanding of systems development.
Students take subjects drawn from three areas: systems (systems engineering, architecture, and optimization), management, and a technical area of the student’s choosing. Application deadlines are in mid-January, and mid-March. Applicants receive a decision within four to six weeks after the deadline by which the complete application was received. For additional information, contact the SDM Program Office (sdm@mit.edu), Room E40-315, 617-452-2432.

**System Design and Management Program**
SDM offers a full-time on-campus option for resident degree students, and a commuter and distance learning instruction option for technical professionals who are continuing in their positions at remote locations while enrolled in the program. The subject requirements are the same for all options, and all programs begin on campus in late August, two weeks before the start of the fall term.

**Full-time Residential Option**
The full-time program requires 12 months in residence at MIT.

**Commuter and Distance Learning Options**
The commuter and distance learning program options require 21 months to complete. Students in both options take three semesters of core classes (offered at a distance, for those in that option) in the first year, and must attend two one-week seminars held on campus in IAP (January) and at the end of the spring term. Distance learning students also must spend one semester in residence at MIT in their second year, taking the required foundation and elective units.

**HARVARD-MIT HEALTH SCIENCES AND TECHNOLOGY PROGRAM**
The Harvard-MIT Health Sciences and Technology (HST) Program’s unique interdisciplinary educational program brings engineering as well as the physical and biological sciences from the scientist’s bench to the patient’s bedside. Conversely, it brings clinical insight from the patient’s bedside to the laboratory bench. In this way, HST students are trained to have deep understanding of engineering, physical sciences, and the biological sciences, complemented with hands-on experience in the clinic or in industry; and they become conversant with the underlying quantitative and molecular aspects of medicine and biomedical science.

HST’s academic programs are described in the Harvard-MIT Health Sciences and Technology Program (p. 200) section.

**JOINT PROGRAM WITH WOODS HOLE OCEANOGRAPHIC INSTITUTION**
MIT and the Woods Hole Oceanographic Institution (WHOI) on Cape Cod offer joint doctoral degrees (http://mit.whoi.edu) in oceanography and doctoral, professional, and master’s degrees in oceanographic engineering.

Graduate study in oceanography encompasses virtually all of the basic sciences as they apply to the marine environment: physics, chemistry, geology, geophysics, and biology. Applied ocean science and engineering allows for concentration in the major engineering fields of aeronautics and astronautics, civil and environmental, mechanical, and electrical engineering and computer science.

The graduate programs administered by joint MIT-WHOI committees draw from the faculty and staff of both institutions. Students accepted to the Joint Program have access to the extensive intellectual and physical resources available for advanced study at both Woods Hole and MIT.

The Joint Program involves several departments at MIT—Biology, and Earth, Atmospheric, and Planetary Sciences in the School of Science; and Aeronautics and Astronautics, Civil and Environmental Engineering, Electrical Engineering and Computer Science, and Mechanical Engineering in the School of Engineering.

Financial aid, offered as research assistantships or fellowships to most entering graduate students, is sufficient to cover tuition and fees and provide a stipend. Upon admission, students register in the appropriate MIT department and at WHOI simultaneously, and are assigned academic advisors at each institution.

Research at WHOI is devoted to using the basic sciences and engineering to gain a better understanding of the marine environment. Some 200 scientists and engineers and a support staff of about 600 work in laboratories located in the village of Woods Hole and on the nearby Quisset Campus. Another 75 people operate three research vessels (ranging from 177 to 279 feet in length), the deep-diving submersible ALVIN, and smaller coastal vessels. WHOI also has remotely-operated research vehicles and autonomous underwater vehicles. Computer services provided within WHOI include links to other institutions and to national networks.

A videoconferencing system between MIT and Woods Hole provides interactive transmission for classes, meetings, and other joint events. Specialized research facilities include the National Ocean Sciences Accelerator Mass Spectrometry Facility and the North-East Regional Ion Microprobe Facility. The library facilities shared with the Marine Biological Laboratory are supplemented by collections of the Northeast Fisheries Center of the National Marine Fisheries Service and the US Geological Survey’s Office of Marine Resources Branch of Atlantic Geology, all located in Woods Hole. The village is situated on the southwest corner of Cape Cod, about 80 miles from Boston.

Subjects, seminars, and opportunities for research participation are offered at both MIT and WHOI. Place of residence is determined by the student’s selected program of study and research interests, and transportation is provided between institutions. Students have the opportunity to participate in oceanographic cruises during graduate study.
The faculty of MIT, together with the WHOI scientific staff, offer a wide variety of formal and informal subjects in various aspects of oceanography and areas directly applicable to ocean science and engineering; both faculties are equally involved in all levels of instruction. The subjects are supplemented by numerous seminars, directed studies, and cross-registration privileges with Harvard, Brown, and the Boston University Marine Program. Complete listings can be found in the subject descriptions of each individual department.

**Physical Oceanography**

Physical oceanography is the study of the physics of the ocean. Its central goal is to describe and explain the complex motions of the ocean. Principal research areas include general circulation, air-sea interaction, shelf dynamics, mesoscale processes, and small-scale processes. The Department of Earth, Atmospheric, and Planetary Sciences offers programs in physical oceanography with WHOI, which lead to the Doctor of Science or Doctor of Philosophy degree.

**Chemical Oceanography**

Chemical oceanographers study the chemical composition of the marine environment and the processes that have produced the present composition of sea water and sediments. Principal research areas include water column geochemistry, sedimentary geochemistry, seawater-basalt interactions, and atmospheric chemistry. The Departments of Earth, Atmospheric, and Planetary Sciences and Civil and Environmental Engineering offer programs with WHOI in chemical oceanography and marine geochemistry. These programs lead to the Doctor of Science or Doctor of Philosophy.

**Marine Geology and Geophysics**

The goal of Marine Geology and Geophysics is to understand the physical and chemical processes that determine the structure and evolution of the ocean basins and their margins. Research is being conducted in a wide range of specialties including micropaleontology, paleoceanography, petrology and volcanic processes, seismology, gravity, magnetics, heat flow, sediment dynamics, and isotope geology. The Department of Earth, Atmospheric, and Planetary Sciences at MIT offers programs with WHOI in marine geology and geophysics which lead to the Doctor of Science or Doctor of Philosophy.

**Biological Oceanography**

Biological oceanography seeks to describe and understand the biological processes which are active in the marine and bordering environments. The research of biological oceanographers is diverse, including ecology, toxicology, biochemistry, animal behavior and physiology, and molecular biology. The Department of Biology, and the Department of Earth, Atmospheric, and Planetary Sciences at MIT offers programs with WHOI in biological oceanography, and may involve research in other MIT departments such as the Department of Civil and Environmental Engineering. The programs lead to the Doctor of Science or Doctor of Philosophy.

**Applied Ocean Science and Engineering**

Applied ocean science and engineering involves the application of physics and the engineering sciences to the study of oceanic processes and the design of instruments, systems, and structures required to observe, measure, and work in the ocean. The Departments of Aeronautics and Astronautics, Civil and Environmental Engineering, Electrical Engineering and Computer Science, and Mechanical Engineering offer joint programs with WHOI in oceanographic engineering. The programs lead to the master’s degree, engineer’s degree, Doctor of Science, or Doctor of Philosophy.

**Inquiries**

Application for admission to the Joint Program in Oceanography and Applied Ocean Science and Engineering with the Woods Hole Oceanographic Institution (WHOI) should be made using the graduate application [https://gradapply.mit.edu/whoi](https://gradapply.mit.edu/whoi). Requests for further information may be addressed to the MIT-WHOI Joint Program, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, 508-289-2225, or to the MIT Joint Program Office, Room 54-820, 617-253-7544. More information is available on the website [http://mit.whoi.edu](http://mit.whoi.edu).

**LEADERS FOR GLOBAL OPERATIONS**

The Leaders for Global Operations (LGO) [http://lgo.mit.edu](http://lgo.mit.edu) program is an educational and research partnership among global operations companies, MIT’s School of Engineering, and the MIT Sloan School of Management. The 24-month program combines graduate education in engineering and management for those with previous postgraduate work experience. Students complete a six-month internship at one of LGO’s partner companies, where they conduct research that forms the basis of a dual-degree thesis. Graduates finish the program with two MIT degrees: an MBA (or SM in management) and an SM from one of seven engineering programs. Graduates take on leadership responsibilities at top global manufacturing and operations companies. LGO coordinates with the Aeronautics and Astronautics, Biological Engineering, Chemical Engineering, Civil and Environmental Engineering, Electrical Engineering and Computer Science, and Mechanical Engineering departments in the School of Engineering, and with the Operations Research Center in the Sloan School of Management.

Visit the LGO website [http://lgo.mit.edu](http://lgo.mit.edu) for more information on each engineering program’s curriculum.
MICROBIOLOGY GRADUATE PROGRAM

Doctoral Program in Microbial Science and Engineering

The Microbiology Graduate Program (http://microbiology.mit.edu)—an interdepartmental and interdisciplinary initiative at MIT—integrates educational resources across the participating departments to build connections among faculty with shared interests and to build an educational community for training students in the study of microbial systems.

The study of microbes has been critical in our current understanding of basic biological processes, evolution, and the functions of the biosphere, and has contributed to numerous fields of engineering. Microbes have the amazing ability to grow in extreme conditions, to grow slowly or rapidly, and to readily exchange DNA. They are essential for life as we know it, but can also be agents of disease. They are instrumental in shaping the environment, in evolution, and in modern biotechnology. Microbes are amenable to virtually all modern approaches in science and engineering. As such, they provide natural engineering laboratories for creating new capabilities for industry (e.g., pharmaceuticals, chemicals, energy) and are the foundation of pioneering efforts in synthetic biology, i.e., building life from its component parts. Effective study of microbes and their applications demands multiple interdisciplinary approaches that cross all scales of biological organization, from molecules to vast ecosystems.

Research in microbiology is going on throughout MIT and involves more than 50 faculty. These faculty are from several departments in both the Schools of Science and Engineering, including Biology; Biological Engineering; Chemical Engineering; Chemistry; Civil and Environmental Engineering; Earth, Atmospheric and Planetary Sciences; Electrical Engineering and Computer Science; Materials Sciences and Engineering; and Physics. Many labs take multiple approaches to studying and manipulating microbial systems and the expertise and research covers a wide range of areas, including biochemistry, biofuels, biotechnology, cell and molecular biology, chemical and biological engineering, computational biology, ecology, environmental biology, evolutionary biology, genetics, genomics, geobiology, immunology, pathogenesis, structural biology, synthetic biology, systems biology, and virology.

Interdisciplinary training in microbiology is in increasing demand in both public and private sectors. This program provides a broad exposure to underlying elements of modern microbiological research and engineering as well as in-depth research experience in specific areas of microbiology. Program graduates will be prepared to work in a range of fields in microbial science and engineering, and will have excellent career options in academia, industry, and government.

Curriculum

The major components of the training program are required coursework, elective coursework, rotations and thesis research, teaching, training in the ethical conduct of research, and qualifying exams.

Required Subjects

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.492[J]</td>
<td>Methods and Problems in Microbiology</td>
<td>12</td>
</tr>
<tr>
<td>7.493[J]</td>
<td>Microbial Genetics and Evolution</td>
<td>12</td>
</tr>
<tr>
<td>7.499</td>
<td>Research Rotations in Microbiology</td>
<td>12</td>
</tr>
<tr>
<td>7.57</td>
<td>Quantitative Biology for Graduate Students</td>
<td>12</td>
</tr>
<tr>
<td>7.51</td>
<td>Principles of Biochemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>or 7.80</td>
<td>Biological Chemistry II</td>
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</tr>
</tbody>
</table>

Elective Subjects

Students must take three elective subjects, totaling 36 units, from the following list. Electives can be chosen to provide depth in a specific area of interest or additional breadth in training. Subjects from some other areas may also fulfill the requirement, with the approval of the Graduate Education committee.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.89</td>
<td>Environmental Microbiology</td>
<td>12</td>
</tr>
<tr>
<td>5.062</td>
<td>Principles of Bioinorganic Chemistry</td>
<td>6</td>
</tr>
<tr>
<td>5.52</td>
<td>Advanced Biological Chemistry</td>
<td>12</td>
</tr>
<tr>
<td>5.64[J]</td>
<td>Frontiers of Interdisciplinary Science in Human Health and Disease</td>
<td>12</td>
</tr>
<tr>
<td>5.78</td>
<td>Biophysical Chemistry Techniques</td>
<td>6</td>
</tr>
<tr>
<td>6.874[J]</td>
<td>Computational Systems Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.26</td>
<td>Molecular Basis of Infectious Disease</td>
<td>12</td>
</tr>
<tr>
<td>or 7.66</td>
<td>Molecular Basis of Infectious Disease</td>
<td></td>
</tr>
<tr>
<td>7.58</td>
<td>Molecular Biology</td>
<td>12</td>
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<tr>
<td>7.62</td>
<td>Microbial Physiology</td>
<td>12</td>
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<tr>
<td>7.63[J]</td>
<td>Immunology</td>
<td>12</td>
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<tr>
<td>7.70</td>
<td>Regulation of Gene Expression</td>
<td>12</td>
</tr>
<tr>
<td>7.77</td>
<td>Nucleic Acids, Structure, Function, Evolution and Their Interactions with Proteins</td>
<td>12</td>
</tr>
<tr>
<td>8.591[J]</td>
<td>Systems Biology</td>
<td>12</td>
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<tr>
<td>or 7.81[J]</td>
<td>Systems Biology</td>
<td></td>
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<tr>
<td>10.542</td>
<td>Biochemical Engineering</td>
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<tr>
<td>10.544</td>
<td>Metabolic and Cell Engineering</td>
<td>12</td>
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<tr>
<td>10.546[J]</td>
<td>Statistical Thermodynamics</td>
<td>12</td>
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<tr>
<td>or 5.70[J]</td>
<td>Statistical Thermodynamics</td>
<td></td>
</tr>
<tr>
<td>20.106[J]</td>
<td>Systems Microbiology</td>
<td>12</td>
</tr>
<tr>
<td>20.440</td>
<td>Analysis of Biological Networks</td>
<td>15</td>
</tr>
</tbody>
</table>
Rotations and Thesis Research
During the first year, students will rotate through three labs of MIT faculty that participate in the Microbiology Graduate Program. These rotations will help provide students broad exposure to microbiology research and will be used to select a lab for their thesis research by the end of the first year. Given the interdisciplinary nature of the program and many research programs, students may be able to work jointly with more than one research supervisor.

Teaching Experience
Learning to effectively communicate scientific ideas is an important skill. Students in the Microbiology program will have an opportunity to improve their communication skills through teaching. Each student will serve as a teaching assistant for one term in an undergraduate or graduate subject related to microbiology. This will typically take place in the second year.

Training in the Ethical Conduct of Research
All students will participate in a course on the ethical conduct of research. This will typically take place during the first and third years.

Qualifying Exams
Students will proceed to PhD candidacy after successful completion of a qualifying exam, typically during the second year. Students will submit a written research proposal in the style of a grant or fellowship application based on their planned thesis project. Students will then present and discuss the research proposal with a small committee of faculty.

Student Advising
In the first year, students will be advised by members of the graduate committee. Once students join a thesis lab, the research mentor will be the primary advisor. Early in the second year, students will form a thesis committee and meet at least annually. The committee will consist of faculty with expertise in the student’s area of research and collectively provide the breadth expected by the program. The thesis committee will primarily provide advice on research. In addition, in the student’s early years the thesis committee will also provide advice on coursework to ensure that students have the appropriate breadth and depth for their educational program. In later years, the graduate and thesis committees will also provide students with advice on career options.

Financial Support and Fellowships
Students in the program will be financially supported throughout their training. This support includes tuition, stipend, and health insurance. All students in the program will receive a stipend that is sufficient to support living in the Cambridge/Boston area. The stipend will be approximately the same as for graduate students in other MIT departments.

During the first year, students are supported by the Microbiology program. In subsequent years, students will be supported as research assistants in their thesis lab.

Although students will be supported, they are strongly encouraged to apply for fellowships.

Inquiries
Email (microbiology@mit.edu) or for further information about the Microbiology (http://web.mit.edu/microbiology) Graduate Program (http://web.mit.edu/microbiology), Room 68-139.

OPERATIONS RESEARCH
Operations research (OR) is the discipline of applying advanced analytical methods to help make better decisions. It uses mathematical modeling, analysis, and optimization in a holistic approach to improving our knowledge of systems and designing useful, efficient systems. Its applications range from engineering to management, and from industry to the public sector.

Operations research has helped advance the mathematics of optimization, applied probability, and statistics. OR researchers, collaborating with colleagues in related fields, have created innovative methods for pricing goods and services, and for marketing them. They have contributed to improving transportation, developing new financial instruments and auctions, and analyzing biological and medical information, as well as many more areas. In today’s complex and interconnected world, the rigorous techniques and methodologies of operations research have become especially important aids to informed decision making.

The Operations Research Center (ORC) (p. 110) coordinates a PhD degree and SM degree in operations research, providing a strong background in OR theory as well as the practical techniques used in building models for a wide variety of applications. In addition, the ORC, in collaboration with the Sloan School of Management, offers a specialized one-year Master of Business Analytics (MBA) (http://mitsloan.mit.edu/master-of-business-analytics).

Founded as an interdepartmental program, the Operations Research Center has maintained its interdisciplinary roots. Its faculty comes from nine different departments at MIT, including the Sloan School of Management, five of the engineering departments, the
Department of Mathematics, the Department of Economics, and the Department of Urban Studies and Planning.

Information about the Operations Research Center and its degree programs is available on the ORC website (http://web.mit.edu/orc/www). For further information, contact Laura Rose (lrose@mit.edu), Room E40-107, 617-253-9303. Email (BusinessAnalytics@mit.edu) for more information on the MBAn program.

PROGRAM IN POLYMERS AND SOFT MATTER

The Schools of Engineering and Science have established a graduate-level Program in Polymers and Soft Matter (PPSM). It is open to qualified students admitted to the graduate program(s) of one of the following five MIT departments: Biological Engineering, Chemical Engineering, Chemistry, Materials Science and Engineering, and/or Mechanical Engineering.

PPSM consists of an initial academic phase in which all students participate (regardless of previous background and research interest); followed by research in a selected area of specialization. The program leads to the doctoral degree; if desired, a master's degree can be obtained through the student's home department.

The core curriculum, taken by all students, provides a common base in the field of polymers and soft matter. It is broad, rigorous, and covers both elementary and advanced subjects spanning the entire range from the molecular level to the continuum. This curriculum takes up the first two terms in the graduate program.

The transition from the academic phase to research is marked by the qualifying exam, which consists of both oral and written sections. The exams are offered at the end of each spring term and are based on the PPSM core curriculum. Successful completion of the exam leads to selection of a research project and the preparation and defense of a thesis proposal.

Any participating faculty member at MIT can act as a research supervisor. The thesis supervisor(s) advises the graduate student on a continuing basis throughout the time of the research project. Completion and successful defense of the thesis before PPSM and departmental faculty fulfill the requirements for the doctoral degree.

For more information, including admission and financial aid procedures, contact the director, Professor Alfredo Alexander-Katz (aalexand@mit.edu), Room NE46-605, 617-452-2238, or visit the website (http://polymerscience.mit.edu).

SOCIAL AND ENGINEERING SYSTEMS

The Doctoral Program in Social and Engineering Systems (SES) offered by the Institute for Data, Systems, and Society is a unique research program focused on addressing concrete and societally significant problems by combining methods from engineering and the social sciences. Core classes provide students with a grounding in probability, mathematical programming, microeconomic theory, and empirical research in the social sciences. Students then build on that foundation with coursework in information, systems, and decision science; social sciences; and classes in their particular area of applied research.

Additional information about this degree program is available under the section on the Institute for Data, Systems, and Society's graduate academic programs (p. 181).

INTERDISCIPLINARY DOCTORAL PROGRAM IN STATISTICS

The Interdisciplinary Doctoral Program in Statistics (p. 490) is an opportunity for students in a multitude of disciplines to specialize at the doctoral level in a statistics-grounded view of their field. Participating programs include Aeronautics and Astronautics, Economics, Mathematics, Political Science, and IDSS's Social and Engineering Systems Doctoral Program.

The program is administered jointly by the Statistics and Data Science Center (SDSC) and the participating academic units. Students enrolled in a doctoral program in a participating department may choose to be considered for the Interdisciplinary Doctoral Program in Statistics. Please refer to the program's website (https://stat.mit.edu/academics/idps) for details on the selection process.

Selected students will complete the home department's degree requirements (including the qualifying exam) along with specified statistics requirements including a doctoral seminar, coursework in probability, statistics, computation and statistics, and data analysis, and a dissertation that utilizes statistical methods in a substantial way.

Inquiries
For more information about the program, contact the Statistics Academic Administrator (strampel@mit.edu).

SUPPLY CHAIN MANAGEMENT PROGRAM

The Supply Chain Management Program (SCM) (http://scm.mit.edu) is designed to provide the global logistics industry with a new type of supply chain professional who is highly trained in both analytical problem solving and change management leadership. This professional degree program, offered through MIT's Center for Transportation and Logistics (CTL), prepares graduates for logistics and supply chain management careers in manufacturing, distribution, retail, transportation, logistics, consulting, and software development organizations. It is designed for early career professionals in supply chain, operations, and industrial engineering to step out of the workforce for a short amount of
time, receive intense training in supply chain fundamentals and leadership skills, and then return to the workforce at a much higher level of responsibility.

The SCM program leads to one of two degrees:

- The Master of Engineering (MEng) in Supply Chain Management is appropriate for students who wish to continue on in research or who plan to pursue a PhD.
- The Master of Applied Science (MASc) in Supply Chain Management is appropriate for students who wish to pursue a career in either industry or consulting.

Details on the subject requirements for each degree can be found on the SCM degree charts page (p. 492).

The SCM program consists of two different cohorts of students each year. The “residential” students (SCMr) spend ten months from August through May on the MIT campus in Cambridge. The “blended” students (SCMb) have already earned the MicroMasters Credential in Supply Chain Management (http://scm.mit.edu/micromasters) through edX and thus spend only five months on MIT’s campus from January through May. In each case, during their time on campus, students take specialized subjects taught by leading logistics and supply chain professionals in areas such as logistics systems, supply chain design, inventory planning, and transportation management. Students also take subjects in leadership, business writing, public speaking, and strategy. During the January Independent Activities Period (IAP), students participate on teams with their peers from MIT’s Supply Chain and Logistics Excellence (SCALE) Network centers in Spain, Malaysia, Luxembourg, China, and Latin America. Each student writes either a master’s thesis (MEng degree) or a capstone report (MASc degree) based on a real-world project sponsored by a participating company, agency, or nongovernmental organization. SCMr students also travel to the international trade hubs in Panama for a supply chain education that spans the globe.

Both programs are primarily for students with industry experience but are open to anyone who can meet the admission requirements. Applicants should have a background in college-level calculus, economics, probability, and statistics. SCMr applicants must take either the GRE or GMAT exam, or take the first three online MicroMasters subjects. SCMb students do not take the GRE or GMAT test. Applicants whose first language is not English must take the IELTS or TOEFL exam. The three admission deadlines for the SCMr program are in late fall and early spring. The single admission deadline for the SCMb program is in early spring.

The Technology and Policy Program (TPP) (http://web.mit.edu/tpp) curriculum provides a solid grounding in technology and policy by combining advanced subjects in a student’s chosen technical field with courses in economics, politics, quantitative methods, and social science, and by requiring completion of a research thesis. To prepare participants for effective professional practice, TPP stresses effective leadership and communication. Students whose research program leaves their summer free are encouraged to participate in TPP’s summer internship program, which places students in government and industry in the United States and around the world.

Many students combine the TPP curriculum with complementary subjects to obtain dual degrees in TPP and either a specialized branch of engineering or an applied social science such as political science or urban studies and planning.

For additional information, see the program description under the Institute for Data, Systems, and Society (p. 181).

GRADUATE PROGRAMS IN TRANSPORTATION

MIT provides students with a broad range of opportunities for transportation-related education. Courses and classes span the School of Engineering, the Sloan School of Management, and the School of Architecture and Planning, with many activities covering interdisciplinary topics that prepare students for future industry, government, or academic careers.

A variety of graduate degrees are available to students interested in transportation studies and research, including the interdepartmental master of science program (MST) and doctoral program in transportation (PhD in Transportation), described below, and the Master of Engineering in Logistics, described under Supply Chain Management (p. 376). MST and PhD in Transportation students are registered in the Department of Civil and Environmental Engineering or the Department of Urban Studies and Planning. The interdepartmental structure of these two programs allows students flexibility in developing individual programs of study that are cross-disciplinary and engage students in research with faculty supervisors across many departments.

Opportunities are also available for students to obtain dual master’s degrees. Students who wish to pursue this option must follow the regular admissions procedure to be admitted to each degree program. Common dual degree pairings include the Master of Science in Transportation with:

- Master in City Planning
- Master of Science in Electrical Engineering and Computer Science
- Master of Science in Operations Research
- Master of Science in Technology and Policy

TECHNOLOGY AND POLICY PROGRAM

The Master of Science in Technology and Policy (p. 499) is an engineering research degree with a strong focus on the role of technology in policy formulation, analysis, and evaluation.
Information on requirements for dual degrees can be found in the section on General Degree Requirements for graduate education.

**Master of Science in Transportation**

The Master of Science in Transportation (MST) (p. 500) program is based on the premise that a common set of analytical approaches and methodologies can be applied to solve a range of transportation problems. The MST provides a common basis for addressing a wide range of problems while allowing enough flexibility to accommodate students with diverse backgrounds and interests.

Students must complete a program of coursework, plus a research-based master’s thesis on a topic of their choosing approved by their thesis supervisor. Coursework includes two required core subjects, at least three additional transportation or related subjects comprising an individually designed program, one policy/technology subject, and a computer programming subject.

Generally, the three subjects chosen for the individually designed program relate to an area of specialization, although this is not required. Common areas of specialization include air transportation, data sciences for transportation, urban transportation, planning methods, logistics, and policy. Some students use the individually designed program to deepen their understanding of a selected area of interest, while others may choose to emphasize breadth rather than depth in their studies. At least one of the selected subjects should address policy or technology. At least two of the designated subjects should be clearly focused on transportation, while the third can be in a field that supports transportation, for example, a subject covering methods used in transportation drawn from fields such as economics, computer science, operations research, political science, or management.

The MST degree usually takes up to two years to complete.

For more information, see the full Master of Science in Transportation program description ([http://cee.mit.edu/graduate/mst](http://cee.mit.edu/graduate/mst)).

**Admission**

An undergraduate degree in engineering is not necessary for admission to the Master of Science in Transportation program, but applicants are expected to have an aptitude for analytical thinking. Backgrounds in the physical or social sciences, urban planning, management, and many other disciplines are equally appropriate foundations for the program.

The only specific subjects required for admission are two subjects in calculus, one in economics, and one in probability. One or more of these subjects may be completed simultaneously with application to the program, and acceptance is then conditional on satisfactory completion of these prerequisites. Applicants should have roughly the equivalent of the following MIT subjects:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.01 Calculus</td>
<td>12</td>
</tr>
<tr>
<td>14.01 Principles of Microeconomics</td>
<td>12</td>
</tr>
<tr>
<td>6.041A Introduction to Probability I</td>
<td>12</td>
</tr>
<tr>
<td>&amp; 6.041B Introduction to Probability II</td>
<td>12</td>
</tr>
<tr>
<td>or 1.010 Introduction to Probability and Statistics in Engineering</td>
<td>12</td>
</tr>
</tbody>
</table>

Students without an equivalent microeconomics course can be admitted, but will have to complete 14.01 Principles of Microeconomics, preferably during their first year in the degree.

All applicants are required to submit Graduate Record Examination (GRE) scores; applicants whose native language is not English are required to submit an English Language Exam. Two exams are accepted: the Test of English as a Foreign Language (TOEFL) and the International English Language Testing System (IELTS). Applicants to the Master of Science in Transportation degree program should achieve a score of at least 100 on the TOEFL iBT or 7.5 on the IELTS.

**Financial Support**

Funding for MST students is usually offered to about 90% of each incoming class. A limited number of fellowships are offered each year, but more often funding takes the form of a research assistantship (RA). A student with RA funding typically works with a faculty member on a research project for 10–20 hours per week. The research that is conducted on that project generally becomes the topic of the student’s thesis.

To learn more about current transportation research at MIT, visit Transportation@MIT ([http://transportation.mit.edu/research/people](http://transportation.mit.edu/research/people)) to peruse the websites of the faculty involved.

RAs are awarded as either a half or full appointment. An award of a full RA (about 20 hours of work per week) covers the student’s tuition for the academic year and provides a monthly stipend to cover living expenses. A half RA (approximately 10 hours of work per week) covers half of the student’s tuition for the academic year and provides half of the regular monthly stipend.

Students who are not awarded financial aid at the time of admission may seek funding through other sources.

**Doctor of Philosophy in Transportation**

The interdisciplinary doctoral program in transportation provides a structured and direct follow-on doctoral program for students enrolled in the Master of Science in Transportation or other transportation-related master’s degree programs offered at MIT or elsewhere. Outstanding applicants without a master’s degree can also be considered for admission to the doctoral program. The interdisciplinary structure allows students great flexibility in developing individual programs of study that cross both disciplinary and departmental lines. The program is administered by a faculty committee responsible for admissions, establishment and oversight.
of program requirements, and conduct of the general examination and dissertation defense.

The interdisciplinary doctoral program in transportation requires completion of at least 120 units of coursework in a program of study proposed by the student, the successful completion of a general examination consisting of both written and oral components, and the submission and defense of an acceptable dissertation.

The doctoral program offers five core areas of study. Students must choose the Transportation Systems Analysis core area and at least one of the Demand and Economics or Performance and Optimization core areas to build a doctoral core program of six subjects.

<table>
<thead>
<tr>
<th>Transportation Systems Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.200[J] Transportation Systems Analysis: Performance and Optimization</td>
</tr>
<tr>
<td>1.201[J] Transportation Systems Analysis: Demand and Economics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demand and Economics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.202 Demand Modeling</td>
</tr>
<tr>
<td>14.381 Statistical Method in Economics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance and Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.093[J] Optimization Methods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planning and Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.251[J] Comparative Land Use and Transportation Planning</td>
</tr>
<tr>
<td>11.478 Behavior and Policy: Connections in Transportation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mobility Models and Knowledge Discovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.077[J] Statistical Learning and Data Mining</td>
</tr>
</tbody>
</table>

Graduates of the interdisciplinary doctoral program receive a PhD in Transportation, although students may petition for other MIT graduate fields of study as their degree designation, subject to approval by the Transportation Graduate Program Committee.

**Inquiries**

Questions about application to graduate programs in transportation should be directed to the Transportation Academic Office. (cee-admissions@mit.edu)
DEGREE CHARTS

Undergraduate Degree Charts
General Bachelor of Science Degree Requirements (p. 36)

School of Architecture and Planning
Architecture (Course 4) (p. 383)
Art and Design (Course 4-B) (p. 385)
Planning (Course 11) (p. 387)

School of Engineering
Aerospace Engineering (Course 16) (p. 389)
Archaeology and Materials as Recommended by the Department of Materials Science and Engineering (Course 3-C) (p. 391)
Biological Engineering (Course 20) (p. 392)
Chemical-Biological Engineering (Course 10-B) (p. 393)
Chemical Engineering (Course 10) (p. 394)
Chemical Engineering (Course 10-C) (p. 396)
Computer Science and Engineering (Course 6-3) (p. 397)
Electrical Engineering and Computer Science (Course 6-2) (p. 399)
Electrical Science and Engineering (Course 6-1) (p. 403)
Engineering as Recommended by the Department of Aeronautics and Astronautics (Course 16-ENG) (p. 406)
Engineering as Recommended by the Department of Chemical Engineering (Course 10-ENG) (p. 407)
Engineering as Recommended by the Department of Mechanical Engineering (Course 2-A) (p. 409)
General Engineering (Course 1-ENG) (p. 410)
Materials Science and Engineering (Course 3) (p. 412)
Materials Science and Engineering (Course 3-A) (p. 414)
Mechanical and Ocean Engineering (Course 2-OE) (p. 416)
Mechanical Engineering (Course 2) (p. 417)
Nuclear Science and Engineering (Course 22) (p. 418)

School of Humanities, Arts, and Social Sciences
Anthropology (Course 21A) (p. 421)
Comparative Media Studies (CMS) (p. 422)
Economics (Course 14-1) (p. 423)
Global Studies and Languages (Course 21G) (p. 424)
History (Course 21H) (p. 427)
Humanities (Course 21) (p. 428)
Humanities and Engineering (Course 21E) (p. 430)
Humanities and Science (Course 21S) (p. 434)
Linguistics and Philosophy (Course 24-2) (p. 438)
Literature (Course 21L) (p. 440)
Mathematical Economics (Course 14-2) (p. 441)
Music (Course 21M-1) (p. 442)
Philosophy (Course 24-1) (p. 443)
Political Science (Course 17) (p. 445)
Science, Technology, and Society/Second Major (STS) (p. 447)
Theater Arts (Course 21M-2) (p. 448)
Writing (Course 21W) (p. 450)

Sloan School of Management
Business Analytics (Course 15-2) (p. 455)
Finance (Course 15-3) (p. 457)
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School of Science
Biology (Course 7) (p. 459)
Biology (Course 7-A) (p. 461)
Brain and Cognitive Sciences (Course 9) (p. 463)
Chemistry (Course 5) (p. 465)
Earth, Atmospheric, and Planetary Sciences (Course 12) (p. 467)
Mathematics (Course 18) (p. 470)
Mathematics with Computer Science (Course 18-C) (p. 475)
Physics (Course 8) (p. 477)

Interdisciplinary Programs
Chemistry and Biology (Course 5-7) (p. 480)
Computer Science and Molecular Biology (Course 6-7) (p. 482)
Computer Science, Economics, and Data Science (Course 6-14) (p. 484)
Urban Science and Planning with Computer Science (Course 11-6) (p. 486)

**Graduate Degree Charts**

Degree charts are provided only for the Master's programs listed below. Consult the Graduate Education Section (p. 61) for general degree requirements.

**School of Engineering**
Electrical Engineering and Computer Science (Course 6-P) (p. 402)

**Interdisciplinary Programs**
Computer Science and Molecular Biology (Course 6-7P) (p. 489)
Statistics (p. 490)
Supply Chain Management (p. 492)
Technology and Policy (p. 499)
Transportation (p. 500)
ARCHITECTURE (COURSE 4)

Department of Architecture (p. 121)

Bachelor of Science in Architecture

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement (one subject can be satisfied by a subject in the Departmental Program); at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (one subject can be satisfied by 4.440[J] in the Departmental Program)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 4.411[J], an option within the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.021 or 4.02A</td>
<td>Design Studio: How to Design 9-12</td>
</tr>
<tr>
<td>4.022</td>
<td>Design Studio: How to Design Intensive 12</td>
</tr>
<tr>
<td>4.023</td>
<td>Architecture Design Studio I (CI-M) 24</td>
</tr>
<tr>
<td>4.024</td>
<td>Architecture Design Studio II 24</td>
</tr>
<tr>
<td>4.302</td>
<td>Foundations in Art, Design, and Spatial Practices (CI-M) 12</td>
</tr>
<tr>
<td>4.401</td>
<td>Environmental Technologies in Buildings 12</td>
</tr>
<tr>
<td>4.440[J]</td>
<td>Introduction to Structural Design 12</td>
</tr>
<tr>
<td>4.500</td>
<td>Design Computation: Art, Objects and Space 12</td>
</tr>
<tr>
<td>4.501</td>
<td>Design and Fabrication of Tiny Homes 12</td>
</tr>
<tr>
<td>or 4.502</td>
<td>Advanced Visualization: Architecture in Motion Graphics</td>
</tr>
<tr>
<td>4.603</td>
<td>Understanding Modern Architecture 12</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>4.605</td>
<td>A Global History of Architecture</td>
</tr>
<tr>
<td>4.614</td>
<td>Building Islam</td>
</tr>
<tr>
<td>4.635</td>
<td>Early Modern Architecture and Art</td>
</tr>
</tbody>
</table>

Restricted Electives

Select one of the following: 24

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.025</td>
<td>Architecture Design Studio III</td>
</tr>
<tr>
<td>Total from the Restricted Electives list 1</td>
<td></td>
</tr>
<tr>
<td>Units in Major</td>
<td>177-180</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
<td>48-51</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs (36)</td>
<td></td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>192</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 The list of Restricted Electives includes subjects that are also listed under Required Subjects. However, in situations where students choose only one subject in a designated group as a Required Subject, it is acceptable to use the subjects not chosen as Restricted Electives.

Restricted Electives

Art, Culture and Technology

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.307</td>
<td>Art, Architecture, and Urbanism in Dialogue 12</td>
</tr>
<tr>
<td>4.322</td>
<td>Introduction to Three-Dimensional Art Work 12</td>
</tr>
<tr>
<td>4.341</td>
<td>Introduction to Photography and Related Media 12</td>
</tr>
<tr>
<td>4.354</td>
<td>Introduction to Video and Related Media 12</td>
</tr>
<tr>
<td>4.368</td>
<td>Studio Seminar in Art and the Public Sphere 12</td>
</tr>
</tbody>
</table>

Building Technology

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.411[J]</td>
<td>D-Lab Schools: Building Technology Laboratory 12</td>
</tr>
<tr>
<td>4.432</td>
<td>Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods 12</td>
</tr>
</tbody>
</table>

Computation

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.501</td>
<td>Design and Fabrication of Tiny Homes * 12</td>
</tr>
</tbody>
</table>
### 4.502 Advanced Visualization: Architecture in Motion Graphics

### 4.504 Design Scripting

### 4.520 Visual Computing I

### 4.522 Visual Computing II

### History, Theory and Criticism of Architecture and Art

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.601</td>
<td>Introduction to Art History</td>
<td>12</td>
</tr>
<tr>
<td>4.602</td>
<td>Modern Art and Mass Culture</td>
<td>12</td>
</tr>
<tr>
<td>4.605</td>
<td>A Global History of Architecture *</td>
<td>12</td>
</tr>
<tr>
<td>4.614</td>
<td>Building Islam *</td>
<td>12</td>
</tr>
<tr>
<td>4.635</td>
<td>Early Modern Architecture and Art *</td>
<td>12</td>
</tr>
<tr>
<td>4.651</td>
<td>Art Since 1940</td>
<td>12</td>
</tr>
</tbody>
</table>

* Denotes a subject that is also listed under Required Subjects. In situations where students choose only one subject in a designated group as a Required Subject, it is acceptable to use the subjects not chosen as Restricted Electives.
ART AND DESIGN (COURSE 4-B)

Department of Architecture (p. 121)

Bachelor of Science in Art and Design

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [three subjects can be satisfied by subjects in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Design Studios

<table>
<thead>
<tr>
<th>Design Studios</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.021 Design Studio: How to Design</td>
<td>9-12</td>
</tr>
<tr>
<td>or 4.02A Design Studio: How to Design Intensive</td>
<td></td>
</tr>
<tr>
<td>4.022 Design Studio: Introduction to Design Techniques and Technologies</td>
<td>12</td>
</tr>
<tr>
<td>4.031 Design Studio: Objects and Interaction 2</td>
<td>12</td>
</tr>
<tr>
<td>or 4.032 Design Studio: Information and Visualization</td>
<td></td>
</tr>
</tbody>
</table>

Foundational Subjects

<table>
<thead>
<tr>
<th>Foundational Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.110 Design Across Scales and Disciplines</td>
<td>12</td>
</tr>
<tr>
<td>4.302 Foundations in Art, Design, and Spatial Practices (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>4.500 Design Computation: Art, Objects and Space</td>
<td>12</td>
</tr>
<tr>
<td>4.657 Design: The History of Making Things</td>
<td>12</td>
</tr>
</tbody>
</table>

Thesis Subjects

<table>
<thead>
<tr>
<th>Thesis Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.THU Undergraduate Thesis</td>
<td>12</td>
</tr>
</tbody>
</table>

Restricted Electives
Select 48 units from among any of the three categories below:

Objects

<table>
<thead>
<tr>
<th>Objects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00A Fundamentals of Engineering Design: Explore Space, Sea and Earth</td>
<td></td>
</tr>
<tr>
<td>2.00 Introduction to Design</td>
<td></td>
</tr>
<tr>
<td>2.007 Design and Manufacturing I 2</td>
<td></td>
</tr>
<tr>
<td>2.009 The Product Engineering Process 2</td>
<td></td>
</tr>
<tr>
<td>4.031 Design Studio: Objects and Interaction 1</td>
<td></td>
</tr>
<tr>
<td>4.041 Design Studio: Advanced Product Design</td>
<td></td>
</tr>
<tr>
<td>4.043 Design Studio: Advanced Interactions</td>
<td></td>
</tr>
<tr>
<td>4.118 Creative Computation</td>
<td></td>
</tr>
<tr>
<td>4.125 Furniture Making Workshop</td>
<td></td>
</tr>
<tr>
<td>4.451 Computational Structural Design and Optimization</td>
<td></td>
</tr>
<tr>
<td>4.501 Design and Fabrication of Tiny Homes</td>
<td></td>
</tr>
<tr>
<td>EC.720[J] D-Lab: Design 2</td>
<td></td>
</tr>
<tr>
<td>MAS.377[J] Objectification: How to Write (and Talk, and Think) about Objects</td>
<td></td>
</tr>
</tbody>
</table>

Information

<table>
<thead>
<tr>
<th>Information</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.032 Design Studio: Information and Visualization 1</td>
<td></td>
</tr>
<tr>
<td>4.051 The Human Factor in Innovation and Design Strategy</td>
<td></td>
</tr>
<tr>
<td>4.053 Visual Communication Fundamentals</td>
<td></td>
</tr>
<tr>
<td>4.502 Advanced Visualization: Architecture in Motion Graphics</td>
<td></td>
</tr>
<tr>
<td>4.504 Design Scripting</td>
<td></td>
</tr>
<tr>
<td>4.520 Visual Computing I</td>
<td></td>
</tr>
<tr>
<td>CMS.405 Visual Design 2</td>
<td></td>
</tr>
<tr>
<td>CMS.622 Applying Media Technologies in the Arts and Humanities</td>
<td></td>
</tr>
<tr>
<td>CMS.633 Digital Humanities: Topics, Techniques, and Technologies</td>
<td></td>
</tr>
<tr>
<td>MAS.110 Fundamentals of Computational Media Design</td>
<td></td>
</tr>
</tbody>
</table>

Art and Experience

<table>
<thead>
<tr>
<th>Art and Experience</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.301 Introduction to Artistic Experimentation</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.307</td>
<td>Art, Architecture, and Urbanism in Dialogue</td>
</tr>
<tr>
<td>4.320</td>
<td>Introduction to Sound Creations</td>
</tr>
<tr>
<td>4.322</td>
<td>Introduction to Three-Dimensional Art Work</td>
</tr>
<tr>
<td>4.341</td>
<td>Introduction to Photography and Related Media</td>
</tr>
<tr>
<td>4.354</td>
<td>Introduction to Video and Related Media</td>
</tr>
<tr>
<td>4.602</td>
<td>Modern Art and Mass Culture</td>
</tr>
<tr>
<td>21M.603</td>
<td>Introduction to Design for the Theater</td>
</tr>
<tr>
<td>CMS.362</td>
<td>Civic Media Collaborative Design Studio</td>
</tr>
<tr>
<td>CMS.634</td>
<td>Designing Interactions</td>
</tr>
</tbody>
</table>

**Units in Major**  
153-156

**Unrestricted Electives**  
60-63

**Units in Major That Also Satisfy the GIRs**  
(36)

**Total Units Beyond the GIRs Required for SB Degree**  
180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. Either 4.031 or 4.032 may be used as a restricted elective if not selected as part of the design studio requirement.

2. Subject has prerequisites that are outside of the program.
PLANNING (COURSE 11)

Department of Urban Studies and Planning (p. 132)

Bachelor of Science in Planning

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [four subjects can be satisfied by subjects in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 11.188 in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.001[J] Introduction to Urban Design and Development</td>
<td>12</td>
</tr>
<tr>
<td>14.01 Principles of Microeconomics</td>
<td>12</td>
</tr>
<tr>
<td>11.188 Urban Planning and Social Science Laboratory (CI-M)</td>
<td>12</td>
</tr>
</tbody>
</table>

Planned Electives
Formulate or select one stream of coursework for 78-81 concentration

Urban Field Experience
Declared majors are encouraged to take the optional urban field experience subject.

<table>
<thead>
<tr>
<th>Thesis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11.027 City to City: Comparing, Researching and Writing about Cities (CI-M) ²</td>
<td>12</td>
</tr>
</tbody>
</table>

Majors are required to write a senior thesis or complete a senior project. The thesis/project writing process is accompanied by a required undergraduate thesis preparation seminar, which meets in the fall

11.THU Undergraduate Thesis 12

Units in Major 150-153

Unrestricted Electives 87-90

Units in Major That Also Satisfy the GIRs (60)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 In consultation with the advisor, students can select from recommended concentrations described in the department’s course maps (http://dusp.mit.edu/degrees/undergraduate) or create their own stream tailored to a particular set of urban, policy, or planning concerns.

2 11.027 City to City: Comparing, Researching and Writing about Cities 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.
AEROSPACE ENGINEERING (COURSE 16)

Bachelor of Science in Aerospace Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects</td>
<td></td>
</tr>
<tr>
<td>must be designated as communication-intensive</td>
<td></td>
</tr>
<tr>
<td>(CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>[can be satisfied from among 6.00, 6.041A/6.041B, 16.001, and 18.03 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 6.111, 16.405[J], 16.622, 16.821, or 16.831[J] 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Departmental Core

<table>
<thead>
<tr>
<th>Departmental Core</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00 Introduction to Computer Science and Programming</td>
<td>12</td>
</tr>
<tr>
<td>16.001 Unified Engineering: Materials and Structures</td>
<td>12</td>
</tr>
<tr>
<td>16.002 Unified Engineering: Signals and Systems</td>
<td>12</td>
</tr>
<tr>
<td>16.003 Unified Engineering: Fluid Dynamics</td>
<td>12</td>
</tr>
<tr>
<td>16.004 Unified Engineering: Thermodynamics</td>
<td>12</td>
</tr>
<tr>
<td>16.06 Principles of Automatic Control</td>
<td>12</td>
</tr>
<tr>
<td>16.07 Dynamics</td>
<td>12</td>
</tr>
<tr>
<td>18.03 Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>16.09 Statistics and Probability</td>
<td>12</td>
</tr>
</tbody>
</table>

6.041B Introduction to Probability II

Professional Area Subjects
Select four subjects from at least three professional areas.  

<table>
<thead>
<tr>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid Mechanics</td>
</tr>
<tr>
<td>16.100 Aerodynamics</td>
</tr>
<tr>
<td>Materials and Structures</td>
</tr>
<tr>
<td>16.20 Structural Mechanics</td>
</tr>
<tr>
<td>Propulsion</td>
</tr>
<tr>
<td>16.50 Aerospace Propulsion</td>
</tr>
<tr>
<td>Computational Tools</td>
</tr>
<tr>
<td>16.90 Computational Modeling and Data Analysis in Aerospace Engineering</td>
</tr>
<tr>
<td>Estimation and Control</td>
</tr>
<tr>
<td>16.30 Feedback Control Systems</td>
</tr>
<tr>
<td>Computer Systems</td>
</tr>
<tr>
<td>6.111 Introductory Digital Systems Laboratory</td>
</tr>
<tr>
<td>16.35 Real-Time Systems and Software</td>
</tr>
<tr>
<td>Communications Systems</td>
</tr>
<tr>
<td>16.36 Communication Systems and Networks</td>
</tr>
<tr>
<td>Humans and Automation</td>
</tr>
<tr>
<td>16.400 Human Systems Engineering</td>
</tr>
<tr>
<td>16.410 Principles of Autonomy and Decision Making</td>
</tr>
</tbody>
</table>

Laboratory and Capstone Subjects
Select one of the following:

<table>
<thead>
<tr>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.82 Flight Vehicle Engineering (CI-M)</td>
</tr>
<tr>
<td>16.83[J] Space Systems Engineering (CI-M)</td>
</tr>
</tbody>
</table>

Select one of the following sequences:

<table>
<thead>
<tr>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Projects:</td>
</tr>
<tr>
<td>16.621 Experimental Projects I</td>
</tr>
<tr>
<td>16.622 Experimental Projects II (CI-M)</td>
</tr>
<tr>
<td>Flight Vehicle Development:</td>
</tr>
<tr>
<td>16.821 Flight Vehicle Development (CI-M)</td>
</tr>
<tr>
<td>Space Systems Development:</td>
</tr>
<tr>
<td>16.831[J] Space Systems Development (CI-M)</td>
</tr>
</tbody>
</table>

Units in Major 180-186

Unrestricted Electives 48

Units in Major That Also Satisfy the GIRs (36)

Total Units Beyond the GIRs Required for SB Degree 192-198
The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

2 Combination of 6.0001 Introduction to Computer Science Programming in Python and 6.0002 Introduction to Computational Thinking and Data Science is also an acceptable option.

2 18.032 Differential Equations is also an acceptable option.

3 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.
ARCHAEOLOGY AND MATERIALS (COURSE 3-C)

Department of Materials Science and Engineering (p. 205)

Bachelor of Science in Archaeology and Materials as Recommended by the Department of Materials Science and Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [can be satisfied by 3.985[J], 3.986, 3.987, and 21A.00; and 3.982 or 3.983 in the Departmental Program]</td>
<td>at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement [can be satisfied by 3.012 and 12.001 in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 3.014 or 12.119 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>3.012 Fundamentals of Materials Science and Engineering</td>
</tr>
<tr>
<td>12</td>
<td>3.014 Materials Laboratory (CI-M)</td>
</tr>
<tr>
<td>12</td>
<td>3.016 Computational Methods for Materials Scientists and Engineers</td>
</tr>
<tr>
<td></td>
<td>or 18.03 Differential Equations</td>
</tr>
<tr>
<td>12</td>
<td>3.022 Microstructural Evolution in Materials</td>
</tr>
<tr>
<td>12</td>
<td>3.032 Mechanical Behavior of Materials</td>
</tr>
<tr>
<td></td>
<td>or 3.044 Materials Processing</td>
</tr>
<tr>
<td>9</td>
<td>3.985[J] Archaeological Science</td>
</tr>
</tbody>
</table>

3.986 The Human Past: Introduction to Archaeology 12
3.987 Human Evolution: Data from Palaeontology, Archaeology, and Materials Science 12
3.990 Seminar in Archaeological Method and Theory (CI-M) 9
3.THU Undergraduate Thesis 2 9
12.001 Introduction to Geology 12
12.119 Analytical Techniques for Studying Environmental and Geologic Samples 12
21A.00 Introduction to Anthropology: Comparing Human Cultures 12

Select one of the following: 12

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1.00 Engineering Computation and Data Science</td>
</tr>
<tr>
<td>12</td>
<td>3.021 Introduction to Modeling and Simulation</td>
</tr>
<tr>
<td>12</td>
<td>6.01 Introduction to EECS via Robotics</td>
</tr>
</tbody>
</table>

Restricted Electives

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>3.982 The Ancient Andean World</td>
</tr>
<tr>
<td>or 3.983 Ancient Mesoamerican Civilization</td>
<td></td>
</tr>
</tbody>
</table>

Select one of the following: 12

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>3.052 Nanomechanics of Materials and Biomaterials</td>
</tr>
<tr>
<td>12</td>
<td>3.07 Introduction to Ceramics</td>
</tr>
<tr>
<td>12</td>
<td>3.14 Physical Metallurgy</td>
</tr>
</tbody>
</table>

Units in Major 183

Unrestricted Electives 69-81

Units in Major That Also Satisfy the GIRs (81)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 18.032 Differential Equations is also an acceptable option.
2 Students may elect up to 9–12 units.
3 Substitution of similar subjects may be permitted by petition.
### Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication 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 Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 20.109]</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

### Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

### Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

#### Required Core Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier I</td>
</tr>
<tr>
<td>5.12</td>
</tr>
<tr>
<td>6.00</td>
</tr>
<tr>
<td>7.03</td>
</tr>
<tr>
<td>18.03</td>
</tr>
<tr>
<td>20.110[J]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier II</td>
</tr>
<tr>
<td>5.07[J]</td>
</tr>
<tr>
<td>or 7.05</td>
</tr>
<tr>
<td>7.06</td>
</tr>
<tr>
<td>20.109</td>
</tr>
<tr>
<td>20.309[J]</td>
</tr>
</tbody>
</table>

#### Restricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier III</td>
</tr>
<tr>
<td>20.320</td>
</tr>
<tr>
<td>20.380</td>
</tr>
</tbody>
</table>

#### Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracks TBD</td>
</tr>
<tr>
<td>Units in Major</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree 192-195

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Combination of 6.0001 Introduction to Computer Science Programming in Python and 6.0002 Introduction to Computational Thinking and Data Science is also acceptable.
CHEMICAL-BIOLOGICAL ENGINEERING (COURSE 10-B)

Department of Chemical Engineering (p. 165)

Bachelor of Science in Chemical-Biological Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement [can be satisfied from among 5.07(J) or 7.05, 5.12, 5.60, 7.03, 10.301, and 18.03 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 10.702(J)]</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects Units

<table>
<thead>
<tr>
<th>Foundational Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.12 Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.60 Thermodynamics and Kinetics</td>
<td>12</td>
</tr>
<tr>
<td>7.03 Genetics</td>
<td>12</td>
</tr>
<tr>
<td>10.10 Introduction to Chemical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>10.702(J) Introduction to Experimental Biology and Communication (CI-M)</td>
<td>18</td>
</tr>
<tr>
<td>18.03 Differential Equations</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intermediate Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.05 General Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>or 5.07[J] Biological Chemistry I</td>
<td></td>
</tr>
<tr>
<td>7.06 Cell Biology</td>
<td>12</td>
</tr>
</tbody>
</table>

Select one of the following:

10.27 Energy Engineering Projects Laboratory (CI-M)
10.28 Chemical-Biological Engineering Laboratory (CI-M)
10.29 Biological Engineering Projects Laboratory (CI-M)

Advanced Subjects

10.37 Chemical Kinetics and Reactor Design 9
10.490 Integrated Chemical Engineering 9

Select two of the following:

10.492A Integrated Chemical Engineering Topics I
or 10.492B Integrated Chemical Engineering Topics I
10.493 Integrated Chemical Engineering Topics II
10.494A Integrated Chemical Engineering Topics III
or 10.494B Integrated Chemical Engineering Topics III

Units in Major 183
Unrestricted Electives 48
Units in Major That Also Satisfy the GIRs (36)
Total Units Beyond the GIRs Required for SB Degree 195

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 18.032 Differential Equations is also an acceptable option.
2 One of these may be substituted with 10.00 Molecule Builders, 10.01 Ethics for Engineers, a second term of 10.490 Integrated Chemical Engineering (with permission of instructor), or one subject of at least nine units in Chemical Engineering. Graduate subjects may not be used as substitutions. In addition, the following undergraduate subjects may not be used as substitutions: 10.04, 10.702[J], 10.806, 10.910, 10.911, 10.UR, 10.URG, and 10.THU.
CHEMICAL ENGINEERING (COURSE 10)

Department of Chemical Engineering (p. 165)

Bachelor of Science in Chemical Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 5.12, 5.07[J] or 7.05, 5.60, 5.61, 10.301, and 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 5.310]</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundational Subjects</td>
<td></td>
</tr>
<tr>
<td>5.12 Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.310 Laboratory Chemistry</td>
<td>12</td>
</tr>
<tr>
<td>5.60 Thermodynamics and Kinetics</td>
<td>12</td>
</tr>
<tr>
<td>10.10 Introduction to Chemical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18.03 Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>Intermediate Subjects</td>
<td></td>
</tr>
<tr>
<td>10.213 Chemical and Biological Engineering Thermodynamics</td>
<td>12</td>
</tr>
<tr>
<td>10.301 Fluid Mechanics</td>
<td>12</td>
</tr>
<tr>
<td>10.302 Transport Processes</td>
<td>12</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>5.03 Principles of Inorganic Chemistry I</td>
<td></td>
</tr>
<tr>
<td>5.07[J] Biological Chemistry I</td>
<td></td>
</tr>
<tr>
<td>5.13 Organic Chemistry II</td>
<td></td>
</tr>
<tr>
<td>5.61 Physical Chemistry</td>
<td></td>
</tr>
<tr>
<td>7.05 General Biochemistry</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>15</td>
</tr>
<tr>
<td>10.26 Chemical Engineering Projects Laboratory</td>
<td></td>
</tr>
<tr>
<td>10.27 Energy Engineering Projects Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.28 Chemical-Biological Engineering Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.29 Biological Engineering Projects Laboratory (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

Advanced Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.32 Separation Processes</td>
<td>6</td>
</tr>
<tr>
<td>10.37 Chemical Kinetics and Reactor Design</td>
<td>9</td>
</tr>
<tr>
<td>10.490 Integrated Chemical Engineering</td>
<td>9</td>
</tr>
<tr>
<td>Select two of the following:</td>
<td>12</td>
</tr>
<tr>
<td>10.492A Integrated Chemical Engineering Topics I</td>
<td></td>
</tr>
<tr>
<td>or 10.492B Integrated Chemical Engineering Topics I</td>
<td></td>
</tr>
<tr>
<td>10.493 Integrated Chemical Engineering Topics II</td>
<td></td>
</tr>
<tr>
<td>10.494A Integrated Chemical Engineering Topics III</td>
<td></td>
</tr>
<tr>
<td>or 10.494B Integrated Chemical Engineering Topics III</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives

<table>
<thead>
<tr>
<th>Select one of the following options:</th>
<th>21-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td></td>
</tr>
<tr>
<td>One subject of at least nine units in Chemical Engineering</td>
<td>6</td>
</tr>
<tr>
<td>Plus one laboratory subject from the following list:</td>
<td></td>
</tr>
<tr>
<td>2.013 Engineering Systems Design (CI-M)</td>
<td></td>
</tr>
<tr>
<td>2.014 Engineering Systems Development (CI-M)</td>
<td></td>
</tr>
<tr>
<td>3.014 Materials Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.26 Chemical Engineering Projects Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.27 Energy Engineering Projects Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.28 Chemical-Biological Engineering Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.29 Biological Engineering Projects Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.467 Polymer Science Laboratory (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

Option 2 |       |
Select one six-unit subject in Chemical Engineering

4

10.702[J] Introduction to Experimental Biology and Communication (CI-M)

<table>
<thead>
<tr>
<th>Units in Major</th>
<th>180-183</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
<td>(36)</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>192-195</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. 18.032 Differential Equations is also an acceptable option.

2. One of 10.26, 10.27, 10.28, or 10.29 must be taken as a departmental requirement and cannot also be used to satisfy the laboratory requirement within restricted electives.

3. One of these may be substituted with 10.00 Molecule Builders, 10.01 Ethics for Engineers, a second term of 10.490 Integrated Chemical Engineering (with permission of instructor), or one subject of at least 9 units in Chemical Engineering.

4. Graduate subjects may not be used as restricted electives. In addition, the following undergraduate subjects may not be used as restricted electives: 10.04, 10.792[J], 10.806, 10.910 and 10.911 Independent Research Problem, 10.UR and 10.URG Undergraduate Research, and 10.THU.
CHEMICAL ENGINEERING (COURSE 10-C)

Department of Chemical Engineering (p. 165)

Bachelor of Science as Recommended by the Department of Chemical Engineering

Students planning to follow this curriculum must submit a statement of goals and a coherent program of subjects no later than the spring term of their junior year.

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Science Requirement</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 5.60 and 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 3.014, 6.111, 10.702[J], or 15.301 in the Departmental Program]</td>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
<tr>
<td>Physical Education Requirement</td>
<td>Swimming requirement, plus four physical education courses for eight points.</td>
<td></td>
</tr>
<tr>
<td>Departmental Program</td>
<td>Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
</tbody>
</table>

Departmental Requirements

<table>
<thead>
<tr>
<th>Units</th>
<th>Thermodynamics and Kinetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.60</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Introduction to Chemical Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.10</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Chemical and Biological Engineering Thermodynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.213</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Fluid Mechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.301</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Transport Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.302</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Differential Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03</td>
<td>12</td>
</tr>
</tbody>
</table>

Restricted Electives

Students must choose electives that form a coherent plan of study. Students must include two restricted electives selected according to the following lists.

Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Materials Laboratory (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.014</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Micro/Nano Processing Technology (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.152[J]</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Introduction to Experimental Biology and Communication (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.702[J]</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Chemical Engineering Projects Laboratory (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.26</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Energy Engineering Projects Laboratory (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.27</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Chemical-Biological Engineering Laboratory (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.28</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Biological Engineering Projects Laboratory (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.29</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Polymer Science Laboratory (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.467</td>
<td>12</td>
</tr>
</tbody>
</table>

Select one additional subject from the above list or the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Cellular Neurophysiology and Computing (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.021[J]</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Computer Systems Engineering (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.033</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Introductory Digital Systems Laboratory (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.111</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Foundations of Information Policy (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.805[J]</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Intermediate Macroeconomics (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.05</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>Management Communication for Undergraduates (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.279</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
<th>People, Teams, and Organizations Laboratory (CI-M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.301</td>
<td>12</td>
</tr>
</tbody>
</table>

Units in Major

<table>
<thead>
<tr>
<th>Units</th>
<th>168</th>
</tr>
</thead>
</table>

Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
<th>48</th>
</tr>
</thead>
</table>

Units in Major That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
<th>(24-36)</th>
</tr>
</thead>
</table>

Total Units Beyond the GIRs Required for SB Degree

<table>
<thead>
<tr>
<th>Units</th>
<th>180-192</th>
</tr>
</thead>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 18.032 Differential Equations is also an acceptable option.

2 If the student chooses to include a subject from the second list of Restricted Electives (6.021[J]-15.301), the subject must fit logically within the plan of study.
COMPUTER SCIENCE AND ENGINEERING (COURSE 6-3)

Department of Electrical Engineering and Computer Science (p. 188)

Bachelor of Science in Computer Science and Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [one subject can be satisfied by 6.805[J] in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 6.004 and 6.042[J] (if taken under joint number 18.062[J]) in the Department Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [satisfied by 6.01, 6.02, 6.03 or 6.08 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Departmental Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0001 Introduction to Computer Science</td>
<td>6</td>
</tr>
<tr>
<td>Programming in Python</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>9-12</td>
</tr>
<tr>
<td>6.01 UAT Oral Communication (CI-M)</td>
<td></td>
</tr>
<tr>
<td>6.02 UAR Seminar in Undergraduate Advanced Research (12 units, CI-M)</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>6.03 Introduction to EECS via Robotics</td>
<td></td>
</tr>
<tr>
<td>6.08 Introduction to EECS via Interconnected Embedded Systems</td>
<td></td>
</tr>
</tbody>
</table>

Computer Science Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.004 Computation Structures</td>
<td>12</td>
</tr>
<tr>
<td>6.006 Introduction to Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>6.009 Fundamentals of Programming</td>
<td>12</td>
</tr>
<tr>
<td>6.031 Elements of Software Construction</td>
<td>15</td>
</tr>
<tr>
<td>6.033 Computer Systems Engineering (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>6.034 Artificial Intelligence</td>
<td>12</td>
</tr>
<tr>
<td>or 6.036 Introduction to Machine Learning</td>
<td></td>
</tr>
<tr>
<td>6.045[J] Automata, Computability, and Complexity</td>
<td>12</td>
</tr>
<tr>
<td>or 6.046[J] Design and Analysis of Algorithms</td>
<td></td>
</tr>
</tbody>
</table>

Elective Subjects
Select two Advanced Undergraduate Subjects 24-30
Select one subject from the departmental list of EECS subjects 12

Units in Major 162-171

Unrestricted Electives 48-66
Units in Major That Also Satisfy the GIRs (36-48)
Total Units Beyond the GIRs Required for SB Degree 180-183

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

Advanced Undergraduate Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.025[J] Medical Device Design (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>6.027[J] Biomolecular Feedback Systems</td>
<td>12</td>
</tr>
<tr>
<td>6.035 Computer Language Engineering</td>
<td>12</td>
</tr>
<tr>
<td>6.047 Computational Biology: Genomes, Networks, Evolution</td>
<td>12</td>
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<td>6.061 Introduction to Electric Power Systems</td>
<td>12</td>
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<tr>
<td>6.101 Introductory Analog Electronics Laboratory (CI-M)</td>
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<td>6.111 Introductory Digital Systems Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>6.115 Microcomputer Project Laboratory (CI-M)</td>
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</tbody>
</table>

1 Of the three required AUS and EECS subjects, at least one must be from the list of Independent Inquiry Subjects.
2 See departmental website (http://www.eecs.mit.edu/academics-admissions/undergraduate-programs) for list of acceptable EECS subjects.
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1151</td>
<td>Microcomputer Project Laboratory - Independent Inquiry</td>
<td>15</td>
</tr>
<tr>
<td>6.131</td>
<td>Power Electronics Laboratory (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>6.1311</td>
<td>Power Electronics Laboratory - Independent Inquiry</td>
<td>15</td>
</tr>
<tr>
<td>6.172</td>
<td>Performance Engineering of Software Systems</td>
<td>18</td>
</tr>
<tr>
<td>6.175</td>
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<td>6.302</td>
<td>Feedback System Design</td>
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</tr>
<tr>
<td>6.602</td>
<td>Fundamentals of Photonics</td>
<td>12</td>
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<tr>
<td>6.701</td>
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</tr>
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</tr>
<tr>
<td>6.813</td>
<td>User Interface Design and Implementation</td>
<td>12</td>
</tr>
<tr>
<td>6.809[J]</td>
<td>Interactive Music Systems</td>
<td>12</td>
</tr>
<tr>
<td>6.814</td>
<td>Database Systems</td>
<td>12</td>
</tr>
<tr>
<td>6.815</td>
<td>Digital and Computational Photography</td>
<td>12</td>
</tr>
<tr>
<td>6.816</td>
<td>Multicore Programming</td>
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</tr>
<tr>
<td>6.819</td>
<td>Advances in Computer Vision</td>
<td>12</td>
</tr>
<tr>
<td>6.837</td>
<td>Computer Graphics</td>
<td>12</td>
</tr>
<tr>
<td>6.905</td>
<td>Large-scale Symbolic Systems</td>
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</tbody>
</table>

**Independent Inquiry Subjects**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>6.035</td>
<td>Computer Language Engineering</td>
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<td>6.047</td>
<td>Computational Biology: Genomes, Networks, Evolution</td>
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</tr>
<tr>
<td>6.100</td>
<td>Electrical Engineering and Computer Science Project</td>
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<tr>
<td>6.111</td>
<td>Introductory Digital Systems Laboratory</td>
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</tr>
<tr>
<td>6.1151</td>
<td>Microcomputer Project Laboratory - Independent Inquiry (CI-M)</td>
<td>15</td>
</tr>
<tr>
<td>6.129[J]</td>
<td>Biological Circuit Engineering Laboratory (CI-M)</td>
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<td>6.1311</td>
<td>Power Electronics Laboratory - Independent Inquiry (CI-M)</td>
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<td>6.161</td>
<td>Modern Optics Project Laboratory (CI-M)</td>
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<td>6.163</td>
<td>Strobe Project Laboratory (CI-M)</td>
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<td>6.170</td>
<td>Software Studio</td>
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<td>6.172</td>
<td>Performance Engineering of Software Systems</td>
<td>18</td>
</tr>
<tr>
<td>6.182</td>
<td>Psychoacoustics Project Laboratory (CI-M)</td>
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<tr>
<td>6.811[J]</td>
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</tr>
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<tr>
<td>6.819</td>
<td>Advances in Computer Vision</td>
<td>12</td>
</tr>
<tr>
<td>6.9041</td>
<td>Ethics for Engineers - Independent Inquiry</td>
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</tr>
<tr>
<td>6.905</td>
<td>Large-scale Symbolic Systems</td>
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</tr>
</tbody>
</table>

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ELECTRICAL ENGINEERING AND COMPUTER SCIENCE (COURSE 6-2)

Department of Electrical Engineering and Computer Science (p. 188)

Bachelor of Science in Electrical Engineering and Computer Science

General Institute Requirements (GI�s)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Science Requirement</th>
<th>Humanities, Arts, and Social Sciences (HASS)</th>
<th>Restricted Electives in Science and Technology (REST)</th>
<th>Laboratory Requirement</th>
<th>Total GIR Subjects Required for SB Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Departmental Requirements

<table>
<thead>
<tr>
<th>Departmental Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Computer Science</td>
<td>6</td>
</tr>
<tr>
<td>Programming in Python</td>
<td></td>
</tr>
<tr>
<td>Circuits and Electronics</td>
<td>12</td>
</tr>
<tr>
<td>Signals and Systems</td>
<td>12</td>
</tr>
<tr>
<td>Differential Equations</td>
<td>6-12</td>
</tr>
<tr>
<td>Engineering Mathematics: Linear Algebra and ODEs</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>9-12</td>
</tr>
<tr>
<td>Seminar in Undergraduate Advanced Research (12 units, CI-M)</td>
<td></td>
</tr>
<tr>
<td>Oral Communication (CI-M)</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>Introduction to EECS via Robotics</td>
<td></td>
</tr>
</tbody>
</table>

EECS Requirements

Select three subjects from the Level 1 list
Select three subjects from the Level 2 list
Select two subjects from the list of Advanced Undergraduate Subjects
Select two subjects from the departmental list of EECS subjects

Units in Major
153-171

Unrestricted Electives
48-81

Units in Major That Also Satisfy the GI�s
(24-60)

Total Units Beyond the GI�s Required for SB Degree
180-189

The units for any subject that counts as one of the 17 GI� subjects cannot also be counted as units required beyond the GI�s.

1 Of the six EECS Requirement subjects, at least two must be categorized as Computer Science, at least two must be categorized as Electrical Engineering, and at least one must be categorized as EECS.

2 6.008 can count as part of the EECS Requirements or as an elective subject, but not both.

3 Chosen electives must satisfy each of the following categories: Advanced Departmental Laboratory, Independent Inquiry, and Probability. A subject may count toward more than one category.

4 See departmental website (http://www.eecs.mit.edu/academics-admissions/undergraduate-programs) for list of acceptable EECS subjects.

Level I EECS Requirements

Electrical Engineering

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.002</td>
<td>Circuits and Electronics</td>
</tr>
<tr>
<td>6.003</td>
<td>Signals and Systems</td>
</tr>
</tbody>
</table>

Computer Science

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.006</td>
<td>Introduction to Algorithms</td>
</tr>
<tr>
<td>6.009</td>
<td>Fundamentals of Programming</td>
</tr>
</tbody>
</table>

EECS

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>6.004</td>
<td>Computation Structures</td>
</tr>
<tr>
<td>6.008</td>
<td>Introduction to Inference</td>
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</tbody>
</table>

Level 2 EECS Requirements

Electrical Engineering

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.011</td>
<td>Signals, Systems and Inference</td>
</tr>
<tr>
<td>6.012</td>
<td>Nanoelectronics and Computing Systems</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>6.013</td>
<td>Electromagnetics and Applications</td>
</tr>
<tr>
<td>6.014</td>
<td>Electromagnetic Fields, Forces and Motion</td>
</tr>
<tr>
<td>6.021[J]</td>
<td>Cellular Neurophysiology and Computing</td>
</tr>
<tr>
<td>6.031</td>
<td>Elements of Software Construction</td>
</tr>
<tr>
<td>6.033</td>
<td>Computer Systems Engineering (CI-M)</td>
</tr>
<tr>
<td>6.034</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>6.045[J]</td>
<td>Automata, Computability, and Complexity</td>
</tr>
<tr>
<td>6.046[J]</td>
<td>Design and Analysis of Algorithms</td>
</tr>
<tr>
<td>6.036</td>
<td>Introduction to Machine Learning</td>
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<tr>
<td>6.025[J]</td>
<td>Medical Device Design (CI-M)</td>
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<tr>
<td>6.027[J]</td>
<td>Biomolecular Feedback Systems</td>
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<td>6.035</td>
<td>Computer Language Engineering</td>
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<tr>
<td>6.1151</td>
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<td>Solid-State Circuits</td>
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<td>6.809[J]</td>
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<td>6.816</td>
<td>Multicore Programming</td>
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<td>6.819</td>
<td>Advances in Computer Vision</td>
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<td>6.837</td>
<td>Computer Graphics</td>
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<td>Software Studio</td>
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<td>Performance Engineering of Software Systems</td>
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<td>6.182</td>
<td>Psychoacoustics Project Laboratory (CI-M)</td>
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<td>Large-scale Symbolic Systems</td>
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<tr>
<td>6.008</td>
<td>Introduction to Inference</td>
</tr>
<tr>
<td>6.041A</td>
<td>Introduction to Probability I</td>
</tr>
<tr>
<td>6.042J</td>
<td>Mathematics for Computer Science</td>
</tr>
<tr>
<td>18.05</td>
<td>Introduction to Probability and Statistics</td>
</tr>
<tr>
<td>18.600</td>
<td>Probability and Random Variables</td>
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</table>

**Advanced Departmental Laboratory Subjects**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>6.025J</td>
<td>Medical Device Design (CI-M)</td>
<td>12</td>
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<tr>
<td>6.035</td>
<td>Computer Language Engineering</td>
<td>12</td>
</tr>
<tr>
<td>6.047</td>
<td>Computational Biology: Genomes, Networks, Evolution</td>
<td>12</td>
</tr>
<tr>
<td>6.073J</td>
<td>Creating Video Games</td>
<td>12</td>
</tr>
<tr>
<td>6.101</td>
<td>Introductory Analog Electronics Laboratory (CI-M)</td>
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<td>6.1311</td>
<td>Power Electronics Laboratory - Independent Inquiry</td>
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<td>6.141J</td>
<td>Robotics: Science and Systems (CI-M)</td>
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<tr>
<td>6.152J</td>
<td>Micro/Nano Processing Technology (CI-M)</td>
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<td>Modern Optics Project Laboratory (CI-M)</td>
<td>12</td>
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<td>6.302</td>
<td>Feedback System Design</td>
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<td>6.804J</td>
<td>Computational Cognitive Science</td>
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<td>6.806</td>
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<td>Advances in Computer Vision</td>
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<td>6.837</td>
<td>Computer Graphics</td>
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</table>

**Probability Subjects**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>6.008</td>
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<td>6.041A</td>
<td>Introduction to Probability I</td>
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<td>18.600</td>
<td>Probability and Random Variables</td>
<td>12</td>
</tr>
</tbody>
</table>
Master of Engineering in Electrical Engineering and Computer Science

For further details on all EECS programs, visit the website (http://www.eecs.mit.edu/acad.html).

The Master of Engineering degree is awarded only to students who have already received, or who will simultaneously receive, one of the Bachelor's degrees listed below. See the degree charts to view the requirements of each undergraduate program.

- Bachelor of Science in Electrical Science and Engineering (Course 6-1) (p. 403)
- Bachelor of Science in Electrical Engineering and Computer Science (Course 6-2) (p. 399)
- Bachelor of Science in Computer Science and Engineering (Course 6-3) (p. 397)

The graduate component of the MEng program is described below.

**Course 6-P Graduate Requirements**

<table>
<thead>
<tr>
<th>Required Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.THM Master of Engineering Program Thesis</td>
</tr>
<tr>
<td>6.997 Professional Perspective Internship</td>
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<table>
<thead>
<tr>
<th>Restricted Electives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four graduate subjects totaling at least 42 units from a list specified by EECS.</td>
</tr>
<tr>
<td>Subjects from a restricted departmental list including 6.998 and subjects from mathematics, science, and engineering electives totaling at least 24 units.</td>
</tr>
</tbody>
</table>

Total Units 91-97

1 6-PA Program requires performance of thesis at company location.

2 The 42 units must be chosen so that among these four subjects and the two Advanced Undergraduate Subjects used for the SB degree there are three subjects that satisfy one of the Department's Concentration Fields (http://www.eecs.mit.edu/docs/ug/Checklist.pdf).
Bachelor of Science in Electrical Science and Engineering

**General Institute Requirements (GIRs)**

The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

**Summary of Subject Requirements**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Required Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

**Physical Education Requirement**

Swimming requirement, plus four physical education courses for eight points.

**Departmental Program**

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Departmental Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0001 Introduction to Computer Science Programming in Python</td>
<td>6</td>
</tr>
<tr>
<td>18.03 or 2.087 Differential Equations or Engineering Mathematics: Linear Algebra and ODEs</td>
<td>6-12</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>9-12</td>
</tr>
<tr>
<td>6.01 Introduction to EECS via Robotics</td>
<td></td>
</tr>
<tr>
<td>6.02 Introduction to EECS via Communication Networks</td>
<td></td>
</tr>
<tr>
<td>6.03 Introduction to EECS via Medical Technology</td>
<td></td>
</tr>
<tr>
<td>6.08 Introduction to EECS via Interconnected Embedded Systems</td>
<td></td>
</tr>
</tbody>
</table>

**Electrical Engineering Requirements**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Required Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.002 Circuits and Electronics</td>
<td>12</td>
</tr>
<tr>
<td>6.003 Signals and Systems</td>
<td>12</td>
</tr>
<tr>
<td>6.004 Computation Structures</td>
<td>12</td>
</tr>
<tr>
<td>Select three of the following</td>
<td>36</td>
</tr>
<tr>
<td>6.011 Signals, Systems and Inference</td>
<td></td>
</tr>
<tr>
<td>6.012 Nanoelectronics and Computing Systems</td>
<td></td>
</tr>
<tr>
<td>6.013 Electromagnetics and Applications</td>
<td></td>
</tr>
<tr>
<td>6.014 Electromagnetic Fields, Forces and Motion</td>
<td></td>
</tr>
<tr>
<td>6.021[J] Cellular Neurophysiology and Computing</td>
<td></td>
</tr>
<tr>
<td>6.036 Introduction to Machine Learning</td>
<td></td>
</tr>
</tbody>
</table>

**Elective Subjects**

Select two subjects from the list of Advanced Undergraduate Subjects (24-30 units in total). Select two subjects from the departmental list of EECS subjects (24 units in total).

**Units in Major Total**

153-168 units

**Units in Major That Also Satisfy the GIRs**

24-48 units

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

180-186 units

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. Chosen electives must satisfy each of the following categories: Advanced Departmental Laboratory, Independent Inquiry, and Probability. A subject may count toward more than one category. See departmental website (http://www.eecs.mit.edu/academics-admissions/undergraduate-programs) for list of acceptable EECS subjects.

2. Advanced Undergraduate Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Required Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.025[J] Medical Device Design (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>6.027[J] Biomedical Feedback Systems</td>
<td>12</td>
</tr>
<tr>
<td>6.035 Computer Language Engineering</td>
<td>12</td>
</tr>
<tr>
<td>6.047 Computational Biology: Genomes, Networks, Evolution</td>
<td>12</td>
</tr>
<tr>
<td>6.061 Introduction to Electric Power Systems</td>
<td>12</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>6.101</td>
<td>Introductory Analog Electronics Laboratory (CI-M)</td>
</tr>
<tr>
<td>6.111</td>
<td>Introductory Digital Systems Laboratory</td>
</tr>
<tr>
<td>6.115</td>
<td>Microcomputer Project Laboratory (CI-M)</td>
</tr>
<tr>
<td>6.1151</td>
<td>Microcomputer Project Laboratory - Independent Inquiry (CI-M)</td>
</tr>
<tr>
<td>6.129[J]</td>
<td>Biological Circuit Engineering Laboratory (CI-M)</td>
</tr>
<tr>
<td>6.131</td>
<td>Power Electronics Laboratory (CI-M)</td>
</tr>
<tr>
<td>6.1311</td>
<td>Power Electronics Laboratory - Independent Inquiry (CI-M)</td>
</tr>
<tr>
<td>6.161</td>
<td>Modern Optics Project Laboratory (CI-M)</td>
</tr>
<tr>
<td>6.163</td>
<td>Strobe Project Laboratory (CI-M)</td>
</tr>
<tr>
<td>6.170</td>
<td>Software Studio</td>
</tr>
<tr>
<td>6.172</td>
<td>Performance Engineering of Software Systems</td>
</tr>
<tr>
<td>6.175</td>
<td>Constructive Computer Architecture</td>
</tr>
<tr>
<td>6.201</td>
<td>Solid-State Circuits</td>
</tr>
<tr>
<td>6.202</td>
<td>Feedback System Design</td>
</tr>
<tr>
<td>6.203</td>
<td>Introduction to Nanoelectronics</td>
</tr>
<tr>
<td>6.281</td>
<td>Machine Vision</td>
</tr>
<tr>
<td>6.283</td>
<td>The Human Intelligence Enterprise</td>
</tr>
<tr>
<td>6.286</td>
<td>Advanced Natural Language Processing</td>
</tr>
<tr>
<td>6.288</td>
<td>User Interface Design and Implementation</td>
</tr>
<tr>
<td>6.289[J]</td>
<td>Interactive Music Systems</td>
</tr>
<tr>
<td>6.2894</td>
<td>Interactive Music Systems</td>
</tr>
<tr>
<td>6.2895</td>
<td>Interactive Music Systems</td>
</tr>
<tr>
<td>6.291</td>
<td>Principles and Practice of Assistive Technology</td>
</tr>
<tr>
<td>6.292</td>
<td>User Interface Design and Implementation</td>
</tr>
<tr>
<td>6.293</td>
<td>Advances in Computer Vision</td>
</tr>
<tr>
<td>6.294</td>
<td>Computer Graphics</td>
</tr>
<tr>
<td>6.295</td>
<td>Large-scale Symbolic Systems</td>
</tr>
<tr>
<td>6.296</td>
<td>Large-scale Symbolic Systems</td>
</tr>
</tbody>
</table>

**Independent Inquiry Subjects**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.035</td>
<td>Computer Language Engineering</td>
<td>12</td>
</tr>
<tr>
<td>6.047</td>
<td>Computational Biology: Genomes, Networks, Evolution</td>
<td>12</td>
</tr>
<tr>
<td>6.100</td>
<td>Electrical Engineering and Computer Science Project</td>
<td>12</td>
</tr>
<tr>
<td>6.111</td>
<td>Introductory Digital Systems Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>6.1151</td>
<td>Microcomputer Project Laboratory - Independent Inquiry (CI-M)</td>
<td>15</td>
</tr>
<tr>
<td>6.129[J]</td>
<td>Biological Circuit Engineering Laboratory (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>6.131</td>
<td>Power Electronics Laboratory (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>6.1311</td>
<td>Power Electronics Laboratory - Independent Inquiry</td>
<td>15</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>6.161</td>
<td>Modern Optics Project Laboratory (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>6.163</td>
<td>Strobe Project Laboratory (CI-M)</td>
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<tr>
<td>6.170</td>
<td>Software Studio</td>
<td>12</td>
</tr>
<tr>
<td>6.172</td>
<td>Performance Engineering of Software Systems</td>
<td>18</td>
</tr>
<tr>
<td>6.175</td>
<td>Constructive Computer Architecture</td>
<td>12</td>
</tr>
<tr>
<td>6.182</td>
<td>Psychoacoustics Project Laboratory (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>6.302</td>
<td>Feedback System Design</td>
<td>12</td>
</tr>
<tr>
<td>6.806</td>
<td>Advanced Natural Language Processing</td>
<td>12</td>
</tr>
<tr>
<td>6.809[J]</td>
<td>Interactive Music Systems</td>
<td>12</td>
</tr>
<tr>
<td>6.816</td>
<td>Multicore Programming</td>
<td>12</td>
</tr>
<tr>
<td>6.819</td>
<td>Advances in Computer Vision</td>
<td>12</td>
</tr>
<tr>
<td>6.837</td>
<td>Computer Graphics</td>
<td>12</td>
</tr>
</tbody>
</table>

**Probability Subjects**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.008</td>
<td>Introduction to Inference</td>
<td>12</td>
</tr>
<tr>
<td>6.041A</td>
<td>Introduction to Probability I</td>
<td>6</td>
</tr>
<tr>
<td>18.05</td>
<td>Introduction to Probability and Statistics</td>
<td>12</td>
</tr>
<tr>
<td>18.600</td>
<td>Probability and Random Variables</td>
<td>12</td>
</tr>
</tbody>
</table>
Bachelor of Science in Engineering as Recommended by the Department of Aeronautics and Astronautics

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Science Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied from among 6.00, 16.001, and 18.03 in the Departmental Program]</td>
<td>1</td>
</tr>
</tbody>
</table>

Total GIR Subjects Required for SB Degree 17

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Departmental Core

<table>
<thead>
<tr>
<th>Departmental Core</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00</td>
<td>12</td>
</tr>
<tr>
<td>6.001</td>
<td>12</td>
</tr>
<tr>
<td>16.002</td>
<td>12</td>
</tr>
<tr>
<td>16.003</td>
<td>12</td>
</tr>
<tr>
<td>16.004</td>
<td>12</td>
</tr>
<tr>
<td>16.06</td>
<td>12</td>
</tr>
<tr>
<td>16.07</td>
<td>12</td>
</tr>
<tr>
<td>18.03</td>
<td>12</td>
</tr>
</tbody>
</table>

Concentration Subjects

These electives define a concentrated area of study and must be chosen with the written approval of the AeroAstro Undergraduate Office. A minimum of 42 units of engineering topics and a minimum of 12 units of mathematics or science topics must be included in the 72 units of concentration electives. In all cases, the concentration subjects must be clearly related to the theme of the concentration. 3

Laboratory and Capstone Subjects

Select one of the following:

- 16.82 Flight Vehicle Engineering (CI-M)
- 16.83[J] Space Systems Engineering (CI-M)

Select one of the following sequences:

- 12-18
  - 16.821 Flight Vehicle Development (CI-M)
  - 16.831[J] Space Systems Development (CI-M)

Units in Major: 180-186

Unrestrictive Electives: 48

Units in Major That Also Satisfy the GIRs: (36)

Total Units Beyond the GIRs Required for SB Degree: 192-198

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Combination of 6.0001 Introduction to Computer Science Programming in Python and 6.0002 Introduction to Computational Thinking and Data Science is also an acceptable option.
2 18.032 Differential Equations is also an acceptable option.
3 A list of approved subjects for each concentration, as well as additional information about the 16-ENG program, is available on the department’s website (http://aeroastro.mit.edu/academics/undergraduate-program/degrees).
ENGINEERING, CHEMICAL ENGINEERING
(COURSE 10-ENG)

Department of Chemical Engineering (p. 165)

Bachelor of Science in Engineering as Recommended by the Department of Chemical Engineering

General Institute Requirements (GI Rs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
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<tbody>
<tr>
<td>Science Requirement</td>
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</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>5.60 Thermodynamics and Kinetics</td>
</tr>
<tr>
<td>12</td>
<td>10.10 Introduction to Chemical Engineering</td>
</tr>
<tr>
<td>12</td>
<td>10.213 Chemical and Biological Engineering</td>
</tr>
<tr>
<td>12</td>
<td>10.301 Fluid Mechanics</td>
</tr>
<tr>
<td>12</td>
<td>10.302 Transport Processes</td>
</tr>
<tr>
<td>9</td>
<td>10.37 Chemical Kinetics and Reactor Design</td>
</tr>
<tr>
<td>12</td>
<td>18.03 Differential Equations</td>
</tr>
</tbody>
</table>

Foundational Concepts

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
Select one of the following Course 10 CI-M subjects:

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>10.26 Chemical Engineering Projects Laboratory (CI-M)</td>
</tr>
<tr>
<td>12</td>
<td>10.27 Energy Engineering Projects Laboratory (CI-M)</td>
</tr>
<tr>
<td>12</td>
<td>10.28 Chemical-Biological Engineering Laboratory (CI-M)</td>
</tr>
<tr>
<td>9</td>
<td>10.29 Biological Engineering Projects Laboratory (CI-M)</td>
</tr>
<tr>
<td>3</td>
<td>10.467 Polymer Science Laboratory (CI-M)</td>
</tr>
</tbody>
</table>

Group II
Select one of the following Institute Laboratory subjects:

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1.106 &amp; 1.107 Environmental Fluid Transport Processes and Hydrology Laboratory and Environmental Chemistry and Biology Laboratory</td>
</tr>
<tr>
<td>3</td>
<td>2.671 Measurement and Instrumentation (CI-M)</td>
</tr>
<tr>
<td>3</td>
<td>3.014 Materials Laboratory (CI-M)</td>
</tr>
<tr>
<td>2</td>
<td>5.310 Laboratory Chemistry</td>
</tr>
<tr>
<td>4</td>
<td>10.702[J] Introduction to Experimental Biology and Communication (CI-M)</td>
</tr>
<tr>
<td>4</td>
<td>12.335 Experimental Atmospheric Chemistry (CI-M)</td>
</tr>
<tr>
<td>2</td>
<td>20.109 Laboratory Fundamentals in Biological Engineering (CI-M)</td>
</tr>
</tbody>
</table>

Group III
Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1.00 Engineering Computation and Data Science</td>
</tr>
<tr>
<td>4</td>
<td>1.080A &amp; 1.080B Environmental Chemistry I and Environmental Chemistry II</td>
</tr>
<tr>
<td>3</td>
<td>3.012 Fundamentals of Materials Science and Engineering</td>
</tr>
<tr>
<td>3</td>
<td>3.155[J] Micro/Nano Processing Technology (CI-M)</td>
</tr>
<tr>
<td>9</td>
<td>5.12 Organic Chemistry I</td>
</tr>
<tr>
<td>12</td>
<td>5.61 Physical Chemistry</td>
</tr>
<tr>
<td>12</td>
<td>6.00 Introduction to Computer Science and Programming</td>
</tr>
</tbody>
</table>
Genetics

Physics of Energy

**Engineering Concentration**

These four electives define a concentrated area of study in one of the following designated concentrations: biomedical engineering, energy, environmental studies, or materials process and design.

**Capstone**

Select 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.

<table>
<thead>
<tr>
<th>Option 1</th>
<th>10.THU</th>
<th>Undergraduate Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 2</td>
<td>Select any combination of the following:</td>
<td></td>
</tr>
<tr>
<td>10.490</td>
<td>Integrated Chemical Engineering</td>
<td></td>
</tr>
<tr>
<td>10.492A</td>
<td>Integrated Chemical Engineering Topics I</td>
<td></td>
</tr>
<tr>
<td>or 10.492B</td>
<td>Integrated Chemical Engineering Topics I</td>
<td></td>
</tr>
<tr>
<td>10.493</td>
<td>Integrated Chemical Engineering Topics II</td>
<td></td>
</tr>
<tr>
<td>10.494A</td>
<td>Integrated Chemical Engineering Topics III</td>
<td></td>
</tr>
<tr>
<td>or 10.494B</td>
<td>Integrated Chemical Engineering Topics III</td>
<td></td>
</tr>
<tr>
<td>Option 3</td>
<td>10.910</td>
<td>Independent Research Problem</td>
</tr>
<tr>
<td>and select any combination of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.492A</td>
<td>Integrated Chemical Engineering Topics I</td>
<td></td>
</tr>
<tr>
<td>or 10.492B</td>
<td>Integrated Chemical Engineering Topics I</td>
<td></td>
</tr>
<tr>
<td>10.493</td>
<td>Integrated Chemical Engineering Topics II</td>
<td></td>
</tr>
<tr>
<td>10.494A</td>
<td>Integrated Chemical Engineering Topics III</td>
<td></td>
</tr>
<tr>
<td>or 10.494B</td>
<td>Integrated Chemical Engineering Topics III</td>
<td></td>
</tr>
</tbody>
</table>

**Units in Major**

171-186

**Unrestricted Electives**

48

**Units in Major That Also Satisfy the GIRs**

(36)

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

183-198

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

---

2. Subject may be of particular interest for energy concentration.

3. Subject may be of particular interest for biomedical engineering concentration.

4. Subject may be of particular interest for environmental studies concentration.

5. 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, and additional information on current subject offerings is available on the Chemical Engineering Department website (https://cheme.mit.edu/academics/course-listing). Note that subjects that have been used to satisfy the foundational concepts may not also be counted toward the engineering concentration.

6. 10.490 may be repeated once for credit with permission of instructor.
ENGINEERING, MECHANICAL ENGINEERING (COURSE 2-A)

Department of Mechanical Engineering (p. 215)

Bachelor of Science in Engineering as Recommended by the Department of Mechanical Engineering

General Institute Requirements (GIRs)

The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
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<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [satisfied by 2.671 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>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Elective Subjects with Engineering Content

Select 72 units (must include one REST subject outside Course 2) 2

<table>
<thead>
<tr>
<th>Units in Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>168</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unrestricted Electives</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units in Major That Also Satisfy the GIRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Units Beyond the GIRs Required for SB Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. Students may also fulfill this requirement by completing an alternative 2.00X subject, i.e., 2.00B.

2. These electives define a concentrated area of study which must be approved by the 2-A review committee. The concentration electives must form an engineering topic. Concentration electives must include one subject that meets the REST GIR, but not subjects that fulfill a HASS GIR. In some cases, non-engineering subjects may be necessary for the particular engineering topic defined by the concentration (e.g., management subjects for an engineering management concentration), in which case additional engineering subjects may be required to meet the engineering accreditation standards. In all cases, the relationship of concentration subjects to the engineering topic must be obvious.
GENERAL ENGINEERING (COURSE 1-ENG)

Department of Civil and Environmental Engineering (p. 174)

Bachelor of Science in General Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 1.00 or 1.000, and 18.03 in the Departmental Program]</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied from among 1.101 and 1.102 or 1.106 and 1.107 in the Departmental Program]</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

General Department Requirements (GDRs)

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00 Engineering Computation and Data Science</td>
</tr>
<tr>
<td>1.010 Introduction to Probability and Statistics in Engineering</td>
</tr>
<tr>
<td>1.013 Senior Civil and Environmental Engineering Design (CI-M)</td>
</tr>
<tr>
<td>1.073 Introduction to Environmental Data Analysis</td>
</tr>
<tr>
<td>1.074 Multivariate Data Analysis</td>
</tr>
<tr>
<td>18.03 Differential Equations</td>
</tr>
</tbody>
</table>

Core Subjects

Select one area of core coursework

<table>
<thead>
<tr>
<th>Environment</th>
</tr>
</thead>
</table>

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.

| Units in Major | 168 |
| Unrestricted Electives | 48-60 |

Total Units Beyond the GIRs Required for SB Degree | 180 |
The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.
MATERIALS SCIENCE AND ENGINEERING (COURSE 3)

Department of Materials Science and Engineering (p. 205)

Bachelor of Science in Materials Science and Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Science Requirement</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>HASS Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 3.014 in the Departmental Program]</td>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
<tr>
<td>Physical Education Requirement</td>
<td>Swimming requirement, plus four physical education courses for eight points.</td>
<td></td>
</tr>
</tbody>
</table>

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.012</td>
</tr>
<tr>
<td>3.014</td>
</tr>
<tr>
<td>3.022</td>
</tr>
<tr>
<td>3.024</td>
</tr>
<tr>
<td>3.032</td>
</tr>
<tr>
<td>3.034</td>
</tr>
<tr>
<td>3.042</td>
</tr>
<tr>
<td>3.044</td>
</tr>
<tr>
<td>18.03</td>
</tr>
<tr>
<td>1.00</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.016</td>
</tr>
<tr>
<td>3.021</td>
</tr>
<tr>
<td>6.00</td>
</tr>
<tr>
<td>6.0001 &amp; 6.0002</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.930 &amp; 3.931</td>
</tr>
<tr>
<td>3.THU</td>
</tr>
</tbody>
</table>

Restricted Electives

Select 48 units from the following:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.004</td>
</tr>
<tr>
<td>3.016</td>
</tr>
<tr>
<td>3.017</td>
</tr>
<tr>
<td>3.021</td>
</tr>
<tr>
<td>3.046</td>
</tr>
<tr>
<td>3.048</td>
</tr>
<tr>
<td>3.052</td>
</tr>
<tr>
<td>3.053[J]</td>
</tr>
<tr>
<td>3.054</td>
</tr>
<tr>
<td>3.055[J]</td>
</tr>
<tr>
<td>3.063</td>
</tr>
<tr>
<td>3.064</td>
</tr>
<tr>
<td>3.07</td>
</tr>
<tr>
<td>3.071</td>
</tr>
<tr>
<td>3.072</td>
</tr>
<tr>
<td>3.074</td>
</tr>
<tr>
<td>3.080</td>
</tr>
<tr>
<td>3.081</td>
</tr>
<tr>
<td>3.086</td>
</tr>
<tr>
<td>3.14</td>
</tr>
<tr>
<td>3.15</td>
</tr>
<tr>
<td>3.152</td>
</tr>
</tbody>
</table>
### 3.153 Nanoscale Materials

### 3.154 Materials Performance in Extreme Environments

### 3.155 Micro/Nano Processing Technology (CI-M)

### 3.156 Photonic Materials and Devices

### 3.18 Materials Science and Engineering of Clean Energy

### 3.19 Sustainable Chemical Metallurgy

<table>
<thead>
<tr>
<th>Units in Major</th>
<th>180-183</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
<td>(39)</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>189-192</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. 18.032 Differential Equations is also an acceptable option.
2. These subjects can count as part of the required subjects or as restricted electives, but not both.
3. Students may elect 9–12 units.
4. Substitution of similar subjects may be permitted by petition.
MATERIALS SCIENCE AND ENGINEERING (COURSE 3-A)

Department of Materials Science and Engineering (p. 205)

Bachelor of Science as Recommended by the Department of Materials Science and Engineering

Students planning to follow this curriculum must submit a program of study no later than the beginning of their junior year.

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 18.03 and 3.012, 3.021, or 3.046 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 3.014 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>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.014 Materials Laboratory (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>Select five of the following core subjects:</td>
<td>60-63</td>
</tr>
<tr>
<td>3.012 Fundamentals of Materials Science and Engineering</td>
<td></td>
</tr>
<tr>
<td>3.016 Computational Methods for Materials Scientists and Engineers</td>
<td></td>
</tr>
<tr>
<td>or 18.03 Differential Equations</td>
<td></td>
</tr>
<tr>
<td>3.022 Microstructural Evolution in Materials</td>
<td></td>
</tr>
<tr>
<td>3.024 Electronic, Optical and Magnetic Properties of Materials</td>
<td></td>
</tr>
<tr>
<td>3.032 Mechanical Behavior of Materials</td>
<td></td>
</tr>
<tr>
<td>3.034 Organic and Biomaterials Chemistry</td>
<td></td>
</tr>
<tr>
<td>3.042 Materials Project Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>3.044 Materials Processing</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td></td>
</tr>
<tr>
<td>Select three of the following:</td>
<td>36</td>
</tr>
<tr>
<td>3.004 Principles of Engineering Practice</td>
<td></td>
</tr>
<tr>
<td>3.016 Computational Methods for Materials Scientists and Engineers</td>
<td>2</td>
</tr>
<tr>
<td>3.017 Modelling, Problem Solving, Computing, and Visualization</td>
<td></td>
</tr>
<tr>
<td>3.021 Introduction to Modeling and Simulation</td>
<td>2</td>
</tr>
<tr>
<td>3.034A Organic and Biomaterials Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>3.046 Thermodynamics of Materials</td>
<td></td>
</tr>
<tr>
<td>3.048 Advanced Materials Processing</td>
<td></td>
</tr>
<tr>
<td>3.052 Nanomechanics of Materials and Biomaterials</td>
<td></td>
</tr>
<tr>
<td>3.053 Molecular, Cellular, and Tissue Biomechanics</td>
<td></td>
</tr>
<tr>
<td>3.054 Cellular Solids: Structure, Properties, Applications</td>
<td></td>
</tr>
<tr>
<td>3.055J Biomaterials Science and Engineering</td>
<td></td>
</tr>
<tr>
<td>3.063 Polymer Physics</td>
<td></td>
</tr>
<tr>
<td>3.064 Polymer Engineering</td>
<td></td>
</tr>
<tr>
<td>3.07 Introduction to Ceramics</td>
<td></td>
</tr>
<tr>
<td>3.071 Amorphous Materials</td>
<td></td>
</tr>
<tr>
<td>3.072 Symmetry, Structure and Tensor Properties of Materials</td>
<td></td>
</tr>
<tr>
<td>3.074 Imaging of Materials</td>
<td></td>
</tr>
<tr>
<td>3.080 Strategic Materials Selection</td>
<td></td>
</tr>
<tr>
<td>3.081 Industrial Ecology of Materials</td>
<td></td>
</tr>
<tr>
<td>3.086 Innovation and Commercialization of Materials Technology</td>
<td></td>
</tr>
<tr>
<td>3.14 Physical Metallurgy</td>
<td></td>
</tr>
<tr>
<td>3.15 Electrical, Optical, and Magnetic Materials and Devices</td>
<td></td>
</tr>
<tr>
<td>3.152 Magnetic Materials</td>
<td></td>
</tr>
<tr>
<td>3.153 Nanoscale Materials</td>
<td></td>
</tr>
<tr>
<td>3.154J Materials Performance in Extreme Environments</td>
<td></td>
</tr>
<tr>
<td>3.155J Micro/Nano Processing Technology (CI-M)</td>
<td></td>
</tr>
<tr>
<td>3.156 Photonic Materials and Devices</td>
<td></td>
</tr>
</tbody>
</table>
3.171 Structural Materials and Manufacturing
3.18 Materials Science and Engineering of Clean Energy
3.19 Sustainable Chemical Metallurgy

Select six electives from a proposal of study approved by the department

<table>
<thead>
<tr>
<th>Units in Major</th>
<th>180-183</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>48</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
<td>(36-39)</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>192</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. 18.032 Differential Equations is also an acceptable option.
2. These subjects may count as part of the required subjects or as restricted electives, but not both.
3. Students can take 3.034 as a required subject or 3.034A as a restricted elective, but cannot count both subjects toward their major.
4. Students must develop a program of six elective subjects appropriate to their stated goals.

Communication-Intensive Subjects in the Major

Required subject (see degree chart above):

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.014 Materials Laboratory</td>
<td>12</td>
</tr>
</tbody>
</table>

Choose one of the following as the second CI-M subject:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.009 The Product Engineering Process</td>
<td>9-18</td>
</tr>
<tr>
<td>2.671 Measurement and Instrumentation</td>
<td></td>
</tr>
<tr>
<td>3.042 Materials Project Laboratory</td>
<td></td>
</tr>
<tr>
<td>3.155J Micro/Nano Processing Technology</td>
<td></td>
</tr>
<tr>
<td>7.02J Introduction to Experimental Biology and Communication</td>
<td></td>
</tr>
<tr>
<td>7.02J Introduction to Experimental Biology and Communication</td>
<td></td>
</tr>
<tr>
<td>7.05 General Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>7.02J Introduction to Experimental Biology and Communication</td>
<td>18</td>
</tr>
<tr>
<td>7.05 General Biochemistry</td>
<td>12</td>
</tr>
</tbody>
</table>

Example of a 3-A Program

A student planning a career in medicine might select the following subjects, in addition to the above requirements, in order to satisfy the premedical requirements recommended by Career Advising and Professional Development:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.12 Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.13 Organic Chemistry II</td>
<td>12</td>
</tr>
<tr>
<td>5.310 Laboratory Chemistry</td>
<td>12</td>
</tr>
</tbody>
</table>
MECHANICAL AND OCEAN ENGINEERING (COURSE 2-OE)

Bachelor of Science in Mechanical and Ocean Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects</td>
<td></td>
</tr>
<tr>
<td>must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 2.001 and 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 2.671 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00A Fundamentals of Engineering Design: Explore Space, Sea and Earth</td>
<td>9</td>
</tr>
<tr>
<td>2.001 Mechanics and Materials I</td>
<td>12</td>
</tr>
<tr>
<td>2.002 Mechanics and Materials II</td>
<td>12</td>
</tr>
<tr>
<td>2.003[J] Dynamics and Control I</td>
<td>12</td>
</tr>
<tr>
<td>2.004 Dynamics and Control II</td>
<td>12</td>
</tr>
<tr>
<td>2.005 Thermal-Fluids Engineering I</td>
<td>12</td>
</tr>
<tr>
<td>2.016 Hydodynamics</td>
<td>12</td>
</tr>
<tr>
<td>2.017[J] Design of Electromechanical Robotic Systems (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>2.065 Acoustics and Sensing</td>
<td>12</td>
</tr>
<tr>
<td>2.086 Numerical Computation for Mechanical Engineers</td>
<td>12</td>
</tr>
<tr>
<td>2.612 Marine Power and Propulsion</td>
<td>12</td>
</tr>
<tr>
<td>2.671 Measurement and Instrumentation (CI-M)</td>
<td></td>
</tr>
<tr>
<td>2.677 Design and Experimentation for Ocean Engineering</td>
<td>6</td>
</tr>
<tr>
<td>2.678 Electronics for Mechanical Systems</td>
<td>6</td>
</tr>
<tr>
<td>18.03 Differential Equations</td>
<td>12</td>
</tr>
</tbody>
</table>

Restricted Electives
Select one elective from the Restricted Electives list below.

Units in Major
Total GIR Subjects Required for SB Degree
Total Units Beyond the GIRs Required for SB Degree

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

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

Restricted Electives

<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.006 Thermal-Fluids Engineering II</td>
<td>12</td>
</tr>
<tr>
<td>2.008 Design and Manufacturing II</td>
<td>12</td>
</tr>
<tr>
<td>2.013 Engineering Systems Design</td>
<td>12</td>
</tr>
<tr>
<td>2.014 Engineering Systems Development</td>
<td>12</td>
</tr>
<tr>
<td>2.019 Design of Ocean Systems</td>
<td>12</td>
</tr>
<tr>
<td>2.092 Finite Element Analysis of Solids and Fluids I</td>
<td>12</td>
</tr>
<tr>
<td>2.12 Introduction to Robotics</td>
<td>12</td>
</tr>
<tr>
<td>2.14 Analysis and Design of Feedback Control Systems</td>
<td>12</td>
</tr>
<tr>
<td>2.700 Principles of Naval Architecture</td>
<td>12</td>
</tr>
<tr>
<td>2.96 Management in Engineering</td>
<td>12</td>
</tr>
<tr>
<td>2.THU Undergraduate Thesis</td>
<td>12</td>
</tr>
</tbody>
</table>

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

Department of Mechanical Engineering (p. 215)

Bachelor of Science in Mechanical Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS) Requirement</td>
<td>8</td>
</tr>
<tr>
<td>at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>[can be satisfied by 2.001 and 18.03 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>[can be satisfied by 2.671 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Core Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.001 Mechanics and Materials I</td>
<td>12</td>
</tr>
<tr>
<td>2.002 Mechanics and Materials II</td>
<td>12</td>
</tr>
<tr>
<td>2.003[J] Dynamics and Control I</td>
<td>12</td>
</tr>
<tr>
<td>2.004 Dynamics and Control II</td>
<td>12</td>
</tr>
<tr>
<td>2.005 Thermal-Fluids Engineering I</td>
<td>12</td>
</tr>
<tr>
<td>2.006 Thermal-Fluids Engineering II</td>
<td>12</td>
</tr>
<tr>
<td>2.007 Design and Manufacturing I</td>
<td>12</td>
</tr>
<tr>
<td>or 2.017[J] Design of Electromechanical Robotic Systems</td>
<td></td>
</tr>
<tr>
<td>2.008 Design and Manufacturing II</td>
<td>12</td>
</tr>
<tr>
<td>2.009 The Product Engineering Process (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>2.086 Numerical Computation for Mechanical Engineers</td>
<td>12</td>
</tr>
<tr>
<td>2.670 Mechanical Engineering Tools</td>
<td>3</td>
</tr>
</tbody>
</table>

2.671 Measurement and Instrumentation (CI-M) | 12 |

Restricted Electives
Select two of the following:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.016 Hydrodynamics</td>
<td></td>
</tr>
<tr>
<td>2.017[J] Design of Electromechanical Robotic Systems</td>
<td></td>
</tr>
<tr>
<td>2.019 Design of Ocean Systems (CI-M)</td>
<td></td>
</tr>
<tr>
<td>2.050[J] Nonlinear Dynamics: Chaos</td>
<td></td>
</tr>
<tr>
<td>2.092 Finite Element Analysis of Solids and Fluids I</td>
<td></td>
</tr>
<tr>
<td>2.12 Introduction to Robotics</td>
<td></td>
</tr>
<tr>
<td>2.14 Analysis and Design of Feedback Control Systems</td>
<td></td>
</tr>
<tr>
<td>2.184 Biomechanics and Neural Control of Movement</td>
<td></td>
</tr>
<tr>
<td>2.370 Fundamentals of Nanoengineering</td>
<td></td>
</tr>
<tr>
<td>2.51 Intermediate Heat and Mass Transfer</td>
<td></td>
</tr>
<tr>
<td>2.60[J] Fundamentals of Advanced Energy Conversion</td>
<td></td>
</tr>
<tr>
<td>2.650[J] Introduction to Sustainable Energy</td>
<td></td>
</tr>
<tr>
<td>2.71 Optics</td>
<td></td>
</tr>
<tr>
<td>2.72 Elements of Mechanical Design</td>
<td></td>
</tr>
<tr>
<td>2.797[J] Molecular, Cellular, and Tissue Biomechanics</td>
<td></td>
</tr>
<tr>
<td>2.813 Energy, Materials, and Manufacturing</td>
<td></td>
</tr>
<tr>
<td>2.96 Management in Engineering</td>
<td></td>
</tr>
</tbody>
</table>

Units in Major 177

Unrestricted Electives 4 48

Units in Major That Also Satisfy the GIRs (36)

Total Units Beyond the GIRs Required for SB Degree 189

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Students may fulfill this requirement by completing an alternative Course 2 CI-M subject (e.g., 2.013, 2.750[J], or 2.760). 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.THU credit, subject to approval of the student’s thesis advisor.

4 The department suggests that students select a basic electronics subject (e.g., 2.678, 6.002, or 22.071) as early as possible in their program.
NUCLEAR SCIENCE AND ENGINEERING (COURSE 22)

Department of Nuclear Science and Engineering (p. 231)

Bachelor of Science in Nuclear Science and Engineering

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [can be satisfied by 22.04[J] in</td>
<td></td>
</tr>
<tr>
<td>the Departmental Program]; at least two of</td>
<td></td>
</tr>
<tr>
<td>these subjects must be designated as</td>
<td></td>
</tr>
<tr>
<td>communication-intensive (CI-H) to fulfill</td>
<td></td>
</tr>
<tr>
<td>the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 8.03, 18.03, and 22.01 or 22.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 22.09 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Basic Requirements

<table>
<thead>
<tr>
<th>Units</th>
<th>Basic Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2.005 Thermal-Fluids Engineering I</td>
</tr>
<tr>
<td></td>
<td>8.03 Physics III</td>
</tr>
<tr>
<td></td>
<td>18.03 Differential Equations</td>
</tr>
<tr>
<td></td>
<td>22.01 Introduction to Nuclear Engineering and Ionizing Radiation</td>
</tr>
<tr>
<td></td>
<td>22.03 Introduction to Nuclear Design</td>
</tr>
<tr>
<td></td>
<td>Select one of the following:</td>
</tr>
<tr>
<td></td>
<td>1.000 Computer Programming for Engineering Applications</td>
</tr>
<tr>
<td></td>
<td>2.086 Numerical Computation for Mechanical Engineers</td>
</tr>
<tr>
<td></td>
<td>6.00 Introduction to Computer Science and Programming</td>
</tr>
<tr>
<td></td>
<td>12.010 Computational Methods of Scientific Programming</td>
</tr>
</tbody>
</table>

Required Core Subjects

<table>
<thead>
<tr>
<th>Units</th>
<th>Required Core Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>22.02 Introduction to Applied Nuclear Physics</td>
</tr>
<tr>
<td>15</td>
<td>22.033 Nuclear Systems Design Project</td>
</tr>
<tr>
<td>12</td>
<td>22.04[J] Social Problems of Nuclear Energy</td>
</tr>
<tr>
<td>12</td>
<td>22.05 Neutron Science and Reactor Physics</td>
</tr>
<tr>
<td>12</td>
<td>22.06 Engineering of Nuclear Systems</td>
</tr>
<tr>
<td>12</td>
<td>22.061 Fusion Energy</td>
</tr>
<tr>
<td>12</td>
<td>22.09 Principles of Nuclear Radiation Measurement and Protection</td>
</tr>
</tbody>
</table>

Required Thesis

<table>
<thead>
<tr>
<th>Units</th>
<th>Required Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>22.THT Undergraduate Thesis Tutorial</td>
</tr>
<tr>
<td>9</td>
<td>22.THU Undergraduate Thesis</td>
</tr>
</tbody>
</table>

Mathematics Elective

Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Mathematics Elective</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>6.041A &amp; 6.041B Introduction to Probability I and Probability II</td>
</tr>
<tr>
<td>12</td>
<td>18.04 Complex Variables with Applications</td>
</tr>
<tr>
<td>12</td>
<td>18.05 Introduction to Probability and Statistics</td>
</tr>
<tr>
<td>12</td>
<td>18.0751 Methods for Scientists and Engineers</td>
</tr>
<tr>
<td>12</td>
<td>18.600 Probability and Random Variables</td>
</tr>
</tbody>
</table>

Restricted Elective in NSE

<table>
<thead>
<tr>
<th>Units</th>
<th>Restricted Elective in NSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>22.071 Electronics, Signals, and Measurement</td>
</tr>
<tr>
<td>12</td>
<td>22.072 Quantum Theory of Radiation Interactions</td>
</tr>
<tr>
<td>12</td>
<td>22.078 Principles of Nuclear Chemical Engineering and Waste Management</td>
</tr>
<tr>
<td>12</td>
<td>22.079 Radiation Damage and Effects in Nuclear Materials</td>
</tr>
<tr>
<td>12</td>
<td>22.081[J] Introduction to Sustainable Energy</td>
</tr>
<tr>
<td>12</td>
<td>2.006 Thermal-Fluids Engineering II</td>
</tr>
<tr>
<td>12</td>
<td>3.14 Physical Metallurgy</td>
</tr>
</tbody>
</table>

Units in Major

189

Unrestricted Electives

48

Units in Major That Also Satisfy the GIRs (48)

Total Units Beyond the GIRs Required for SB Degree

189
The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. 18.032 Differential Equations is also an acceptable option.
2. Unit totals shown are the minimum requirements.
3. Consult the NSE Academic Office, Room 24-102, regarding substitutions.
ANTHROPOLOGY (COURSE 21A)

Anthropology Section (p. 241)

Bachelor of Science in Anthropology

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21A.00 Introduction to Anthropology: Comparing Human Cultures</td>
<td>12</td>
</tr>
<tr>
<td>21A.01 How Culture Works</td>
<td>12</td>
</tr>
<tr>
<td>21A.155 Food, Culture, and Politics (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>21A.802 Seminar in Ethnography and Fieldwork (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 (21A.THT) and a thesis (21A.THU). The decision to write a thesis is made in consultation between the student and advisor.

Units in Major That Also Satisfy the GIRs (36-72)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
COMPARATIVE MEDIA STUDIES (CMS)

Bachelor of Science in Comparative Media Studies

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Science Requirement</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Introductory</td>
</tr>
<tr>
<td>CMS.100</td>
<td>Introduction to Media Studies</td>
</tr>
<tr>
<td>12</td>
<td>Media Practice and Production</td>
</tr>
<tr>
<td>CMS.335[J]</td>
<td>Short Attention Span Documentary</td>
</tr>
<tr>
<td>CMS.362</td>
<td>Civic Media Collaborative Design Studio</td>
</tr>
<tr>
<td>CMS.590[J]</td>
<td>Design and Development of Games for Learning</td>
</tr>
<tr>
<td>CMS.609[J]</td>
<td>The Word Made Digital</td>
</tr>
<tr>
<td>CMS.622</td>
<td>Applying Media Technologies in the Arts and Humanities</td>
</tr>
<tr>
<td>CMS.633</td>
<td>Digital Humanities: Topics, Techniques, and Technologies</td>
</tr>
<tr>
<td>CMS.634</td>
<td>Designing Interactions</td>
</tr>
</tbody>
</table>

21W.752 Making Documentary: Audio, Video, and More

Communication-intensive in the Major

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMS.701</td>
<td>Current Debates in Media (CI-M)</td>
</tr>
<tr>
<td>12</td>
<td>Select one of the following:</td>
</tr>
<tr>
<td>CMS.400</td>
<td>Media Systems and Texts (CI-M)</td>
</tr>
<tr>
<td>CMS.405</td>
<td>Visual Design (CI-M)</td>
</tr>
<tr>
<td>CMS.407</td>
<td>Sound Studies (CI-M)</td>
</tr>
<tr>
<td>CMS.614[J]</td>
<td>Network Cultures (CI-M)</td>
</tr>
<tr>
<td>CMS.618[J]</td>
<td>Interactive Narrative (CI-M)</td>
</tr>
<tr>
<td>CMS.336[J]</td>
<td>Social Justice and The Documentary Film (CI-M)</td>
</tr>
</tbody>
</table>

Restricted Electives
Select 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>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>Units in Major</td>
</tr>
<tr>
<td>96-132</td>
<td>Unrestricted Electives</td>
</tr>
<tr>
<td>36-72</td>
<td>Units in Major That Also Satisfy the GIRs</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree

180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
ECONOMICS (COURSE 14-1)

Bachelor of Science in Economics

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Communication-intensive (CI-H) requirement</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01 Principles of Microeconomics</td>
<td>12</td>
</tr>
<tr>
<td>or 14.03 Microeconomic Theory and Public Policy</td>
<td></td>
</tr>
<tr>
<td>14.02 Principles of Macroeconomics</td>
<td>12</td>
</tr>
<tr>
<td>14.30 Introduction to Statistical Methods in Economics</td>
<td>12</td>
</tr>
<tr>
<td>14.32 Econometric Data Science</td>
<td>12</td>
</tr>
<tr>
<td>14.THU Thesis</td>
<td>15</td>
</tr>
<tr>
<td>Select two to three of the following, including one subject from the Macroeconomics list and two subjects designated as CI-M:</td>
<td>24-36</td>
</tr>
<tr>
<td>Macroeconomics</td>
<td></td>
</tr>
<tr>
<td>14.05 Intermediate Macroeconomics (CI-M)</td>
<td></td>
</tr>
<tr>
<td>14.06 Advanced Macroeconomics</td>
<td></td>
</tr>
</tbody>
</table>

48 Units in Major

57-93 Unrestricted Electives

147-159 Total Units in Major That Also Satisfy the GIRs

180 Total Units Beyond the GIRs Required for SB Degree

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Students with a score of 5 on the Economics AP exam may substitute 14.03 Microeconomic Theory and Public Policy.

2 Or an approved alternative in statistics (consult department).

3 May be replaced by an additional elective subject in economics.

4 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
### Summary of Subject Requirements

<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 (HASS) Requirement</td>
<td>8</td>
</tr>
<tr>
<td>at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

### Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

### Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

1. **Prerequisite Subjects**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.301</td>
</tr>
<tr>
<td>21G.302</td>
</tr>
</tbody>
</table>

2. **Required Subjects**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.304</td>
</tr>
<tr>
<td>21G.306</td>
</tr>
<tr>
<td>21G.307</td>
</tr>
</tbody>
</table>

Registration for 21G.306 and 21G.307 must be simultaneous with one of the following:

- 21G.308 | Writing (Like the) French |
- 21G.310 | French Conversation: Intensive Practice |
- 21G.311 | Introduction to French Culture |
- 21G.312 | Basic Themes in French Literature and Culture |

21G.315 | A Window onto Contemporary French Society |
21G.320 | Introduction to French Literature |
21G.321 | Childhood and Youth in French and Francophone Cultures |
21G.322 | Frenchness in an Era of Globalization |
21G.325 | New Culture of Gender: Queer France |
21G.326 | Global Africa: Creative Cultures |
21G.328 | African Migrations |
21G.341 | Contemporary French Film and Social Issues |
21G.344 | French Feminist Literature: Yesterday and Today |
21G.346 | Topics in Modern French Literature and Culture |
21G.347 | Social and Literary Trends in Contemporary Short French Fiction |
21G.348 | Global Paris |

### Restricted Electives

A coherent program of eight subjects beyond French II, which may include a pre-thesis tutorial (21G.THT) and a thesis (21G.THU).

| Units in Major | 96 |
| Unrestricted Electives | 78-114 |
| Total Units Required for SB Degree | 180 |

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. The units for the prerequisite subjects are not included in the calculations for this degree chart.

2. This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
**General Institute Requirements (GIRs)**

The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

### Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</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>

### Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

### Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

#### Prerequisite Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.401</td>
</tr>
<tr>
<td>21G.402</td>
</tr>
</tbody>
</table>

#### Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.404</td>
</tr>
<tr>
<td>21G.406</td>
</tr>
<tr>
<td>21G.407</td>
</tr>
</tbody>
</table>

Registration for 21G.406 and 21G.407 must be simultaneous with one of the following:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.405</td>
</tr>
<tr>
<td>21G.409</td>
</tr>
<tr>
<td>21G.410</td>
</tr>
<tr>
<td>21G.412</td>
</tr>
<tr>
<td>21G.414</td>
</tr>
<tr>
<td>21G.415</td>
</tr>
<tr>
<td>21G.416</td>
</tr>
<tr>
<td>21G.417</td>
</tr>
</tbody>
</table>

### Restricted Electives

A coherent program of eight subjects beyond German II, which may include a pre-thesis tutorial (21G.THT) and a thesis (21G.THU).

#### Units in Major

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>138</td>
</tr>
</tbody>
</table>

#### Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>78-114</td>
</tr>
</tbody>
</table>

#### Units in Major That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-72</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree: 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. The units for the prerequisite subjects are not included in the calculations for this degree chart.

2. This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects may be satisfied by subjects in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Prerequisite Subjects ¹ ²

<table>
<thead>
<tr>
<th>Units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.701 Spanish I</td>
<td></td>
</tr>
<tr>
<td>21G.702 Spanish II</td>
<td></td>
</tr>
</tbody>
</table>

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.704 Spanish IV</td>
<td>12</td>
</tr>
<tr>
<td>21G.708 Spanish: Communication Intensive I</td>
<td>3</td>
</tr>
<tr>
<td>21G.709 Spanish: Communication Intensive II</td>
<td>3</td>
</tr>
</tbody>
</table>

Registration for 21G.708 and 21G.709 must be simultaneous with one of the following range of subjects:

<table>
<thead>
<tr>
<th>Units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.716[J] Introduction to Contemporary Hispanic Literature and Film</td>
<td></td>
</tr>
<tr>
<td>21G.717[J] Introduction to Hispanic Culture</td>
<td></td>
</tr>
<tr>
<td>21G.731[J] Creation of a Continent: Representations of Hispanic America, 1492-1898, in Literature and Film</td>
<td></td>
</tr>
<tr>
<td>21G.732 The Making of the Latin American City: Culture, Gender, and Citizenship</td>
<td></td>
</tr>
<tr>
<td>21G.735 Advanced Topics in Hispanic Literature and Film</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives
A coherent program of eight subjects beyond Spanish II, which may include a pre-thesis tutorial (21G.THT) and a thesis (21G.THU).

Units in Major

<table>
<thead>
<tr>
<th>Units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21G.736 The Short Story in Spain and Hispanic America</td>
<td></td>
</tr>
<tr>
<td>21G.738[J] Literature and Social Conflict: Perspectives on the Hispanic World</td>
<td></td>
</tr>
</tbody>
</table>

Units in Major That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>138 Total GIR Subjects Required for SB Degree</td>
<td></td>
</tr>
</tbody>
</table>

Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>78-114 Unrestricted Electives ³</td>
<td></td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree

<table>
<thead>
<tr>
<th>Units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>180 Total Units Beyond the GIRs Required for SB Degree</td>
<td></td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

¹ The units for the prerequisite subjects are not included in the calculations for this degree chart.
² 21G.700 Intensive Spanish for Advanced Beginner Students and 21G.705 Intensive Beginning Spanish for Medicine and Health are each an acceptable substitution for the combination of 21G.701 and 21G.702.
³ This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
HISTORY (COURSE 21H)

History Section (p. 259)

Bachelor of Science in History

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
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<td>Science Requirement</td>
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</tr>
<tr>
<td>Requirement [between three and six subjects can be satisfied by subjects in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select one 21H seminar subject (excluding 21H.390) ¹</td>
<td>9-12</td>
</tr>
<tr>
<td>21H.390 Theories and Methods in the Study of History (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>21H.THT History Pre-Thesis Tutorial</td>
<td>12</td>
</tr>
<tr>
<td>21H.THU History Thesis (CI-M)</td>
<td>12</td>
</tr>
</tbody>
</table>

Restricted Electives
Select a coherent program, in consultation with a major advisor, of seven subjects from the history curriculum and three related subjects from a second HASS discipline ²

| Units in Major                                | 147-168 |
| Unrestricted Electives                         | 48-105  |
| Units in Major That Also Satisfy the GIRs      | (36-72) |
| Total Units Beyond the GIRs Required for SB Degree | 180    |

¹ Select from among 21H subjects for which the first digit after the decimal point is 3. See the History website (http://history.mit.edu/subjects) for additional information.
² The seven 21H subjects must be drawn from two geographical areas and include one pre-modern subject (before 1700) and one modern subject.
HUMANITIES (COURSE 21)

Bachelor of Science in Humanities

All options in this major are by special arrangement, requiring approval by the Dean of the School of Humanities, Arts, and Social Sciences (SHASS). The approval process requires students to designate two communication-intensive (CI-M) subjects in their proposed program of study at the time they submit their proposal for review. The proposed CI-M subjects will be reviewed by the SHASS Academic Administrator and the Subcommittee on the Communication Requirement (SOCR) before the program proposal is submitted to the Dean of SHASS. In most cases, CI-M subjects are selected from among advanced subjects serving as CI-M subjects for related programs. For example, a student proposing a program in American Studies may want to include a subject that serves as a CI-M subject in the history major (Course 21H). Up to six subjects (72 units) may be used for both the major and the GIRs, but the units from those subjects may not count toward the 180 units required beyond the GIRs. In addition, no more than one subject that counts toward the distribution component of the HASS Requirement may also be counted toward the requirements of any program for this major. At least eight of the subjects required for the chosen program cannot also count toward another major or a minor.

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
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<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects can be from the Departmental Program. Only one subject being used to meet the distribution component of the HASS Requirement may be counted toward the degree program.]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.THT Humanities Pre-Thesis Tutorial</td>
<td>6</td>
</tr>
<tr>
<td>21.THU Undergraduate Thesis in Humanities</td>
<td>12</td>
</tr>
</tbody>
</table>

Restricted Electives
The restricted electives for each option are determined in consultation with the faculty advisor in the chosen field.

American Studies
A minimum of nine subjects (108 units) beyond the pre-thesis and thesis. Remaining subjects selected from at least two of the three disciplinary areas.

Ancient and Medieval Studies
A minimum of nine subjects (108 units) beyond the pre-thesis and thesis, including one language subject in Area I (or equivalent proficiency); the eight remaining subjects must be selected from at least two of the three other disciplinary areas (Areas II-IV), with at least one subject in both Ancient and Medieval periods.

Asian and Asian Diaspora Studies
A minimum of nine subjects (108 units) beyond the pre-thesis and thesis, including two language subjects in Area I (or equivalent proficiency), and seven other subjects selected from at least two of the three disciplinary areas (Areas II-IV).

Latin American and Latino/a Studies
A minimum of eight subjects (96 units) beyond the introductory course, pre-thesis, and thesis. Remaining subjects include two language subjects in Area I (or equivalent proficiency), and six subjects selected from at least two of the three disciplinary areas (Areas II-IV).

Russian and Eurasian Studies
A minimum of nine subjects (108 units) beyond the pre-thesis and thesis, two of which must satisfy the language requirement, and at least six of which must be MIT subjects or subjects taken at Harvard or Wellesley under cross-registration.

Women's and Gender Studies
A minimum of eight subjects (96 units) beyond the introductory course, pre-thesis, and thesis. Remaining subjects include two language subjects in Area I (or equivalent proficiency), and six subjects selected from at least two of the three disciplinary areas (Areas II-IV).

WGS.101 Introduction to Women's and Gender Studies
WGS.301 Feminist Thought
A minimum of seven subjects (84 units) beyond the introductory course, advanced feminist theory course, pre-thesis, and thesis. In consultation with the director, the pre-thesis and thesis may be replaced by two additional WGS courses.

<table>
<thead>
<tr>
<th>Units in Major</th>
<th>126-162</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>54-126</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
<td>(36-72)</td>
</tr>
<tr>
<td><strong>Total Units Beyond the GIRs Required for SB Degree</strong></td>
<td>180</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. With the consent of the faculty advisor in the chosen field, a student may substitute two subjects for the pre-thesis and thesis requirement.
2. See the Interdisciplinary Programs section for more detailed information about American Studies (p. 339).
3. See the Interdisciplinary Programs section for more detailed information about Ancient and Medieval Studies (p. 341).
4. See the Interdisciplinary Programs section for more detailed information about Asian and Asian Diaspora Studies (p. 342).
5. See the Interdisciplinary Programs section for more detailed information about Latin American and Latino/a Studies (p. 344).
6. See the Interdisciplinary Programs section for more detailed information about Russian and Eurasian Studies (p. 345).
7. Students majoring in Russian and Eurasian Studies may substitute two subjects for the pre-thesis tutorial and thesis.
8. See the Interdisciplinary Programs section for more detailed information about Women’s and Gender Studies (p. 346).
9. This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
HUMANITIES AND ENGINEERING (COURSE 21E)

Bachelor of Science in Humanities and Engineering

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 component of 21E degrees.

Students must designate two CI-M subjects by petitioning the Subcommittee on the Communication Requirement (http://web.mit.edu/commreq/cim/course21e21s.html). Normally, students are expected to complete one CI-M from each area of study, usually chosen from the subjects designated as CI-M for each major.

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement [up to six subjects can be from the Departmental Program. Only one subject being used to meet the distribution component of the HASS Requirement may be counted toward the degree program.]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the humanities component, choose one of the following (further details may be obtained from the descriptions of programs in specific fields and the relevant field office):</td>
<td>81-114</td>
</tr>
</tbody>
</table>

American Studies 1
Ancient and Medieval Studies 1
Anthropology
Asian and Asian Diaspora Studies 1
Comparative Media Studies
Global Studies and Languages (in French, German, or Spanish)
History
Latin American and Latino/a Studies 1
Literature
Music
Russian and Eurasian Studies 1
Science, Technology, and Society (STS)
Theater Arts
Women’s and Gender Studies 1
Writing: Creative
Writing: Digital Media
Writing: Science Writing

For the engineering component, select six elective subjects restricted to one of the engineering curricula and approved by a faculty member in the field.

<table>
<thead>
<tr>
<th>Units in Major That Also Satisfy the GIRs</th>
<th>36-72</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>180</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 American Studies, Ancient and Medieval Studies, Asian and Asian Diaspora Studies, Latin American and Latino/a Studies, Russian and Eurasian Studies and Women’s and Gender Studies are also available as options within the Course 21 degree program (p. 428), by special arrangement with the Dean of the School of Humanities, Arts, and Social Sciences.

2 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.

Restricted Electives: Humanities Component (by area of study)

<table>
<thead>
<tr>
<th>American Studies</th>
<th>63-84</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select seven elective subjects, including two in history and two in literature</td>
<td></td>
</tr>
<tr>
<td>21.THT</td>
<td>Humanities Pre-Thesis Tutorial 1</td>
</tr>
<tr>
<td>21.THU</td>
<td>Undergraduate Thesis in Humanities</td>
</tr>
<tr>
<td>Total Units</td>
<td>81-102</td>
</tr>
</tbody>
</table>
With the consent of the faculty advisor, a student may substitute two subjects for 21.THT and 21.THU.

**Ancient and Medieval Studies**

Select seven elective subjects that follow the general structure of the Minor 1

- 21.THT Humanities Pre-Thesis Tutorial 6
- 21.THU Undergraduate Thesis in Humanities 12

Total Units 81-102

See the minor in Ancient and Medieval Studies (p. 350) for a list of available subjects and a description of the structure of the program.

**Anthropology**

21A.00 Introduction to Anthropology: Comparing Human Cultures 12

or 21A.01 How Culture Works 90-96

Select eight elective subjects 1

Total Units 102-108

An honors thesis may be done at the invitation and approval of faculty.

**Asian and Asian Diaspora Studies**

Select seven elective subjects that follow the general structure of the Minor 1

- 21.THT Humanities Pre-Thesis Tutorial 6
- 21.THU Undergraduate Thesis in Humanities 12

Total Units 81-102

See the minor in Asian and Asian Diaspora Studies (p. 352) for a list of available subjects and a description of the structure of the program.

**Comparative Media Studies**

CMS.100 Introduction to Media Studies 12

CMS.701 Current Debates in Media 12

Select one of the following Practice and Production subjects:

- CMS.335[J] Short Attention Span Documentary 12
- CMS.362 Civic Media Collaborative Design Studio 12
- CMS.590[J] Design and Development of Games for Learning 12
- CMS.622 Applying Media Technologies in the Arts and Humanities 12
- CMS.633 Digital Humanities: Topics, Techniques, and Technologies 12
- CMS.634 Designing Interactions 12
- 21W.752 Making Documentary: Audio, Video, and More 12

Select five CMS electives 1

Total Units 81-102

A pre-thesis tutorial (CMS.THT) and thesis (CMS.THU), totaling 18 units of credit, may be substituted for one CMS elective.

**Global Studies and Languages (in French, German, or Spanish)**

Select nine elective subjects, which may include a pre-thesis tutorial and thesis (21G.THT and 21G.THU), subject to faculty approval

Total Units 81-108

**History**

Select five elective subjects 1

Select one 21H seminar subject (excluding 21H.390) 2

- 21H.390 Theories and Methods in the Study of History 12

- 21H.THT History Pre-Thesis Tutorial 12

- 21H.THU History Thesis 12

Total Units 99-108

The five 21H subjects must include one pre-modern subject (before 1700).

Select from among 21H subjects for which the first digit after the decimal point is 3. See the History website (http://history.mit.edu/subjects) for additional information.

**Latin American and Latino/a Studies**

17.55[J] Introduction to Latin American Studies 12

Select six elective subjects, including study in at least two disciplines and subjects in either Spanish or Portuguese

- 21.THT Humanities Pre-Thesis Tutorial 6

- 21.THU Undergraduate Thesis in Humanities 12

Total Units 84-102

**Literature**

Select eight elective subjects, including two seminars and subjects in three historical periods or thematic complexes

Total Units 96

**Music**

21M.301 Harmony and Counterpoint I 12

Select two terms of performance subjects (6 units each)

Select one of the following:

- 21M.220 Medieval and Renaissance Music 12
- 21M.235 Baroque and Classical Music 12
- 21M.260 Music since 1900 12
Select one of the following:  
21M.291 Music of India  
21M.292 Music of Indonesia  
21M.293 Music of Africa  
21M.294 Popular Musics of the World  
21M.299 Studies in World Music

Restricted Electives
A coherent program of four subjects from the music curriculum chosen in consultation with faculty advisor(s)

Total Units 48

Russian and Eurasian Studies
Select seven elective subjects, two of which must satisfy the language requirement
21.THT Humanities Pre-Thesis Tutorial 6
21.THU Undergraduate Thesis in Humanities 12

Total Units 81-102

Science, Technology, and Society (STS)
Select seven elective subjects 1
STS.004 Intersections: Science, Technology, and the World 12
STS.THT Undergraduate Thesis Tutorial 6
STS.THU Undergraduate Thesis 12

Total Units 93-114

1 Must include at least one Tier I subject (http://sts-program.mit.edu/academics/undergraduate/tier-i-subjects) in addition to STS.004 and one Tier II subject (http://sts-program.mit.edu/academics/undergraduate/tier-ii-subjects).

Theater Arts
Select seven elective subjects. Qualified students may, with departmental approval, substitute a thesis (21M.THU) for one of these 12-unit electives.
21M.710 Script Analysis 12

Select 12 units of the following:
21M.803 Performance and Design Workshop 12
21M.806 Applied Performance and Design Production 12
21M.809 Performance and Design Intensive 12
21M.851 Independent Study in Performance and Design 12

Total Units 90-108

Women's and Gender Studies
WGS.101 Introduction to Women's and Gender Studies 12

WGS.301] Feminist Thought 12

Select five elective subjects
21.THT Humanities Pre-Thesis Tutorial 1 6
21.THU Undergraduate Thesis in Humanities 12

Total Units 102

1 With the permission of the director of the program, students may substitute two 12-unit subjects for 21.THT and 21.THU.

Writing: Creative
Select seven subjects centered in creative or expository writing 2
21W.THT Writing and Humanistic Studies Pre-Thesis Tutorial 6
21W.THU Writing and Humanistic Studies Thesis 12

Total Units 102

2 One of these subjects is normally at the introductory level; one may be selected from a related field.

Writing: Digital Media
21W.765[J] Interactive Narrative 12
21W.785 Communicating with Web-Based Media 12

Select a CI-M subject in writing 12
Select three related subjects from another department 27-36
21W.THT Writing and Humanistic Studies Pre-Thesis Tutorial 6
21W.THU Writing and Humanistic Studies Thesis 12

Total Units 93-102

Writing: Science Writing
Select a subject in basic exposition 1 12
Select a subject in digital media 12
Select a subject in science, technology, and society 9-12
Select an elective writing subject 12
21W.777 Science Writing in Contemporary Society 12
21W.778 Science Journalism 12
21W.792 Science Writing Internship 12
21W.THT Writing and Humanistic Studies Pre-Thesis Tutorial 6
21W.THU Writing and Humanistic Studies Thesis 12

Total Units 99-102
2 Select from the 21W subjects for which the first digit after the decimal is 0.
Bachelor of Science in Humanities and Science

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 Science component of 21S degrees.

Students must designate two CI-M subjects by petitioning the Subcommittee on the Communication Requirement (http://web.mit.edu/commreq/cim/course21e21s.html). Normally, students are expected to complete one CI-M from each area of study, usually chosen from the subjects designated as CI-M for each major.

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects can be from the Departmental Program. Only one subject being used to meet the distribution component of the HASS Requirement may be counted toward the degree program,] at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>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</td>
<td>81-114</td>
</tr>
<tr>
<td>Ancient and Medieval Studies</td>
<td>1</td>
</tr>
<tr>
<td>Anthropology</td>
<td></td>
</tr>
<tr>
<td>Asian and Asian Diaspora Studies</td>
<td>1</td>
</tr>
<tr>
<td>Comparative Media Studies</td>
<td></td>
</tr>
<tr>
<td>Global Studies and Languages (in French, German, or Spanish)</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td></td>
</tr>
<tr>
<td>Latin American and Latino/a Studies</td>
<td>1</td>
</tr>
<tr>
<td>Literature</td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td></td>
</tr>
<tr>
<td>Russian and Eurasian Studies</td>
<td>1</td>
</tr>
<tr>
<td>Science, Technology, and Society (STS)</td>
<td></td>
</tr>
<tr>
<td>Theater Arts</td>
<td></td>
</tr>
<tr>
<td>Women’s and Gender Studies</td>
<td>1</td>
</tr>
<tr>
<td>Writing: Creative</td>
<td></td>
</tr>
<tr>
<td>Writing: Digital Media</td>
<td></td>
</tr>
<tr>
<td>Writing: Science Writing</td>
<td></td>
</tr>
</tbody>
</table>

For the science component, select six elective subjects restricted to one of the science curricula and approved by a faculty member in the field.

Units in Major 135-186
Unrestricted Electives 2 48-117
Units in Major That Also Satisfy the GIRs (36-72)
Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 American Studies, Ancient and Medieval Studies, Asian and Asian Diaspora Studies, Latin American and Latino/a Studies, Russian and Eurasian Studies and Women's and Gender Studies are also available as options within the Course 21 degree program (p. 428), by special arrangement with the Dean of the School of Humanities, Arts, and Social Sciences.

2 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
### Restricted Electives: Humanities Component (by area of study)

**American Studies**
Select seven elective subjects, including two in history and two in literature

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.THT Humanities Pre-Thesis Tutorial</td>
<td>6</td>
</tr>
<tr>
<td>21.THU Undergraduate Thesis in Humanities</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>81-102</strong></td>
</tr>
</tbody>
</table>

*With the consent of the faculty advisor, a student may substitute two subjects for 21.THT and 21.THU.*

**Ancient and Medieval Studies**
Select seven elective subjects that follow the general structure of the Minor

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.THT Humanities Pre-Thesis Tutorial</td>
<td>6</td>
</tr>
<tr>
<td>21.THU Undergraduate Thesis in Humanities</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>81-102</strong></td>
</tr>
</tbody>
</table>

See the minor in Ancient and Medieval Studies (p. 350) for a list of available subjects and a description of the structure of the program.

**Anthropology**
21A.00 Introduction to Anthropology: Comparing Human Cultures
or 21A.01 How Culture Works
Select eight elective subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMS.100 Introduction to Media Studies</td>
<td>12</td>
</tr>
<tr>
<td>CMS.701 Current Debates in Media</td>
<td>12</td>
</tr>
<tr>
<td>Select one of the following Practice and Production subjects:</td>
<td>12</td>
</tr>
<tr>
<td>CMS.335[J] Short Attention Span Documentary</td>
<td></td>
</tr>
<tr>
<td>CMS.362 Civic Media Collaborative Design Studio</td>
<td></td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>102-108</strong></td>
</tr>
</tbody>
</table>

An honors thesis may be done at the invitation and approval of the faculty.

**Asian and Asian Diaspora Studies**
Select seven elective subjects that follow the general structure of the Minor

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.THT Humanities Pre-Thesis Tutorial</td>
<td>6</td>
</tr>
<tr>
<td>21.THU Undergraduate Thesis in Humanities</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>81-102</strong></td>
</tr>
</tbody>
</table>

See the minor in Asian and Asian Diaspora Studies (p. 352) for a list of available subjects and a description of the structure of the program.

**Comparative Media Studies**
CMS.590[J] Design and Development of Games for Learning
CMS.609[J] The Word Made Digital
CMS.622 Applying Media Technologies in the Arts and Humanities
CMS.633 Digital Humanities: Topics, Techniques, and Technologies
CMS.634 Designing Interactions
21W.752 Making Documentary: Audio, Video, and More
Select five CMS electives

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMS.335[J] Short Attention Span Documentary</td>
<td></td>
</tr>
<tr>
<td>CMS.362 Civic Media Collaborative Design Studio</td>
<td></td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>81-102</strong></td>
</tr>
</tbody>
</table>

A pre-thesis tutorial (CMS.THT) and thesis (CMS.THU), totaling 18 units of credit, may be substituted for one CMS elective.

**Global Studies and Languages (in French, German, or Spanish)**
Select nine elective subjects, which may include a pre-thesis tutorial (21G.THT) and thesis (21G.THU), subject to faculty approval

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>81-108</strong></td>
</tr>
</tbody>
</table>

**History**
Select five elective subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select one 21H seminar subject (excluding 21H.390)</td>
<td>9-12</td>
</tr>
<tr>
<td>21H.390 Theories and Methods in the Study of History</td>
<td>12</td>
</tr>
<tr>
<td>21H.THT History Pre-Thesis Tutorial</td>
<td>12</td>
</tr>
<tr>
<td>21H.THU History Thesis</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>99-108</strong></td>
</tr>
</tbody>
</table>

The five 21H subjects must include one pre-modern subject (before 1700).

Select from among 21H subjects for which the first digit after the decimal point is 3. See the History website (http://history.mit.edu/subjects) for additional information.

**Latin American and Latino/a Studies**
17.55[J] Introduction to Latin American Studies
Select six elective subjects, including study in at least two disciplines and subjects in Spanish or Portuguese

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.THT Humanities Pre-Thesis Tutorial</td>
<td>6</td>
</tr>
<tr>
<td>21.THU Undergraduate Thesis in Humanities</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td><strong>84-102</strong></td>
</tr>
</tbody>
</table>

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## Literature
Select eight elective subjects, including two seminars and subjects in three historical periods or thematic complexes.

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
</tr>
</tbody>
</table>

## Music
21M.301 Harmony and Counterpoint I
Select two terms of Performance subjects (6 units each)

<table>
<thead>
<tr>
<th>Select one of the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>21M.220 Medieval and Renaissance Music</td>
</tr>
<tr>
<td>21M.235 Baroque and Classical Music</td>
</tr>
<tr>
<td>21M.260 Music since 1900</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

## Restricted Electives
A coherent program of four subjects from the music curriculum chosen in consultation with faculty advisor(s).

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
</tr>
</tbody>
</table>

## Russian and Eurasian Studies
Select seven elective subjects, two of which must satisfy the language requirement

| 21.THT Humanities Pre-Thesis Tutorial |
| 21.THU Undergraduate Thesis in Humanities |

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>81-102</td>
</tr>
</tbody>
</table>

## Science, Technology, and Society (STS)
Select seven elective subjects

| 21M.710 Script Analysis |
| 21M.803 Performance and Design Workshop |
| 21M.806 Applied Performance and Design Production |
| 21M.809 Performance and Design Intensive |
| 21M.851 Independent Study in Performance and Design |

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-108</td>
</tr>
</tbody>
</table>

## Theater Arts
Select seven elective subjects. Qualified students may, with departmental approval, substitute a thesis (21M.ThU) for one these 12-unit electives.

| 21M.710 Script Analysis |
| 21M.803 Performance and Design Workshop |
| 21M.806 Applied Performance and Design Production |
| 21M.809 Performance and Design Intensive |
| 21M.851 Independent Study in Performance and Design |

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>66-84</td>
</tr>
</tbody>
</table>

## Writing: Creative
Select seven subjects centered in creative or expository writing

| 21W.764[J] The Word Made Digital |
| 21W.765[J] Interactive Narrative |
| 21W.785 Communicating with Web-Based Media |

| Select a CI-I subject in writing |
| Select three related subjects from another department |

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>84</td>
</tr>
</tbody>
</table>

## Writing: Digital Media
Select seven subjects centered in creative or expository writing

| 21W.764[J] The Word Made Digital |
| 21W.765[J] Interactive Narrative |
| 21W.785 Communicating with Web-Based Media |

| Select a CI-I subject in writing |
| Select three related subjects from another department |

<table>
<thead>
<tr>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>102</td>
</tr>
</tbody>
</table>

| Must include at least one Tier I subject (http://sts-program.mit.edu/academics/undergraduate/tier-i-subjects) in addition to STS.004 and one Tier II subject (http://sts-program.mit.edu/academics/undergraduate/tier-ii-subjects). |

| One of these subjects is normally at the introductory level; one may be selected from a related field. |
### Writing and Humanistic Studies

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21W.THU</td>
<td>Writing and Humanistic Studies Thesis</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td><strong>Total Units</strong></td>
<td><strong>93-102</strong></td>
</tr>
</tbody>
</table>

#### Writing: Science Writing

1. Select a subject in basic exposition  
2. Select a subject in digital media  
3. Select a subject in science, technology, and society  
4. Select an elective writing subject  

- **21W.777** Science Writing in Contemporary Society  
- **21W.778** Science Journalism  
- **21W.792** Science Writing Internship  
- **21W.THT** Writing and Humanistic Studies Pre-Thesis Tutorial  
- **21W.THU** Writing and Humanistic Studies Thesis  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Total Units</strong></td>
<td><strong>99-102</strong></td>
</tr>
</tbody>
</table>

---

\(^2\) Select from the 21W subjects for which the first digit after the decimal is a 0.
LINGUISTICS AND PHILOSOPHY (COURSE 24-2)

Department of Linguistics and Philosophy (p. 262)

Bachelor of Science in Linguistics and Philosophy (Linguistics Track)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and five subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by either 24.905[J] or 24.909 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.900</td>
<td></td>
</tr>
<tr>
<td>or 24.9000</td>
<td></td>
</tr>
<tr>
<td>24.901 Language and Its Structure I: Phonology</td>
<td>12</td>
</tr>
<tr>
<td>24.902 Language and Its Structure II: Syntax</td>
<td>12</td>
</tr>
<tr>
<td>24.903 Language and Its Structure III: Semantics and Pragmatics</td>
<td>12</td>
</tr>
<tr>
<td>24.918 Workshop in Linguistic Research (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>Select one of the following three Linguistic Analysis subjects:</td>
<td>12</td>
</tr>
<tr>
<td>24.909 Field Methods in Linguistics (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

24.910 Advanced Topics in Linguistic Analysis (CI-M)
24.914 Language Variation and Change (CI-M)

Select one of the following three Philosophy subjects: 12
24.09 Minds and Machines
24.241 Logic I
24.251 Introduction to Philosophy of Language (CI-M)

Select one of the following four Experimental Results subjects: 12
24.904 Language Acquisition
24.905[J] Laboratory in Psycholinguistics
24.906[J] The Linguistic Study of Bilingualism
24.915 Linguistic Phonetics

Restricted Electives
A coherent program of three additional subjects from linguistics, philosophy, or a related area 36

Units in Major 132
Unrestricted Electives 2 84-120

Units in Major That Also Satisfy the GIRs (36-72)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Students who do not use 24.905[J] or 24.909 to satisfy the Laboratory Requirement may count a sixth subject from within the Departmental Program toward the HASS Requirement.

2 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
Bachelor of Science in Linguistics and Philosophy (Philosophy Track)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement</td>
<td></td>
</tr>
<tr>
<td>[between three and five subjects can be from</td>
<td></td>
</tr>
<tr>
<td>the Departmental Program]; at least two of</td>
<td></td>
</tr>
<tr>
<td>these subjects must be designated as</td>
<td></td>
</tr>
<tr>
<td>communication-intensive (CI-H) to fulfill</td>
<td></td>
</tr>
<tr>
<td>the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by</td>
<td>1</td>
</tr>
<tr>
<td>24.905(J) in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.900 Introduction to Linguistics ¹</td>
</tr>
<tr>
<td>24.251 Introduction to Philosophy of Language (CI-M)</td>
</tr>
<tr>
<td>24.260 Topics in Philosophy (CI-M)</td>
</tr>
</tbody>
</table>

Select one of the following Logic subjects: ²

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.118 Paradox and Infinity</td>
</tr>
<tr>
<td>24.241 Logic I</td>
</tr>
<tr>
<td>24.242 Logic II</td>
</tr>
<tr>
<td>24.243 Classical Set Theory</td>
</tr>
<tr>
<td>24.244 Modal Logic</td>
</tr>
<tr>
<td>24.245 Theory of Models</td>
</tr>
</tbody>
</table>

Select two of the following Knowledge and Reality subjects:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.05 Philosophy of Religion</td>
</tr>
<tr>
<td>24.08[J] Philosophical Issues in Brain Science</td>
</tr>
<tr>
<td>24.09 Minds and Machines</td>
</tr>
<tr>
<td>24.111 Philosophy of Quantum Mechanics</td>
</tr>
</tbody>
</table>

Restricted Electives

A coherent program of four additional subjects, at least two of which must be in Linguistics and Philosophy, approved by the major advisor.

Units in Major

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.211 Theory of Knowledge</td>
</tr>
<tr>
<td>24.212 Philosophy of Perception</td>
</tr>
<tr>
<td>24.215 Topics in the Philosophy of Science</td>
</tr>
<tr>
<td>24.221 Metaphysics</td>
</tr>
<tr>
<td>24.253 Philosophy of Mathematics</td>
</tr>
<tr>
<td>24.280 Foundations of Probability</td>
</tr>
<tr>
<td>Select one of the following:</td>
</tr>
<tr>
<td>9.65 Cognitive Processes</td>
</tr>
<tr>
<td>24.903 Language and Its Structure III: Semantics and Pragmatics</td>
</tr>
<tr>
<td>24.904 Language Acquisition</td>
</tr>
<tr>
<td>24.905[J] Laboratory in Psycholinguistics ³</td>
</tr>
<tr>
<td>Restricted Electives ⁴</td>
</tr>
<tr>
<td>Unrestricted Electives</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

¹ 24.9000 How Language Works is also an acceptable option.
² Students may select a logic subject from another department (e.g., Mathematics) with the approval of their major advisor.
³ Students who do not use 24.905(J) to satisfy the Laboratory Requirement may count a sixth subject from within the Departmental Program toward the HASS Requirement.
⁴ This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
Bachelor of Science in Literature

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

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

Select three of the following seminars

- 21L.701 Literary Methods (CI-M)
- 21L.702 Studies in Fiction (CI-M)
- 21L.703 Studies in Drama (CI-M)
- 21L.704 Studies in Poetry (CI-M)
- 21L.705 Major Authors (CI-M)
- 21L.706 Studies in Film (CI-M)
- 21L.707 Problems in Cultural Interpretation (CI-M)
- 21L.709 Studies in Literary History (CI-M)
- 21L.715 Media in Cultural Context (CI-M)

Restricted Electives

Select seven additional subjects to form a coherent program

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>78-84</td>
</tr>
</tbody>
</table>

Units in Major

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>114-120</td>
</tr>
</tbody>
</table>

Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>96-102</td>
</tr>
</tbody>
</table>

Units in Major That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-72</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>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Four of the 10 subjects from the required subjects and restricted electives must be chosen, in consultation with a faculty advisor, either from four of five historical periods (ancient and medieval; Renaissance and Restoration; 18th century and Enlightenment; 19th century and Romanticism; 20th century and contemporary culture) or from four of five thematic complexes (historical period; genre or mode; author study; film, media, and popular culture; gender and ethnic studies).

2 A maximum of three subjects may be selected from among introductory subjects (http://lit.mit.edu/curriculum/introductory-subjects), as described on the Literature website.

3 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
MATHEMATICAL ECONOMICS (COURSE 14-2)

Economics Department (p. 249)

Bachelor of Science in Mathematical Economics

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement</td>
<td></td>
</tr>
<tr>
<td>[between one and three subjects can be from the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement</td>
<td></td>
</tr>
<tr>
<td>[can be satisfied by 14.30, and 18.03 or 18.06 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>[as satisfied by 14.32 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01 Principles of Microeconomics</td>
<td>12</td>
</tr>
<tr>
<td>14.02 Principles of Macroeconomics</td>
<td>12</td>
</tr>
<tr>
<td>14.30 Introduction to Statistical Methods in Economics</td>
<td>12</td>
</tr>
<tr>
<td>14.32 Econometric Data Science</td>
<td>12</td>
</tr>
<tr>
<td>18.100A Real Analysis ¹</td>
<td>12</td>
</tr>
<tr>
<td>18.03 Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>or 18.06 Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>14.12 Economic Applications of Game Theory ²</td>
<td></td>
</tr>
<tr>
<td>14.04 Intermediate Microeconomic Theory</td>
<td></td>
</tr>
<tr>
<td>14.15 Networks</td>
<td></td>
</tr>
<tr>
<td>14.19 Market Design</td>
<td></td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.05 Intermediate Macroeconomics (CI-M)</td>
<td></td>
</tr>
<tr>
<td>14.18 Mathematical Economic Modeling (CI-M)</td>
<td></td>
</tr>
<tr>
<td>14.33 Research and Communication in Economics: Topics, Methods, and Implementation (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.104 Seminar in Analysis (CI-M)</td>
<td></td>
</tr>
<tr>
<td>18.504 Seminar in Logic (CI-M)</td>
<td></td>
</tr>
<tr>
<td>18.784 Seminar in Number Theory (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives

Select three additional subjects in mathematics and economics, with at least one subject in each discipline.

Units in Major  144

Unrestricted Electives  84-96

Units in Major That Also Satisfy the GIRs (48-60)

Total Units Beyond the GIRs Required for SB Degree  180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

¹ Alternative versions of this subject, 18.100B, 18.100P, and 18.100Q, also satisfy this requirement.
² Subject has prerequisites that are outside of the program.
MUSIC (COURSE 21M-1)

Music and Theater Arts Section (p. 269)

Bachelor of Science in Music

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives in Science and Technology (REST) 2 Requirement

Laboratory Requirement (12 units) 1

Total GIR Subjects Required for SB Degree 17

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21M.301 Harmony and Counterpoint I</td>
<td>12</td>
</tr>
<tr>
<td>21M.500 Advanced Seminar in Music (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
</tr>
<tr>
<td>21M.220 Medieval and Renaissance Music (CI-M)</td>
<td></td>
</tr>
<tr>
<td>21M.235 Baroque and Classical Music (CI-M)</td>
<td></td>
</tr>
<tr>
<td>21M.260 Music since 1900 (CI-M)</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
</tr>
<tr>
<td>21M.291 Music of India</td>
<td></td>
</tr>
<tr>
<td>21M.292 Music of Indonesia</td>
<td></td>
</tr>
<tr>
<td>21M.293 Music of Africa</td>
<td></td>
</tr>
<tr>
<td>21M.294 Popular Musics of the World</td>
<td></td>
</tr>
<tr>
<td>21M.299 Studies in World Music</td>
<td></td>
</tr>
<tr>
<td>Select two terms of Performance subjects (6 units each); see list below.</td>
<td>12</td>
</tr>
</tbody>
</table>

Restricted Electives
In consultation with the advisor, select 60 units from the music curriculum (21M.000 - 21M.599). 1

| Units in Major | 120 |
| Unrestricted Electives 2 | 96-132 |
| Units in Major That Also Satisfy the GIRs | 36-72 |
| Total Units Beyond the GIRs Required for SB Degree | 180 |

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 A maximum of 24 restricted elective units may be comprised of introductory subjects (21M.0xx). A maximum of 24 restricted elective units may be comprised of Performance subjects (6 units each), with the exception of 21M.480 which may be repeated without limitation.

2 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.

Performance Subjects

| 21M.401 | MIT Concert Choir | 6 |
| 21M.405 | MIT Chamber Chorus | 6 |
| 21M.410 | Vocal Repertoire and Performance | 6 |
| 21M.421 | MIT Symphony | 6 |
| 21M.423 | Conducting and Score-Reading | 6 |
| 21M.426 | MIT Wind Ensemble | 6 |
| 21M.442 | MIT Festival Jazz Ensemble | 6 |
| 21M.445 | Chamber Music Society | 6 |
| 21M.450 | MIT Balinese Gamelan | 6 |
| 21M.451 | Studio Accompanying for Pianists | 3-6 |
| 21M.460 | MIT Senegalese Drum Ensemble | 6 |
| 21M.480 | Advanced Music Performance | 6 |
| 21M.490 | Emerson Scholar Solo Recital | 6 |
PHILOSOPHY (COURSE 24-1)

Department of Linguistics and Philosophy (p. 262)

Bachelor of Science in Philosophy

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

Select one introductory philosophy subject (number range 24.00-24.09) 2

Select one of the following History of Philosophy subjects: 3

- 24.01 Classics of Western Philosophy
- 24.201 Topics in the History of Philosophy (CI-M)

Select one of the following Knowledge and Reality subjects: 12

- 24.05 Philosophy of Religion
- 24.08(J) Philosophical Issues in Brain Science
- 24.09 Minds and Machines
- 24.111 Philosophy of Quantum Mechanics
- 24.211 Theory of Knowledge
- 24.212 Philosophy of Perception
- 24.215 Topics in the Philosophy of Science
- 24.221 Metaphysics (CI-M)
- 24.251 Introduction to Philosophy of Language (CI-M)
- 24.253 Philosophy of Mathematics
- 24.280 Foundations of Probability

Select one of the following Value subjects: 12

- 24.02 Moral Problems and the Good Life
- 24.03 Good Food: The Ethics and Politics of Food
- 24.04(J) Justice
- 24.06(J) Bioethics
- 24.07 The Ethics of Climate Change
- 24.10 Moral Psychology (CI-M)
- 24.140(J) Literature and Philosophy
- 24.222 Decisions, Games and Rational Choice
- 24.230 Meta-ethics
- 24.231 Ethics (CI-M)
- 24.235(J) Philosophy of Law (CI-M)
- 24.236 Topics in Social Theory and Practice
- 24.237(J) Feminist Thought

Select one of the following Logic subjects: 4 12

- 24.118 Paradox and Infinity
- 24.241 Logic I
- 24.242 Logic II
- 24.243 Classical Set Theory
- 24.244 Modal Logic
- 24.245 Theory of Models
- 24.260 Topics in Philosophy (CI-M)

Restricted Electives
Select a coherent program of five additional subjects, two of which must be in philosophy, with approval of the major advisor.

Units in Major 132

Unrestricted Electives 5 84-120

Units in Major That Also Satisfy the GIRs (36-72)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

---

1 No more than four of the total number of philosophy subjects for the major may be introductory philosophy subjects. At least three of the total number of philosophy courses must be at the 200 level or above.
2 The introductory subject cannot also be used as a departmental distribution subject. Students may substitute an appropriate philosophy concourse subject.
Students may substitute another subject with a history of philosophy orientation, with the approval of the major advisor in consultation with the instructor.

Students may select a logic subject from another department (e.g., Mathematics) with the approval of their major advisor.

This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
Bachelor of Science in Political Science

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement</td>
<td></td>
</tr>
<tr>
<td>[between two and five subjects can inform the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 17.803 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.801 Political Science Scope and Methods</td>
<td>12</td>
</tr>
<tr>
<td>(CI-M)</td>
<td></td>
</tr>
<tr>
<td>17.803 Political Science Laboratory</td>
<td>15</td>
</tr>
<tr>
<td>17.THT Thesis Research Design Seminar (CI-M)</td>
<td>12</td>
</tr>
<tr>
<td>17.THU Undergraduate Political Science Thesis</td>
<td>12</td>
</tr>
<tr>
<td>(at least 12 units; additional units by special arrangement)</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives
Select seven subjects, including one subject from the each of the four groups listed below and 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.

Units in Major

<table>
<thead>
<tr>
<th>Units in Major</th>
<th>132-135</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>81-120</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
<td>(36-72)</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>180</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Students typically enroll in subjects as follows: 17.801, fall term, junior year; 17.803, spring term, junior year; 17.THT, fall term, senior year; 17.THU, spring term, senior year.

2 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.

Restricted Electives

Political Philosophy/Social Theory
Select one subject in political philosophy/social theory from the following:

<table>
<thead>
<tr>
<th>Political Philosophy/Social Theory</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.007[J] Feminist Thought</td>
<td>12</td>
</tr>
<tr>
<td>17.01[J] Justice</td>
<td></td>
</tr>
<tr>
<td>17.021[J] Philosophy of Law</td>
<td></td>
</tr>
<tr>
<td>17.03 Introduction to Political Thought</td>
<td>12</td>
</tr>
<tr>
<td>17.035[J] Libertarianism in History</td>
<td></td>
</tr>
<tr>
<td>17.04[J] Modern Conceptions of Freedom</td>
<td></td>
</tr>
<tr>
<td>17.05[J] Humane Warfare: Ancient and Medieval Perspectives on Ethics in War</td>
<td></td>
</tr>
<tr>
<td>17.051 Ethics of Energy Policy</td>
<td></td>
</tr>
</tbody>
</table>

American Politics
Select one subject in American politics from the following:

<table>
<thead>
<tr>
<th>American Politics</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.20 Introduction to the American Political Process</td>
<td>12</td>
</tr>
<tr>
<td>17.245 Constitutional Law: Structures of Power and Individual Rights</td>
<td>12</td>
</tr>
<tr>
<td>17.251 Congress and the American Political System I</td>
<td>12</td>
</tr>
<tr>
<td>17.261 Congress and the American Political System II</td>
<td>12</td>
</tr>
<tr>
<td>17.263 Electoral Politics, Public Opinion, and Democracy</td>
<td>12</td>
</tr>
<tr>
<td>17.265 Public Opinion and American Democracy</td>
<td>12</td>
</tr>
<tr>
<td>17.267 Democracy in America</td>
<td>12</td>
</tr>
<tr>
<td>17.269 Race, Ethnicity, and American Politics</td>
<td>12</td>
</tr>
</tbody>
</table>
Public Policy

Select one of the following options: 12

Option 1
Select one political science subject in public policy from the following:

17.30[J] Making Public Policy
17.303[J] Methods of Policy Analysis
17.307 American Public Policy for Washington Interns
17.309[J] Science, Technology, and Public Policy
17.315 Health Policy
17.317 US Social Policy
17.381[J] The Art and Science of Negotiation: Advanced Applications
17.391[J] Human Rights at Home and Abroad
17.393[J] Environmental Law, Policy, and Economics: Pollution Prevention and Control

Option 2
Select one subject in another field designated as fulfilling the public policy requirement

International Politics

Select one of the following options: 12

Option 1
Select one subject in international relations / security studies from the following:

17.40 American Foreign Policy: Past, Present, and Future
17.401 History of International Politics in the Modern World
17.407 Chinese Foreign Policy
17.41 Introduction to International Relations
17.411 Globalization, Migration, and International Relations
17.42 Causes and Prevention of War
17.433 International Relations of East Asia

17.445 International Relations Theory in the Cyber Age
17.447 Cybersecurity
17.473 The Politics of Nuclear Proliferation
17.483 US Military Power

Option 2
Select one subject in comparative politics from the following:

17.50 Introduction to Comparative Politics
17.509 Social Movements in Comparative Perspective
17.515 Comparative Electoral Politics
17.523 Ethnic Conflict in World Politics
17.53 The Rise of Asia
17.537 Politics and Policy in Contemporary Japan
17.55[J] Introduction to Latin American Studies
17.56 The Politics of Crime and Policing
17.561 European Politics
17.565 Israel: History, Politics, Culture, and Identity 1
17.569 Russia’s Foreign Policy: Toward the Post-Soviet States and Beyond
17.57[J] Soviet and Post-Soviet Politics and Society: 1917 to the Present
17.571 Engineering Democratic Development in Africa
17.581 Riots, Rebellions, Revolutions
17.591 Research Seminar in Applied International Studies

1 17.567, a 9-unit version of this subject that is taught during IAP, is also acceptable.
Science, Technology, and Society (STS)

Science, Technology, and Society Program (p. 278)

Bachelor of Science in Science, Technology, and Society (Second Major)

The full major in Science, Technology, and Society (STS) may be pursued only as a second major in conjunction with another degree program in a field of engineering or science, or in other fields on a case-by-case basis.

General Institute Requirements (GIRs)

The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Tier I</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STS.004 Intersections: Science, Technology, and the World (CI-M)</td>
<td>12</td>
</tr>
</tbody>
</table>

Select one of the following: 12

| STS.001 Technology in American History       |       |
| STS.002 Finance and Society                  |       |
| STS.003 The Rise of Modern Science           |       |
| STS.006[1] Bioethics                         |       |
| STS.007 Technology in History                |       |

STST.008 Technology and Experience

STST.009 Evolution and Society

STST.012 Science in Action: Technologies and Controversies in Everyday Life

Tier II

Select one subject from the list of Tier II subjects 1 9-12

STST.THT Undergraduate Thesis Tutorial 6

STST.THU Undergraduate Thesis (CI-M) 12

Restricted Electives

Select 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

Units in Major 153-162

Unrestricted Electives 2 54-99

Units in Major That Also Satisfy the GIRs (36-72)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 See list of Tier II subjects on department’s website (http://sts-program.mit.edu/academics/undergraduate/tier-ii-subjects).

2 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
THEATER ARTS (COURSE 21M-2)

Music and Theater Arts Section (p. 269)

Bachelor of Science in Theater Arts

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Science Requirement</th>
<th>Humanities, Arts, and Social Sciences (HASS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>[between three and six subjects can be satisfied by subjects in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
</tr>
</tbody>
</table>

Restricted Electives in Science and Technology (REST) Requirement

Laboratory Requirement (12 units)

Total GIR Subjects Required for SB Degree 17

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

Theoretical Studies

Select three of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>21M.611</th>
<th>Foundations of Theater Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21M.690</td>
<td>Sport as Performance</td>
</tr>
<tr>
<td></td>
<td>21M.700</td>
<td>China on Stage</td>
</tr>
<tr>
<td></td>
<td>21M.706</td>
<td>Asian American Theater</td>
</tr>
<tr>
<td></td>
<td>21M.710</td>
<td>Script Analysis</td>
</tr>
<tr>
<td></td>
<td>21M.711</td>
<td>Production Seminar</td>
</tr>
<tr>
<td></td>
<td>21M.714</td>
<td>Contemporary American Theater</td>
</tr>
<tr>
<td></td>
<td>21M.715</td>
<td>Topics in Theater Arts</td>
</tr>
<tr>
<td></td>
<td>21M.800</td>
<td>All the World’s a Stage: Socio-Political Perspectives in Global Performance</td>
</tr>
<tr>
<td></td>
<td>21M.846</td>
<td>Topics in Performance Studies</td>
</tr>
</tbody>
</table>

Performance and Design Practica

Select at least 12 units from the following:

<table>
<thead>
<tr>
<th>21M.803</th>
<th>Performance and Design Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>21M.806</td>
<td>Applied Performance and Design Production</td>
</tr>
<tr>
<td>21M.809</td>
<td>Performance and Design Intensive</td>
</tr>
<tr>
<td>21M.851</td>
<td>Independent Study in Performance and Design</td>
</tr>
</tbody>
</table>

Restricted Electives

In consultation with the Major Advisor, select 12 units of restricted electives. Qualified students may, with departmental approval, substitute 12 units of thesis (21M.THU).

Units in Major 120

Unrestricted Electives 96-132
Units in Major That Also Satisfy the GIRs (36-72)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.

2 Pursuit of the thesis is by application only. By the beginning of the second semester of the junior year, all interested students will write a thesis proposal in consultation with the Major Advisor. This proposal will be submitted to the Theater Arts Curriculum Committee, which will communicate its decision to the student in April.
WRITING (COURSE 21W)

Comparative Media Studies/Writing Program (p. 243)

Bachelor of Science in Writing
(Creative Writing Option)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21W.THT</td>
<td>Writing and Humanistic Studies Pre-Thesis Tutorial</td>
</tr>
<tr>
<td>21W.THU</td>
<td>Writing and Humanistic Studies Thesis (CI-M)</td>
</tr>
</tbody>
</table>

Select one of the following: 12

- 21W.757 Fiction Workshop (CI-M)
- 21W.758 Genre Fiction Workshop (CI-M)
- 21W.759 Writing Science Fiction (CI-M)
- 21W.762 Poetry Workshop (CI-M)
- 21W.770 Advanced Fiction Workshop (CI-M)
- 21W.771 Advanced Poetry Workshop (CI-M)
- 21W.777 Science Writing in Contemporary Society (CI-M)

Restricted Electives
Select six subjects centered on creative writing, of which one is normally introductory; three subjects in literature, one of which may be in CMS.

<table>
<thead>
<tr>
<th>Units in Major</th>
<th>129-138</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>78-123</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
<td>(36-72)</td>
</tr>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>180</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
Bachelor of Science in Writing (Digital Media Option)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS) Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
</tbody>
</table>

Total GIR Subjects Required for SB Degree 17

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21W.765[J] Interactive Narrative</td>
</tr>
<tr>
<td>21W.785 Communicating with Web-Based Media</td>
</tr>
<tr>
<td>21W.THT Writing and Humanistic Studies Pre-Thesis Tutorial</td>
</tr>
<tr>
<td>21W.THU Writing and Humanistic Studies Thesis (CI-M)</td>
</tr>
</tbody>
</table>

Select one of the following: 12

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21W.757 Fiction Workshop (CI-M)</td>
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<tr>
<td>21W.758 Genre Fiction Workshop (CI-M)</td>
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<tr>
<td>21W.762 Poetry Workshop (CI-M)</td>
</tr>
<tr>
<td>21W.770 Advanced Fiction Workshop (CI-M)</td>
</tr>
<tr>
<td>21W.771 Advanced Poetry Workshop (CI-M)</td>
</tr>
<tr>
<td>21W.777 Science Writing in Contemporary Society (CI-M)</td>
</tr>
</tbody>
</table>

Restricted Electives

Select three subjects in writing, which may be in digital media, creative writing, or science writing, and three related subjects from another department.

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>63-72</td>
</tr>
</tbody>
</table>

Unrestricted Electives 1 78-123

Units in Major That Also Satisfy the GIRs (36-72)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.
Bachelor of Science in Writing (Science Writing Option)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [between three and six subjects can be from the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21W.777</td>
<td>12</td>
</tr>
<tr>
<td>Science Writing in Contemporary Society (CI-M)</td>
<td></td>
</tr>
<tr>
<td>21W.778</td>
<td>12</td>
</tr>
<tr>
<td>Science Journalism</td>
<td></td>
</tr>
<tr>
<td>21W.792</td>
<td>12</td>
</tr>
<tr>
<td>Science Writing Internship</td>
<td></td>
</tr>
<tr>
<td>21W.THT</td>
<td>6</td>
</tr>
<tr>
<td>Writing and Humanistic Studies Pre-Thesis Tutorial</td>
<td></td>
</tr>
<tr>
<td>21W.THU</td>
<td>12</td>
</tr>
<tr>
<td>Writing and Humanistic Studies Thesis (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives
Select four subjects in writing, of which one is normally introductory; three are writing subjects approved for this major, and one is in digital media
Select one approved Science, Technology, and Society subject

Units in Major | 114

Unrestricted Electives

<table>
<thead>
<tr>
<th>Unrestricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-138</td>
<td></td>
</tr>
</tbody>
</table>

Units in Major That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units in Major That Also Satisfy the GIRs</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(36-72)</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>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td></td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

\footnote{This chart has been calculated based on an overlap of 36 units (three subjects) between the HASS General Institute Requirement and the departmental requirements. Students who develop a program of study with more overlap will be able to select more unrestricted electives to meet the number of total units beyond the GIRs required for an SB degree.}
MANAGEMENT (COURSE 15-1)

Management Programs (p. 284)

Bachelor of Science in Management

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement [one subject can be satisfied by 14.01 in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 14.30, 15.0791, or 18.600 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 14.32, 15.075[J], 15.301, or 15.417 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01</td>
<td>12</td>
</tr>
<tr>
<td>or 15.0111</td>
<td></td>
</tr>
<tr>
<td>15.279</td>
<td>12</td>
</tr>
<tr>
<td>15.301</td>
<td>15</td>
</tr>
<tr>
<td>15.501</td>
<td>12</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

Restricted Electives
Select two of the following:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.417 Laboratory in Investments (CI-M)</td>
</tr>
<tr>
<td>15.7611 Introduction to Operations Management</td>
</tr>
<tr>
<td>15.8141 Marketing Innovation</td>
</tr>
<tr>
<td>15.9001 Competitive Strategy</td>
</tr>
</tbody>
</table>

Concentration Subjects
Five subjects from a defined concentration or an individualized concentration with the approval of the Sloan Undergraduate Education Office. At least three of the subjects must be from Course 15.¹

Units in the Major
135-159

Unrestricted Electives
48-78

Units in Major That Also Satisfy the GIRs
(24-36)

Total Units Beyond the GIRs Required for SB Degree
180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

¹ Two six-unit subjects count as one elective.
BUSINESS ANALYTICS (COURSE 15-2)

Management Programs (p. 284)

Bachelor of Science in Business Analytics

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 15.053 and 6.0001/6.0002 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 6.01, 6.02, 14.32, or 15.075[J] 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>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
</table>
| 6.0001 | Introduction to Computer Science and Programming in Python
| 6 |
| 6.036 | Introduction to Machine Learning |
| 12 |
| 15.053 | Optimization Methods in Business Analytics |
| 12 |
| 15.276 | Communicating with Data (CI-M) |
| 12 |
| 15.312 | Organizational Processes for Business Analytics (CI-M) |
| 12 |
| 15.780 | Stochastic Models in Business Analytics |
| 12 |
| Select one of the following: | 6-12 |
| 6.0002 | Introduction to Computational Thinking and Data Science
| 6 |
| 6.01 | Introduction to EECS via Robotics |

6.02 Introduction to EECS via Communication Networks

Select one of the following:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.30</td>
<td>Introduction to Statistical Methods in Economics</td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>15.0791</td>
<td>Introduction to Applied Probability</td>
</tr>
<tr>
<td>18.600</td>
<td>Probability and Random Variables</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
</table>
| 14.32 | Econometric Data Science
| 2 |
| 15.075[J] | Statistical Thinking and Data Analysis |

Restricted Electives

Select five subjects from the lists below. At least three of the subjects must be from Course 15.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.0251</td>
<td>Game Theory for Strategic Advantage</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>15.0341</td>
<td>Econometrics for Managers: Correlation and Causality in a Big Data World</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>15.0621</td>
<td>Data Mining: Finding the Models and Predictions that Create Value</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>15.0711</td>
<td>The Analytics Edge</td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>15.0741</td>
<td>Predictive Data Analytics and Statistical Modeling</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>15.6731</td>
<td>Negotiation Analysis</td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>15.7611</td>
<td>Introduction to Operations Management</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>15.772[J]</td>
<td>D-Lab: Supply Chains</td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>15.8141</td>
<td>Marketing Innovation</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. 6.00 Introduction to Computer Science and Programming is an acceptable alternative to the combination of 6.0001 and 6.0002.

2. 14.32 can count as a Required Subject or as a Restricted Elective, but not both.

3. Two six-unit subjects count as one elective.

4. Consult the Sloan Office of Undergraduate Education regarding additional options.
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.874[j]</td>
<td>People and the Planet: Environmental Governance and Science</td>
<td>9</td>
</tr>
<tr>
<td>1.022</td>
<td>Introduction to Network Models</td>
<td>12</td>
</tr>
<tr>
<td>1.041</td>
<td>Transportation Systems Modeling</td>
<td>12</td>
</tr>
<tr>
<td>6.034</td>
<td>Artificial Intelligence</td>
<td>12</td>
</tr>
<tr>
<td>6.050[j]</td>
<td>Information, Entropy, and Computation</td>
<td>9</td>
</tr>
<tr>
<td>9.40</td>
<td>Introduction to Neural Computation</td>
<td>12</td>
</tr>
<tr>
<td>14.12</td>
<td>Economic Applications of Game Theory</td>
<td>12</td>
</tr>
<tr>
<td>14.15[j]</td>
<td>Networks</td>
<td>12</td>
</tr>
<tr>
<td>14.32</td>
<td>Econometric Data Science</td>
<td>12</td>
</tr>
<tr>
<td>18.06</td>
<td>Linear Algebra</td>
<td>12</td>
</tr>
</tbody>
</table>

1. Subject has prerequisites that are outside of the program.
2. 14.32 can count as a Required Subject or as a Restricted Elective, but not both.
FINANCE (COURSE 15-3)

Management Programs (p. 284)

Bachelor of Science in Finance

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS) Requirement [one subject can be satisfied by 14.01 in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 14.30, 15.053, 15.0791, or 18.600 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 15.417 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01 Principles of Microeconomics</td>
<td>9-12</td>
</tr>
<tr>
<td>or 15.0111 Economic Analysis for Business Decisions</td>
<td></td>
</tr>
<tr>
<td>15.417 Laboratory in Investments (CI-M)</td>
<td>15</td>
</tr>
<tr>
<td>15.418 Laboratory in Corporate Finance (CI-M)</td>
<td>15</td>
</tr>
<tr>
<td>15.501 Corporate Financial Accounting</td>
<td>12</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>14.30 Introduction to Statistical Methods in Economics</td>
<td></td>
</tr>
<tr>
<td>15.0791 Introduction to Applied Probability</td>
<td></td>
</tr>
<tr>
<td>18.600 Probability and Random Variables</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>14.32 Econometric Data Science</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.075[J] Statistical Thinking and Data Analysis</td>
<td></td>
</tr>
</tbody>
</table>

Finance Electives

Five to seven subjects from the following list, including at least one subject from the Investments area and one subject from the Corporate Finance area.

Investments

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.4331 Financial Markets</td>
<td></td>
</tr>
<tr>
<td>15.4371 Options and Futures Markets</td>
<td></td>
</tr>
</tbody>
</table>

Corporate Finance

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.4311 Entrepreneurial Finance and Venture Capital</td>
<td></td>
</tr>
<tr>
<td>15.4341 Advanced Corporate Finance</td>
<td></td>
</tr>
<tr>
<td>15.4451 Mergers, Acquisitions, and Private Equity</td>
<td></td>
</tr>
</tbody>
</table>

Topics in Finance

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.4871 Algorithmic Trading and Quantitative Investment Strategies</td>
<td></td>
</tr>
</tbody>
</table>

Non-Finance Electives

Select up to two of the following:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.053 Optimization Methods in Business Analytics</td>
<td></td>
</tr>
<tr>
<td>15.279 Management Communication for Undergraduates (CI-M)</td>
<td></td>
</tr>
<tr>
<td>or 15.276 Communicating with Data</td>
<td></td>
</tr>
<tr>
<td>15.301 People, Teams, and Organizations Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>or 15.312 Organizational Processes for Business Analytics</td>
<td></td>
</tr>
<tr>
<td>15.7611 Introduction to Operations Management</td>
<td></td>
</tr>
<tr>
<td>15.8141 Marketing Innovation</td>
<td></td>
</tr>
<tr>
<td>15.9001 Competitive Strategy</td>
<td></td>
</tr>
</tbody>
</table>

Units in Major

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.9001 Competitive Strategy</td>
<td>138-150</td>
</tr>
</tbody>
</table>

Units in Unrestricted Electives

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select one of the following:</td>
<td>66-84</td>
</tr>
</tbody>
</table>

Units in Major That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>180</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Consult the Sloan Office of Undergraduate Education regarding additional options.
BIOLOGY (COURSE 7)

Department of Biology (p. 301)

Bachelor of Science in Biology

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

Subjects
Science Requirement 6
Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.

Restricted Electives in Science and Technology (REST) Requirement [can be satisfied from among 5.12 or 5.60 and 7.03 or 7.05 in the Departmental Program]

Laboratory Requirement (12 units) [can be satisfied by 7.02[J] or 20.109 in the Departmental Program]

Total GIR Subjects Required for SB Degree 17

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.12 Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.60 Thermodynamics and Kinetics</td>
<td>12</td>
</tr>
<tr>
<td>or 20.110[J] Thermodynamics of Biomolecular Systems</td>
<td></td>
</tr>
<tr>
<td>7.03 Genetics</td>
<td>12</td>
</tr>
<tr>
<td>7.05 General Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>or 5.07[J] Biological Chemistry I</td>
<td></td>
</tr>
<tr>
<td>7.06 Cell Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.18 Topics in Experimental Biology (CI-M)</td>
<td>30</td>
</tr>
</tbody>
</table>

Select one of the following: 15-18

7.02[J] Introduction to Experimental Biology and Communication (CI-M)

20.109 Laboratory Fundamentals in Biological Engineering (CI-M)

Restricted Electives

Select three undergraduate-level 12-unit subjects offered by the Department of Biology for which 7.03 and/or 7.05 are prerequisites. 3

Unrestricted Electives

7.08[J] Biological Chemistry II | 12 |
7.09 Quantitative and Computational Biology | 12 |
7.20[J] Human Physiology | 12 |
7.21 Microbial Physiology | 12 |
7.22 Developmental Biology | 12 |
7.23[J] Immunology | 12 |
7.26 Molecular Basis of Infectious Disease | 12 |
7.27 Principles of Human Disease | 12 |
7.28 Molecular Biology | 12 |
7.29[J] Cellular and Molecular Neurobiology | 12 |
7.31 Current Topics in Mammalian Biology: Medical Implications | 12 |
7.32 Systems Biology | 12 |
7.37[J] Molecular and Engineering Aspects of Biotechnology | 12 |
| or 7.371 Biological and Engineering Principles Underlying Novel Biotherapeutics | |
7.41 Principles of Chemical Biology | 12 |
7.45 The Hallmarks of Cancer | 12 |
7.46 Building with Cells | 12 |
7.49[J] Developmental Neurobiology | 12 |
9.15 Neural Circuits, Neuromodulatory, and Neuroendocrine Systems | 12 |

Units in Major 141-144

Units in Major That Also Satisfy the GIRs (36)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 The department recommends 5.60 or 20.110[J] to fulfill this component of the program, but it will also accept 2.005, 3.012, 8.044, or 10.213.
2 Before enrolling in 7.18, students must complete an approved 12-unit UROP or non-credit research experience.
3 Exceptions: The combination of 7.30A[J] and 7.30B[J] is eligible as a restricted elective; 7.19 cannot be used as a restricted elective. Graduate-level subjects may not be used as restricted electives.
9.17 Systems Neuroscience Laboratory 12
(C1-M)

The combination of 7.30A[I] and 7.30B[I] counts as one Biology restricted elective.
BIOLOGY (COURSE 7-A)

Bachelor of Science in Biology

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects</td>
<td></td>
</tr>
<tr>
<td>must be designated as communication-intensive</td>
<td></td>
</tr>
<tr>
<td>(CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement [can be satisfied from among 5.12 or 5.60 and 7.03 or 7.05 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 7.02[J] or 20.109 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>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.12  Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.60  Thermodynamics and Kinetics ¹</td>
<td>12</td>
</tr>
<tr>
<td>or 20.110[J] Thermodynamics of Biomolecular Systems</td>
<td></td>
</tr>
<tr>
<td>7.03  Genetics</td>
<td>12</td>
</tr>
<tr>
<td>7.05  General Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>or 5.07[J] Biological Chemistry I</td>
<td></td>
</tr>
<tr>
<td>7.06  Cell Biology</td>
<td>12</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>15-18</td>
</tr>
<tr>
<td>7.02[J] Introduction to Experimental Biology and Communication (CI-M)</td>
<td></td>
</tr>
<tr>
<td>20.109 Laboratory Fundamentals in Biological Engineering (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives

Select three undergraduate-level 12-unit subjects offered by the Department of Biology for which 7.03 and/or 7.05 are prerequisites. ²

Select one of the following CI-Ms: ⁹-¹⁸

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.014 Materials Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>5.383  Fast-flow Peptide and Protein Synthesis and Time- and Frequency-resolved Spectroscopy of Photosynthesis (CI-M)</td>
<td></td>
</tr>
<tr>
<td>6.021[J] Cellular Neurophysiology and Computing (CI-M)</td>
<td></td>
</tr>
<tr>
<td>7.19  Communication in Experimental Biology (CI-M)</td>
<td></td>
</tr>
<tr>
<td>8.13  Experimental Physics I (CI-M)</td>
<td></td>
</tr>
<tr>
<td>9.12  Experimental Molecular Neurobiology (CI-M)</td>
<td></td>
</tr>
<tr>
<td>9.17  Systems Neuroscience Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>9.28  Current Topics in Developmental Neurobiology (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.26 Chemical Engineering Projects Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.27 Energy Engineering Projects Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.28 Chemical-Biological Engineering Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>10.29 Biological Engineering Projects Laboratory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>20.380 Biological Engineering Design (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

Units in Major ¹²⁰-¹³²

Unrestricted Electives ⁸⁴-⁹⁶

Units in Major That Also Satisfy the GIRs (36)

Total Units Beyond the GIRs Required for SB Degree ¹⁸⁰

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

¹ The department recommends 5.60 or 20.110[J] to fulfill this component of the program, but it will also accept 2.005, 3.012, 8.044, or 10.213.

² Exceptions: The combination of 7.30A[J] and 7.30B[J] is eligible as a restricted elective; 9.15 is eligible as a restricted elective; 7.19 cannot be used as a restricted elective. Graduate-level subjects may not be used as restricted electives.

Restricted Electives

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.08[J] Biological Chemistry II</td>
<td>12</td>
</tr>
<tr>
<td>7.09  Quantitative and Computational Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.20[J] Human Physiology</td>
<td>12</td>
</tr>
<tr>
<td>7.21  Microbial Physiology</td>
<td>12</td>
</tr>
<tr>
<td>7.22  Developmental Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.23[J] Immunology</td>
<td>12</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>7.26</td>
<td>Molecular Basis of Infectious Disease</td>
</tr>
<tr>
<td>7.27</td>
<td>Principles of Human Disease</td>
</tr>
<tr>
<td>7.28</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>7.29[J]</td>
<td>Cellular and Molecular Neurobiology</td>
</tr>
<tr>
<td>7.31</td>
<td>Current Topics in Mammalian Biology: Medical Implications</td>
</tr>
<tr>
<td>7.32</td>
<td>Systems Biology</td>
</tr>
<tr>
<td>7.37[J]</td>
<td>Molecular and Engineering Aspects of Biotechnology</td>
</tr>
<tr>
<td>or 7.371</td>
<td>Biological and Engineering Principles Underlying Novel Biotherapeutics</td>
</tr>
<tr>
<td>7.41</td>
<td>Principles of Chemical Biology</td>
</tr>
<tr>
<td>7.45</td>
<td>The Hallmarks of Cancer</td>
</tr>
<tr>
<td>7.46</td>
<td>Building with Cells</td>
</tr>
<tr>
<td>7.49[J]</td>
<td>Developmental Neurobiology</td>
</tr>
<tr>
<td>9.15</td>
<td>Neural Circuits, Neuromodulatory, and Neuroendocrine Systems</td>
</tr>
</tbody>
</table>

BRAIN AND COGNITIVE SCIENCES (COURSE 9)

Department of Brain and Cognitive Sciences (p. 307)

Bachelor of Science in Brain and Cognitive Sciences

**General Institute Requirements (GIRs)**
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement [three subjects can be satisfied by 9.00 and two other HASS subjects in the Departmental Program]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 6.00 and 9.01 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by a laboratory in the Departmental Program]</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

**Physical Education Requirement**
Swimming requirement, plus four physical education courses for eight points.

**Departmental Program**
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td></td>
</tr>
<tr>
<td>6.00</td>
<td>12</td>
</tr>
<tr>
<td>9.00</td>
<td>12</td>
</tr>
<tr>
<td>9.01</td>
<td>12</td>
</tr>
<tr>
<td>9.07</td>
<td>12</td>
</tr>
<tr>
<td>Tier 2</td>
<td></td>
</tr>
<tr>
<td>Select three of the following; up to seven may be taken:</td>
<td>36-84</td>
</tr>
<tr>
<td>9.04</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9.09[J]</th>
<th>Cellular and Molecular Neurobiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.11</td>
<td>The Human Brain</td>
</tr>
<tr>
<td>9.15</td>
<td>Neural Circuits, Neuromodulatory, and Neuroendocrine Systems (CI-M)</td>
</tr>
<tr>
<td>9.16</td>
<td>Cellular and Synaptic Neurophysiology</td>
</tr>
<tr>
<td>9.18[J]</td>
<td>Developmental Neurobiology</td>
</tr>
<tr>
<td>9.19</td>
<td>Computational Psycholinguistics</td>
</tr>
<tr>
<td>9.21[J]</td>
<td>Cellular Neurophysiology and Computing</td>
</tr>
<tr>
<td>9.31</td>
<td>Neurobiology of Learning and Memory</td>
</tr>
<tr>
<td>9.35</td>
<td>Perceptual Systems</td>
</tr>
<tr>
<td>9.85</td>
<td>Infant and Early Childhood Cognition (CI-M)</td>
</tr>
</tbody>
</table>

**Laboratory [Tier 2]**
Select one of the following: 12

| 9.12             | Experimental Molecular Neurobiology (CI-M) |
| 9.17             | Systems Neuroscience Laboratory (CI-M)    |
| 9.59[J]          | Laboratory in Psycholinguistics (CI-M)    |
| 9.60             | Machine-Motivated Human Vision (CI-M)     |

**Tier 3**
Select up to four of the following: 0-48

| 9.24             | Disorders and Diseases of the Nervous System |
| 9.26[J]          | Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience |
| 9.28             | Current Topics in Developmental Neurobiology (CI-M) |
| 9.32             | Genes, Circuits, and Behavior               |
| 9.42             | The Brain and Its Interface with the Body   |
| 9.46             | Neuroscience of Morality (CI-M)             |

**Research**
Select one of the following (Laboratory cannot also count for Research): 12-18

| 9.12             | Experimental Molecular Neurobiology (CI-M) |
| 9.17             | Systems Neuroscience Laboratory (CI-M)    |
| 9.41             | Research and Communication in Neuroscience and Cognitive Science (CI-M) |
### Research in Brain and Cognitive Sciences

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.50</td>
<td>Research in Brain and Cognitive Sciences</td>
</tr>
<tr>
<td>9.59[J]</td>
<td>Laboratory in Psycholinguistics (CI-M)</td>
</tr>
<tr>
<td>9.60</td>
<td>Machine-Motivated Human Vision (CI-M)</td>
</tr>
<tr>
<td>9.URG</td>
<td>Undergraduate Research</td>
</tr>
</tbody>
</table>

### Restricted Electives

Select zero to four subjects. 9.URG cannot count as a Restricted Elective.

<table>
<thead>
<tr>
<th>Units in Major</th>
<th>168-195</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted Electives</td>
<td>48-72</td>
</tr>
<tr>
<td>Units in Major That Also Satisfy the GIRs</td>
<td>(60)</td>
</tr>
</tbody>
</table>

Total Units Beyond the GIRs Required for SB Degree: 180-183

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

---

2 Combination of 6.0001 Introduction to Computer Science Programming in Python and 6.0002 Introduction to Computational Thinking and Data Science is also acceptable.
CHEMISTRY (COURSE 5)

Department of Chemistry (p. 312)

Bachelor of Science in Chemistry (Standard Option)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

Subjects
Science Requirement 6
Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.
Restricted Electives in Science and Technology (REST) Requirement [two subjects can be satisfied by 5.07][J] (if taken under joint number 20.507)[J] and 5.12, 5.601/5.602, or 5.611/5.612 in the Departmental Program]
Laboratory Requirement (12 units) [can be satisfied from among 5.351, 5.352, 5.353, and 5.363 in the Departmental Program]
Total GIR Subjects Required for SB Degree 17

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.03 Principles of Inorganic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.07[J] Biological Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.12 Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>5.13 Organic Chemistry II</td>
<td>12</td>
</tr>
<tr>
<td>5.601 Thermodynamics I</td>
<td>6</td>
</tr>
<tr>
<td>5.602 Thermodynamics II and Kinetics</td>
<td>6</td>
</tr>
<tr>
<td>5.611 Introduction to Spectroscopy</td>
<td>6</td>
</tr>
<tr>
<td>5.612 Electronic Structure of Molecules</td>
<td>6</td>
</tr>
</tbody>
</table>

Select two of the following: 24

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.04 Principles of Inorganic Chemistry II</td>
<td>12</td>
</tr>
<tr>
<td>5.08[J] Biological Chemistry II</td>
<td>12</td>
</tr>
<tr>
<td>5.43 Advanced Organic Chemistry</td>
<td>12</td>
</tr>
<tr>
<td>5.62 Physical Chemistry</td>
<td>12</td>
</tr>
</tbody>
</table>

Departmental Laboratory Requirement

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.351 Fundamentals of Spectroscopy</td>
<td>4</td>
</tr>
<tr>
<td>5.352 Synthesis of Coordination Compounds and Kinetics (CI-M)</td>
<td>5</td>
</tr>
<tr>
<td>5.353 Macromolecular Prodrugs</td>
<td>4</td>
</tr>
<tr>
<td>5.361 Expression and Purification of Enzyme Mutants</td>
<td>4</td>
</tr>
</tbody>
</table>

Select a minimum of 14 units from the list of Laboratory Restricted Electives, at least one of which must be a CI-M

Choose one of the following options: 20

Option 1
Select at least 20 units from the list of Laboratory Restricted Electives

Option 2

5.39 Research and Communication in Chemistry (CI-M)

Units in Major 147

Unrestricted Electives 57-69

Units in Major That Also Satisfy the GIRs (24-36)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

Laboratory Restricted Electives

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.362 Kinetics of Enzyme Inhibition (CI-M)</td>
<td>5</td>
</tr>
<tr>
<td>5.363 Organic Structure Determination</td>
<td>4</td>
</tr>
<tr>
<td>5.371 Continuous Flow Chemistry: Sustainable Conversion of Reclaimed Vegetable Oil into Biodiesel</td>
<td>4</td>
</tr>
<tr>
<td>5.372 Chemistry of Renewable Energy</td>
<td>4</td>
</tr>
<tr>
<td>5.373 Dinitrogen Cleavage</td>
<td>4</td>
</tr>
<tr>
<td>5.381 Quantum Dots</td>
<td>4</td>
</tr>
<tr>
<td>5.382 Time- and Frequency-resolved Spectroscopy of Photosynthesis (CI-M)</td>
<td>5</td>
</tr>
<tr>
<td>5.383 Fast-flow Peptide and Protein Synthesis</td>
<td>4</td>
</tr>
</tbody>
</table>

Department of Chemistry (p. 312)
Bachelor of Science in Chemistry (Flexible Option)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [two subjects can be satisfied by 5.07[J] (if taken under joint number 20.507[J]) and 5.12 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied from among 5.351, 5.352, 5.353, and 5.363 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.03</td>
<td>12</td>
</tr>
<tr>
<td>5.07[J]</td>
<td>12</td>
</tr>
<tr>
<td>5.12</td>
<td>12</td>
</tr>
<tr>
<td>5.601</td>
<td>6</td>
</tr>
<tr>
<td>5.611</td>
<td>6</td>
</tr>
<tr>
<td>Select 24 units of the following:</td>
<td>24</td>
</tr>
<tr>
<td>5.04</td>
<td></td>
</tr>
<tr>
<td>5.08[J]</td>
<td></td>
</tr>
<tr>
<td>5.13</td>
<td></td>
</tr>
<tr>
<td>5.43</td>
<td></td>
</tr>
<tr>
<td>5.602</td>
<td></td>
</tr>
<tr>
<td>5.612</td>
<td></td>
</tr>
<tr>
<td>5.62</td>
<td></td>
</tr>
<tr>
<td>Elective Focus</td>
<td>36</td>
</tr>
</tbody>
</table>

Unrestricted Electives 59-71

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. With approval by the faculty advisor, subjects outside the Department of Chemistry may be used.
2. Laboratory Restricted Electives cannot be double-counted within the program.
3. Before enrolling in 5.39, students must have completed an approved 12-unit UROP or non-credit research experience.

Departmental Laboratory Requirement

<table>
<thead>
<tr>
<th>Departmental Laboratory Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.351 Fundamentals of Spectroscopy</td>
<td>4</td>
</tr>
<tr>
<td>5.352 Synthesis of Coordination Compounds and Kinetics (CI-M)</td>
<td>5</td>
</tr>
<tr>
<td>5.353 Macromolecular Prodrugs</td>
<td>4</td>
</tr>
<tr>
<td>5.361 Expression and Purification of Enzyme Mutants</td>
<td>4</td>
</tr>
</tbody>
</table>

Choose one of the following options: 20

Option 1
Select at least 20 units from the list of Laboratory Restricted Electives

Option 2
5.39 Research and Communication in Chemistry (CI-M)

Option 3
A set of laboratory subjects of similar extent, subject to the approval of the department

Units in Major 145

Unrestricted Electives 59-71

Units in Major That Also Satisfy the GIRs (24-36)

Total Units Beyond the GIRs Required for SB Degree 180

Laboratory Restricted Electives

<table>
<thead>
<tr>
<th>Laboratory Restricted Electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.362 Kinetics of Enzyme Inhibition (CI-M)</td>
<td>5</td>
</tr>
<tr>
<td>5.363 Organic Structure Determination</td>
<td>4</td>
</tr>
<tr>
<td>5.371 Continuous Flow Chemistry: Sustainable Conversion of Reclaimed Vegetable Oil into Biodiesel</td>
<td>4</td>
</tr>
<tr>
<td>5.372 Chemistry of Renewable Energy</td>
<td>4</td>
</tr>
<tr>
<td>5.373 Dinitrogen Cleavage</td>
<td>4</td>
</tr>
<tr>
<td>5.381 Quantum Dots</td>
<td>4</td>
</tr>
<tr>
<td>5.382 Time- and Frequency-resolved Spectroscopy of Photosynthesis (CI-M)</td>
<td>5</td>
</tr>
<tr>
<td>5.383 Fast-flow Peptide and Protein Synthesis</td>
<td>4</td>
</tr>
</tbody>
</table>
EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES (COURSE 12)

Department of Earth, Atmospheric, and Planetary Sciences (p. 317)

Bachelor of Science in Earth, Atmospheric, and Planetary Sciences

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement [can be satisfied by 12.001, 12.002, or 12.003, and 18.03 in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by a laboratory/field subject 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

General Department Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductory Subjects</td>
<td></td>
</tr>
<tr>
<td>Select two of the following:</td>
<td>24</td>
</tr>
<tr>
<td>12.001 Introduction to Geology</td>
<td></td>
</tr>
<tr>
<td>12.002 Introduction to Geophysics and Planetary Science</td>
<td></td>
</tr>
<tr>
<td>12.003 Introduction to Atmosphere, Ocean, and Climate Dynamics</td>
<td></td>
</tr>
<tr>
<td>12.007 Geobiology: History of Life on Earth</td>
<td></td>
</tr>
<tr>
<td>12.TIP Thesis Preparation</td>
<td>6</td>
</tr>
<tr>
<td>12.THU Undergraduate Thesis (at least 6 units, CI-M)</td>
<td>6</td>
</tr>
<tr>
<td>Laboratory/Field Subjects</td>
<td>12-15</td>
</tr>
</tbody>
</table>

Concentration Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.115 Field Geology</td>
<td>2</td>
</tr>
<tr>
<td>12.116 and Analysis of Geologic Data (CI-M)</td>
<td></td>
</tr>
<tr>
<td>12.307 Weather and Climate Laboratory (CI-M)</td>
<td>3</td>
</tr>
<tr>
<td>12.335 Experimental Atmospheric Chemistry (CI-M)</td>
<td>3</td>
</tr>
<tr>
<td>12.410[J] Observational Techniques of Optical Astronomy (CI-M)</td>
<td>4</td>
</tr>
</tbody>
</table>

Concentration Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-63</td>
</tr>
</tbody>
</table>

Supporting Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-42</td>
</tr>
</tbody>
</table>

Units in Major

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>144-156</td>
</tr>
</tbody>
</table>

Unrestricted Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-72</td>
</tr>
</tbody>
</table>

Units in Major That Also Satisfy the GIRs

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(12-36)</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 With approval of the advisor, one subject may be counted toward concentration coursework if not taken as a General Departmental Requirement.

2 Recommended for concentration area 1. May also be applicable to areas 3 and 4.

3 Recommended for concentration areas 2 and 4.

4 Recommended for concentration area 3.

Areas of Concentration

Area 1—Geoscience: Geology, Geochemistry, Geophysics, Geobiology

Select 60-63 units:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.005 Applications of Continuum Mechanics to Earth, Atmospheric, and Planetary Sciences</td>
<td>12</td>
</tr>
<tr>
<td>12.104 Geochemistry of Natural Waters</td>
<td>12</td>
</tr>
<tr>
<td>12.108 Structure of Earth Materials</td>
<td>12</td>
</tr>
<tr>
<td>12.109 Petrology</td>
<td>15</td>
</tr>
<tr>
<td>12.110A Sedimentary Environments</td>
<td>6</td>
</tr>
<tr>
<td>12.110B Sedimentology in the Field</td>
<td>9</td>
</tr>
<tr>
<td>12.113 Structural Geology</td>
<td>12</td>
</tr>
<tr>
<td>12.163 Geomorphology</td>
<td>12</td>
</tr>
<tr>
<td>12.177 Astrobiology, Origins and Early Evolution of Life</td>
<td>12</td>
</tr>
<tr>
<td>12.201 Essentials of Global Geophysics</td>
<td>12</td>
</tr>
<tr>
<td>12.214 Essentials of Applied Geophysics</td>
<td>12</td>
</tr>
</tbody>
</table>

Area 2—Atmospheres, Oceans, and Climate

Select 48 units:

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.301 Climate Science</td>
<td>12</td>
</tr>
<tr>
<td>or 12.318 Introduction to Atmospheric Data and Large-scale Dynamics</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.009[J]</td>
<td>Nonlinear Dynamics: The Natural Environment</td>
<td>12</td>
</tr>
<tr>
<td>12.086</td>
<td>Modeling Environmental Complexity</td>
<td>12</td>
</tr>
<tr>
<td>12.174</td>
<td>Biogeochemistry of Natural and Perturbed Systems</td>
<td>12</td>
</tr>
<tr>
<td>12.300[J]</td>
<td>Global Change Science</td>
<td>12</td>
</tr>
<tr>
<td>12.306</td>
<td>Atmospheric Physics and Chemistry</td>
<td>12</td>
</tr>
<tr>
<td>12.315</td>
<td>Atmospheric Radiation and Convection</td>
<td>12</td>
</tr>
<tr>
<td>12.320B[J]</td>
<td>Introduction to Hydrology Modeling</td>
<td>6</td>
</tr>
<tr>
<td>12.336[J]</td>
<td>Air Pollution</td>
<td>12</td>
</tr>
<tr>
<td>12.338</td>
<td>Aerosol and Cloud Microphysics and Chemistry</td>
<td>12</td>
</tr>
<tr>
<td>12.349</td>
<td>Mechanisms and Models of the Global Carbon Cycle</td>
<td>12</td>
</tr>
<tr>
<td>12.372</td>
<td>Elements of Modern Oceanography</td>
<td>12</td>
</tr>
<tr>
<td>12.377</td>
<td>The History of Earth's Climate</td>
<td>12</td>
</tr>
<tr>
<td>12.390</td>
<td>Fluid Dynamics of the Atmosphere and Ocean</td>
<td>12</td>
</tr>
<tr>
<td>12.422</td>
<td>Planetary Atmospheres</td>
<td>12</td>
</tr>
<tr>
<td>12.420</td>
<td>Physics and Chemistry of the Solar System</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td><strong>Area 3—Planetary Science and Astronomy</strong></td>
<td></td>
</tr>
<tr>
<td>12.43[J]</td>
<td>Space Systems Engineering</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td><strong>Select 48-51 units:</strong></td>
<td></td>
</tr>
<tr>
<td>12.006[J]</td>
<td>Nonlinear Dynamics: Chaos</td>
<td>12</td>
</tr>
<tr>
<td>12.104</td>
<td>Geochemistry of Natural Waters</td>
<td>12</td>
</tr>
<tr>
<td>12.108</td>
<td>Structure of Earth Materials</td>
<td>12</td>
</tr>
<tr>
<td>12.109</td>
<td>Petrology</td>
<td>15</td>
</tr>
<tr>
<td>12.177</td>
<td>Astrobiology, Origins and Early Evolution of Life</td>
<td>12</td>
</tr>
<tr>
<td>12.422</td>
<td>Planetary Atmospheres</td>
<td>12</td>
</tr>
<tr>
<td>12.43[J]</td>
<td>Space Systems Engineering</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td><strong>Area 4—Environmental Systems</strong></td>
<td></td>
</tr>
<tr>
<td>12.009[J]</td>
<td>Nonlinear Dynamics: The Natural Environment</td>
<td>12</td>
</tr>
<tr>
<td>12.021</td>
<td>Earth Science, Energy, and the Environment</td>
<td>12</td>
</tr>
<tr>
<td>12.086</td>
<td>Modeling Environmental Complexity</td>
<td>12</td>
</tr>
<tr>
<td>12.110A</td>
<td>Sedimentary Environments</td>
<td>6</td>
</tr>
<tr>
<td>12.110B</td>
<td>Sedimentology in the Field</td>
<td>9</td>
</tr>
<tr>
<td>12.119</td>
<td>Analytical Techniques for Studying Environmental and Geologic Samples</td>
<td>12</td>
</tr>
<tr>
<td>12.158</td>
<td>Molecular Biogeochemistry</td>
<td>9</td>
</tr>
<tr>
<td>12.163</td>
<td>Geomorphology</td>
<td>12</td>
</tr>
<tr>
<td>12.174</td>
<td>Biogeochemistry of Natural and Perturbed Systems</td>
<td>12</td>
</tr>
<tr>
<td>12.177</td>
<td>Astrobiology, Origins and Early Evolution of Life</td>
<td>12</td>
</tr>
<tr>
<td>12.301</td>
<td>Climate Science</td>
<td>12</td>
</tr>
<tr>
<td>12.349</td>
<td>Mechanisms and Models of the Global Carbon Cycle</td>
<td>12</td>
</tr>
<tr>
<td>12.377</td>
<td>The History of Earth's Climate</td>
<td>12</td>
</tr>
<tr>
<td>12.385</td>
<td>Science, Politics, and Environmental Policy</td>
<td>9</td>
</tr>
<tr>
<td>1</td>
<td>1 With approval of the academic advisor, students may count one subject from list of General Department Requirements as long as it is also not counting toward the General Department Requirement. Students may also substitute one subject from off of the degree chart if approved by the academic advisor.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Recommended supporting subjects: 3.012 or 5.60, 5.12, 7.05, 18.03 or 18.06.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Recommended supporting subjects: 5.60, 8.03, 18.03.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Recommended supporting subjects: 8.03, 8.04, 8.044, 18.03.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Recommended supporting subjects: 5.12, 6.802[J], 8.03, 18.03 or 18.06.</td>
<td></td>
</tr>
</tbody>
</table>

**Supporting Subjects**

**Select 36-42 units:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.060A</td>
<td>Fluid Mechanics I</td>
<td>6</td>
</tr>
<tr>
<td>1.061A &amp; 1.106</td>
<td>Transport Processes in the Environment I &amp; Environmental Fluid Transport Processes and Hydrology Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>1.080A &amp; 1.107</td>
<td>Environmental Chemistry I &amp; Environmental Chemistry and Biology Laboratory</td>
<td>12</td>
</tr>
<tr>
<td>2.001</td>
<td>Mechanics and Materials I</td>
<td>12</td>
</tr>
<tr>
<td>2.016</td>
<td>Hydrodynamics</td>
<td>12</td>
</tr>
<tr>
<td>3.012</td>
<td>Fundamentals of Materials Science and Engineering</td>
<td>12-15</td>
</tr>
<tr>
<td>or 5.60</td>
<td>Thermodynamics and Kinetics</td>
<td></td>
</tr>
<tr>
<td>5.12</td>
<td>Organic Chemistry I</td>
<td>12</td>
</tr>
<tr>
<td>6.00</td>
<td>Introduction to Computer Science and Programming</td>
<td>12</td>
</tr>
<tr>
<td>6.01</td>
<td>Introduction to EECS via Robotics</td>
<td>12</td>
</tr>
<tr>
<td>Course</td>
<td>Title</td>
<td>Credits</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>7.05</td>
<td>General Biochemistry</td>
<td>12</td>
</tr>
<tr>
<td>8.03</td>
<td>Physics III</td>
<td>12</td>
</tr>
<tr>
<td>8.04</td>
<td>Quantum Physics I</td>
<td>12</td>
</tr>
<tr>
<td>8.044</td>
<td>Statistical Physics I</td>
<td>12</td>
</tr>
<tr>
<td>8.07</td>
<td>Electromagnetism II</td>
<td>12</td>
</tr>
<tr>
<td>8.09</td>
<td>Classical Mechanics III</td>
<td>12</td>
</tr>
<tr>
<td>12.010</td>
<td>Computational Methods of Scientific Programming</td>
<td>12</td>
</tr>
<tr>
<td>12.012</td>
<td>MatLab, Statistics, Regression, Signal Processing</td>
<td>12</td>
</tr>
<tr>
<td>12.320A[]&amp; 12.320B[]</td>
<td>Introduction to Hydrology and Water Resources and Introduction to Hydrology Modeling</td>
<td>12</td>
</tr>
<tr>
<td>14.01</td>
<td>Principles of Microeconomics</td>
<td>12</td>
</tr>
<tr>
<td>18.03</td>
<td>Differential Equations ¹</td>
<td>12</td>
</tr>
<tr>
<td>18.05</td>
<td>Introduction to Probability and Statistics</td>
<td>12</td>
</tr>
<tr>
<td>18.06</td>
<td>Linear Algebra</td>
<td>12</td>
</tr>
<tr>
<td>18.300</td>
<td>Principles of Continuum Applied Mathematics</td>
<td>12</td>
</tr>
</tbody>
</table>

¹ 18.032 Differential Equations is also an acceptable option.
MATHEMATICS (COURSE 18)

Department of Mathematics (p. 324)

Bachelor of Science in Mathematics (General Mathematics Option)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Science Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>6</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [one subject can be satisfied by 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
<th>18.03 Differential Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives
Select 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 one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>18.06 Linear Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18.700 Linear Algebra</td>
</tr>
<tr>
<td></td>
<td>18.701 Algebra I</td>
</tr>
</tbody>
</table>

Units in Major

| Units | 108 |

Unrestricted Electives

| Units | 84 |

Units in Major That Also Satisfy the GIRs

| Units | (12) |

Total Units Beyond the GIRs Required for SB Degree

| Units | 180 |

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

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. 18.032 Differential Equations, which places more emphasis on theory, is also an acceptable option.

Communication-Intensive Subjects in the Major
To satisfy the requirement that students take two CI-M subjects, students must select one of the following options:

**Option A**
Select two of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>18.104 Seminar in Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18.204 Undergraduate Seminar in Discrete Mathematics</td>
</tr>
<tr>
<td></td>
<td>18.384 Undergraduate Seminar in Physical Mathematics</td>
</tr>
<tr>
<td></td>
<td>18.424 Seminar in Information Theory</td>
</tr>
<tr>
<td></td>
<td>18.434 Seminar in Theoretical Computer Science</td>
</tr>
<tr>
<td></td>
<td>18.504 Seminar in Logic</td>
</tr>
<tr>
<td></td>
<td>18.704 Seminar in Algebra</td>
</tr>
<tr>
<td></td>
<td>18.784 Seminar in Number Theory</td>
</tr>
<tr>
<td></td>
<td>18.821 Project Laboratory in Mathematics</td>
</tr>
<tr>
<td></td>
<td>18.904 Seminar in Topology</td>
</tr>
<tr>
<td></td>
<td>18.994 Seminar in Geometry</td>
</tr>
</tbody>
</table>

**Option B**
Select one subject from Option A and one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>8.06 Quantum Physics III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14.33 Research and Communication in Economics: Topics, Methods, and Implementation</td>
</tr>
<tr>
<td></td>
<td>18.100P Real Analysis</td>
</tr>
<tr>
<td></td>
<td>18.100Q Real Analysis</td>
</tr>
<tr>
<td></td>
<td>18.200 Principles of Discrete Applied Mathematics</td>
</tr>
<tr>
<td></td>
<td>18.642 Topics in Mathematics with Applications in Finance</td>
</tr>
</tbody>
</table>
Bachelor of Science in Mathematics (Applied Mathematics Option)

General Institute Requirements (GIRs)

The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [one subject can be satisfied by 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

| 18.03 | Differential Equations
| 18.04 | Complex Variables with Applications
| or 18.112 | Functions of a Complex Variable
| 18.06 | Linear Algebra
| 18.300 | Principles of Continuum Applied Mathematics

Select one of the following:

| 18.200 | Principles of Discrete Applied Mathematics (15 units, CI-M)
| 18.200A | Principles of Discrete Applied Mathematics (12 units)

Restricted Electives

Select four additional 12-unit Course 18 subjects from the following two groups with at least one subject from each group: ³

Group I—Probability and statistics, combinatorics, computer science

Group II—Numerical analysis, physical mathematics, nonlinear dynamics

Units in Major 108-111

Unrestricted Electives 81-84

Units in Major That Also Satisfy the GIRs (12)

Total Units Beyond the GIRs Required for SB Degree 180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

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, 18.032 Differential Equations, which places more emphasis on theory, is also an acceptable option.

² Students may substitute 18.700 Linear Algebra, which places more emphasis on theory and proofs, or the more advanced subject, 18.701 Algebra I.

³ A list of acceptable subjects is available from Math Academic Services and on the department’s website (http://math.mit.edu).

Communication-Intensive Subjects in the Major

To satisfy the requirement that students take two CI-M subjects, students must select one of the following options:

Option A

Select two of the following:

| 18.104 | Seminar in Analysis
| 18.204 | Undergraduate Seminar in Discrete Mathematics
| 18.384 | Undergraduate Seminar in Physical Mathematics
| 18.424 | Seminar in Information Theory
| 18.434 | Seminar in Theoretical Computer Science
| 18.504 | Seminar in Logic
| 18.704 | Seminar in Algebra
| 18.784 | Seminar in Number Theory
| 18.821 | Project Laboratory in Mathematics
| 18.904 | Seminar in Topology
| 18.994 | Seminar in Geometry

Option B

Select one subject from Option A and one of the following:

| 8.06 | Quantum Physics III
| 14.33 | Research and Communication in Economics: Topics, Methods, and Implementation
| 18.100P | Real Analysis
| 18.100Q | Real Analysis
| 18.200 | Principles of Discrete Applied Mathematics
| 18.642 | Topics in Mathematics with Applications in Finance |
**Bachelor of Science in Mathematics (Pure Mathematics Option)**

**General Institute Requirements (GIRs)**
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

**Summary of Subject Requirements**

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total GIR Subjects Required for SB Degree</strong></td>
<td>17</td>
</tr>
</tbody>
</table>

**Physical Education Requirement**
Swimming requirement, plus four physical education courses for eight points.

**Departmental Program**
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03  Differential Equations(^1)</td>
<td>12</td>
</tr>
<tr>
<td>18.100B Real Analysis (^2)</td>
<td>12</td>
</tr>
<tr>
<td>18.701 Algebra I</td>
<td>12</td>
</tr>
<tr>
<td>18.702 Algebra II</td>
<td>12</td>
</tr>
<tr>
<td>18.901 Introduction to Topology</td>
<td>12</td>
</tr>
<tr>
<td><strong>Restricted Electives</strong></td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12</td>
</tr>
<tr>
<td>18.101 Analysis and Manifolds</td>
<td></td>
</tr>
<tr>
<td>18.102 Introduction to Functional Analysis</td>
<td></td>
</tr>
<tr>
<td>18.103 Fourier Analysis: Theory and Applications</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Select one undergraduate seminar from the following:</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.104 Seminar in Analysis (CI-M)</td>
<td></td>
</tr>
<tr>
<td>18.504 Seminar in Logic (CI-M)</td>
<td></td>
</tr>
<tr>
<td>18.704 Seminar in Algebra (CI-M)</td>
<td></td>
</tr>
<tr>
<td>18.784 Seminar in Number Theory (CI-M)</td>
<td></td>
</tr>
<tr>
<td>18.904 Seminar in Topology (CI-M)</td>
<td></td>
</tr>
<tr>
<td>18.994 Seminar in Geometry (CI-M)</td>
<td></td>
</tr>
</tbody>
</table>

Select two additional 12-unit Course 18 subjects of essentially different content, with the first decimal digit one or higher

<table>
<thead>
<tr>
<th><strong>Units in Major</strong></th>
<th>108</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unrestricted Electives</strong></td>
<td>84</td>
</tr>
<tr>
<td><strong>Units in Major That Also Satisfy the GIRs</strong></td>
<td>(12)</td>
</tr>
<tr>
<td><strong>Total Units Beyond the GIRs Required for SB Degree</strong></td>
<td>180</td>
</tr>
</tbody>
</table>

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

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. 18.032 Differential Equations, which places more emphasis on theory, is also an acceptable option.

2. Alternate versions of this subject, 18.100A, 18.100P and 18.100Q, also satisfy this requirement.

**Communication-Intensive Subjects in the Major**
To satisfy the requirement that students take two CI-M subjects, students must select one of the following options:

**Option A**
Select two of the following:
- 18.104 Seminar in Analysis
- 18.204 Undergraduate Seminar in Discrete Mathematics
- 18.384 Undergraduate Seminar in Physical Mathematics
- 18.424 Seminar in Information Theory
- 18.434 Seminar in Theoretical Computer Science
- 18.504 Seminar in Logic
- 18.704 Seminar in Algebra
- 18.784 Seminar in Number Theory
- 18.821 Project Laboratory in Mathematics
- 18.904 Seminar in Topology
- 18.994 Seminar in Geometry

**Option B**
Select one subject from Option A and one of the following:
- 8.06 Quantum Physics III
- 14.33 Research and Communication in Economics: Topics, Methods, and Implementation
- 18.100P Real Analysis
- 18.100Q Real Analysis
- 18.200 Principles of Discrete Applied Mathematics
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.642</td>
<td>Topics in Mathematics with Applications in Finance</td>
</tr>
</tbody>
</table>
### MATHEMATICS WITH COMPUTER SCIENCE (COURSE 18-C)

Department of Mathematics (p. 324)

**Bachelor of Science in Mathematics with Computer Science**

**General Institute Requirements (GIRs)**

The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 18.03 or 18.06 and 18.062][J] (if taken under joint number 6.042[J]) in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 6.009 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>

**Physical Education Requirement**

Swimming requirement, plus four physical education courses for eight points.

**Departmental Program**

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Foundational Subjects</strong></td>
<td></td>
</tr>
<tr>
<td>18.03 Differential Equations</td>
<td>12</td>
</tr>
<tr>
<td>18.06 Linear Algebra</td>
<td>12</td>
</tr>
<tr>
<td><strong>Discrete Mathematics</strong></td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>12-15</td>
</tr>
<tr>
<td>18.062[J] Mathematics for Computer Science</td>
<td></td>
</tr>
<tr>
<td>18.200 Principles of Discrete Applied Mathematics (15 units, CI-M)</td>
<td></td>
</tr>
<tr>
<td>18.200A Principles of Discrete Applied Mathematics</td>
<td></td>
</tr>
<tr>
<td><strong>Computation and Algorithms</strong></td>
<td></td>
</tr>
<tr>
<td>6.0001 Introduction to Computer Science Programming in Python</td>
<td></td>
</tr>
</tbody>
</table>

| 6.006 Introduction to Algorithms | 12 |
| 6.009 Fundamentals of Programming | 12 |
| 18.400[J] Automata, Computability, and Complexity | 12 |
| or 18.404 Theory of Computation |   |
| 18.410[J] Design and Analysis of Algorithms | 12 |

Select one of the following: 3

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.031 Elements of Software Construction</td>
</tr>
<tr>
<td>6.034 Artificial Intelligence</td>
</tr>
<tr>
<td>6.036 Introduction to Machine Learning</td>
</tr>
</tbody>
</table>

**Restricted Electives**

Select four additional 12-unit subjects from Course 18 4

Select one additional subject of at least 12 units from Course 6 5

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>162-168</td>
</tr>
</tbody>
</table>

**Unrestricted Electives**

48-54

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>(24-36)</td>
</tr>
</tbody>
</table>

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

180-192

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

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. 18.032 Differential Equations, which places more emphasis on theory, is also an acceptable option.

2  Students may substitute 18.700 Linear Algebra, which places more emphasis on theory and proofs, or the more advanced subject, 18.701 Algebra I.

3  Students may substitute 6.033.

4  The overall program must consist of subjects of essentially different content, and must include at least five Course 18 subjects with a first decimal digit of 1 or higher.

5  The additional Course 6 subject may be 6.01, 6.02, 6.03, 6.170, 6.172, a Foundation or Header subject or, with the permission of the Department of Mathematics, an advanced Course 6 subject with sufficient mathematical content.

**Communication-Intensive Subjects in the Major**

To satisfy the requirements that students take two CI-M subjects, students must select one of the following options:

**Option A**

Select two subjects from the list below:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.104 Seminar in Analysis</td>
</tr>
<tr>
<td>18.204 Undergraduate Seminar in Discrete Mathematics</td>
</tr>
<tr>
<td>18.384 Undergraduate Seminar in Physical Mathematics</td>
</tr>
<tr>
<td>Course Code</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>18.424</td>
</tr>
<tr>
<td>18.434</td>
</tr>
<tr>
<td>18.504</td>
</tr>
<tr>
<td>18.704</td>
</tr>
<tr>
<td>18.784</td>
</tr>
<tr>
<td>18.821</td>
</tr>
<tr>
<td>18.904</td>
</tr>
<tr>
<td>18.994</td>
</tr>
</tbody>
</table>

**Option B**

*Select one subject from Option A and one of the following:*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.033</td>
<td>Computer Systems Engineering</td>
</tr>
<tr>
<td>8.06</td>
<td>Quantum Physics III</td>
</tr>
<tr>
<td>14.33</td>
<td>Research and Communication in Economics: Topics, Methods, and Implementation</td>
</tr>
<tr>
<td>18.100P</td>
<td>Real Analysis</td>
</tr>
<tr>
<td>18.100Q</td>
<td>Real Analysis</td>
</tr>
<tr>
<td>18.200</td>
<td>Principles of Discrete Applied Mathematics</td>
</tr>
<tr>
<td>18.642</td>
<td>Topics in Mathematics with Applications in Finance</td>
</tr>
</tbody>
</table>
PHYSICS (COURSE 8)

Department of Physics (p. 330)

Bachelor of Science in Physics (Focused Option)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 8.03 or 8.04, and 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [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>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.03</td>
</tr>
<tr>
<td>8.03</td>
</tr>
<tr>
<td>8.033</td>
</tr>
<tr>
<td>8.04</td>
</tr>
<tr>
<td>8.044</td>
</tr>
<tr>
<td>8.05</td>
</tr>
<tr>
<td>8.06</td>
</tr>
<tr>
<td>8.13</td>
</tr>
<tr>
<td>8.14</td>
</tr>
<tr>
<td>8.223</td>
</tr>
<tr>
<td>8.THU</td>
</tr>
</tbody>
</table>

Restricted Electives

One subject in the Department of Mathematics beyond 18.03

Two subjects in the Department of Physics in addition to those listed above, including at least one of the following:

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.07</td>
</tr>
<tr>
<td>8.08</td>
</tr>
<tr>
<td>8.09</td>
</tr>
</tbody>
</table>

Units in Major 174

Unrestricted Electives 48

Units in Major That Also Satisfy the GIRs 36

Total Units Beyond the GIRs Required for SB Degree 186

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. 18.032 Differential Equations is also an acceptable option.

2. A thesis of 12 units is required. Not more than 30 units of thesis credit may be included in the minimum units beyond the General Institute Requirements required for the SB degree.

3. Subject descriptions identify subjects that cannot be used for this purpose.
Bachelor of Science in Physics (Flexible Option)

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 8.03 or 8.04, and 18.03 in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>18.03 Differential Equations¹</td>
</tr>
<tr>
<td>12</td>
<td>8.03  Physics III</td>
</tr>
<tr>
<td>12</td>
<td>8.04  Quantum Physics I</td>
</tr>
<tr>
<td>12</td>
<td>8.044 Statistical Physics I</td>
</tr>
<tr>
<td>6-12</td>
<td>8.21  Physics of Energy</td>
</tr>
<tr>
<td>or 8.223 Classical Mechanics II</td>
<td></td>
</tr>
<tr>
<td>9-12</td>
<td>Select one of the following:</td>
</tr>
<tr>
<td>12</td>
<td>8.05  Quantum Physics II</td>
</tr>
<tr>
<td>12</td>
<td>8.20  Introduction to Special Relativity</td>
</tr>
<tr>
<td></td>
<td>8.033 Relativity</td>
</tr>
<tr>
<td>18</td>
<td>Select one of the following experimental experiences, subject to the approval of the department:</td>
</tr>
<tr>
<td></td>
<td>8.13  Experimental Physics I (CI-M)</td>
</tr>
<tr>
<td></td>
<td>A laboratory subject of similar intensity in another department</td>
</tr>
<tr>
<td></td>
<td>An experimental research project or senior thesis ²</td>
</tr>
<tr>
<td></td>
<td>An experimentally oriented summer externship</td>
</tr>
</tbody>
</table>

Restricted Electives

At least one subject in the Department of Physics in addition to those listed above ³
Three subjects forming one intellectually coherent unit in some area, not necessarily physics, subject to the approval of the department

Units in Major
129-138

Unrestricted Electives
66-87

Units in Major That Also Satisfy the GIRs
(24-36)

Total Units Beyond the GIRs Required for SB Degree
180

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

¹ 18.032 Differential Equations is also an acceptable option.
² Not more than 30 units of thesis credit may be included in the minimum units beyond the General Institute Requirements required for the SB degree.
³ Subject descriptions identify subjects that cannot be used for this purpose.

Communication-Intensive Subjects in the Major
To satisfy the requirement that students take two CI-M subjects, students must select two of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>8.06  Quantum Physics III</td>
</tr>
<tr>
<td>12</td>
<td>8.13  Experimental Physics I</td>
</tr>
<tr>
<td>18</td>
<td>8.14  Experimental Physics II</td>
</tr>
<tr>
<td>12</td>
<td>8.226 Forty-three Orders of Magnitude</td>
</tr>
<tr>
<td>12</td>
<td>STS.042[J] Einstein, Oppenheimer, Feynman: Physics in the 20th Century</td>
</tr>
</tbody>
</table>
CHEMISTRY AND BIOLOGY (COURSE 5-7)

Chemistry and Biology (p. 338)

Bachelor of Science in Chemistry and Biology

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Science Requirement</th>
<th>Humanities, Arts, and Social Sciences (HASS)</th>
<th>Restricted Electives in Science and Technology (REST)</th>
<th>Laboratory Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>8</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 5.12 or 5.60 and 7.03 in the Departmental Program]

Laboratory Requirement (12 units) [can be satisfied by 7.02[J] or the combination of 5.351, 5.352, and 5.363 or 7.102 in the Departmental Program]

Total GIR Subjects Required for SB Degree 17

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.03</td>
<td>Principles of Inorganic Chemistry I</td>
</tr>
<tr>
<td>5.12</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>5.13</td>
<td>Organic Chemistry II</td>
</tr>
<tr>
<td>5.60</td>
<td>Thermodynamics and Kinetics</td>
</tr>
<tr>
<td>7.03</td>
<td>Genetics</td>
</tr>
<tr>
<td>7.06</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>5.07[J]</td>
<td>Biological Chemistry I</td>
</tr>
<tr>
<td>or 7.05</td>
<td>General Biochemistry</td>
</tr>
</tbody>
</table>

Restricted Electives

Select two of the following: 24

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.04</td>
<td>Principles of Inorganic Chemistry II</td>
</tr>
<tr>
<td>5.08[J]</td>
<td>Biological Chemistry II</td>
</tr>
<tr>
<td>5.43</td>
<td>Advanced Organic Chemistry</td>
</tr>
<tr>
<td>5.61</td>
<td>Physical Chemistry</td>
</tr>
</tbody>
</table>

Departmental Laboratory Requirement
Select 49-61 units from one of the three departmental laboratory tracks

Units in Major 157-169

Unrestricted Electives 48-59

Units in Major That Also Satisfy the GIRs (36)

Total Units Beyond the GIRs Required for SB Degree 180-181

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 Subject has prerequisites that are outside of the program.

Departmental Laboratory Track 1

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.351</td>
<td>Fundamentals of Spectroscopy</td>
</tr>
<tr>
<td>5.352</td>
<td>Synthesis of Coordination Compounds and Kinetics</td>
</tr>
<tr>
<td>5.361</td>
<td>Expression and Purification of Enzyme Mutants</td>
</tr>
<tr>
<td>5.362</td>
<td>Kinetics of Enzyme Inhibition (CI-M)</td>
</tr>
<tr>
<td>5.363</td>
<td>Organic Structure Determination</td>
</tr>
<tr>
<td>5.382</td>
<td>Time- and Frequency-resolved Spectroscopy of Photosynthesis (CI-M)</td>
</tr>
<tr>
<td>7.102</td>
<td>Laboratory in Molecular Biology</td>
</tr>
</tbody>
</table>
Select four of the following:  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.353</td>
<td>Macromolecular Prodrugs</td>
</tr>
<tr>
<td>5.371</td>
<td>Continuous Flow Chemistry: Sustainable Conversion of Reclaimed Vegetable Oil into Biodiesel</td>
</tr>
<tr>
<td>5.372</td>
<td>Chemistry of Renewable Energy</td>
</tr>
<tr>
<td>5.373</td>
<td>Dinitrogen Cleavage $^1$</td>
</tr>
<tr>
<td>5.381</td>
<td>Quantum Dots $^1$</td>
</tr>
<tr>
<td>5.383</td>
<td>Fast-flow Peptide and Protein Synthesis</td>
</tr>
</tbody>
</table>

Total Units 49

**Departmental Laboratory Track 2**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.351</td>
<td>Fundamentals of Spectroscopy</td>
</tr>
<tr>
<td>5.352</td>
<td>Synthesis of Coordination Compounds and Kinetics</td>
</tr>
<tr>
<td>5.363</td>
<td>Organic Structure Determination</td>
</tr>
<tr>
<td>5.382</td>
<td>Time- and Frequency-resolved Spectroscopy of Photosynthesis (CI-M)</td>
</tr>
<tr>
<td>7.02[j]</td>
<td>Introduction to Experimental Biology and Communication (CI-M)</td>
</tr>
</tbody>
</table>

Select four of the following:  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.353</td>
<td>Macromolecular Prodrugs</td>
</tr>
<tr>
<td>5.371</td>
<td>Continuous Flow Chemistry: Sustainable Conversion of Reclaimed Vegetable Oil into Biodiesel</td>
</tr>
<tr>
<td>5.372</td>
<td>Chemistry of Renewable Energy</td>
</tr>
<tr>
<td>5.373</td>
<td>Dinitrogen Cleavage $^1$</td>
</tr>
<tr>
<td>5.381</td>
<td>Quantum Dots $^1$</td>
</tr>
<tr>
<td>5.383</td>
<td>Fast-flow Peptide and Protein Synthesis</td>
</tr>
</tbody>
</table>

Total Units 52

**Departmental Laboratory Track 3**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.351</td>
<td>Fundamentals of Spectroscopy</td>
</tr>
<tr>
<td>5.352</td>
<td>Synthesis of Coordination Compounds and Kinetics</td>
</tr>
<tr>
<td>5.363</td>
<td>Organic Structure Determination</td>
</tr>
<tr>
<td>7.02[j]</td>
<td>Introduction to Experimental Biology and Communication (CI-M)</td>
</tr>
<tr>
<td>7.18</td>
<td>Topics in Experimental Biology (CI-M)</td>
</tr>
</tbody>
</table>

Total Units 61

$^1$ Requires selection of 5.61 as a restricted elective.
COMPUTER SCIENCE AND MOLECULAR BIOLOGY (COURSE 6-7)

Computer Science and Molecular Biology (p. 338)

Bachelor of Science in Computer Science and Molecular Biology

General Institute Requirements (GIrS)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

<table>
<thead>
<tr>
<th>Summary of Subject Requirements</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS) Requirement; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement [can be satisfied by 5.12 and 6.042[J] in the Departmental Program]</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied by 7.02[J] or 20.109 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematics and Introductory</strong></td>
<td></td>
</tr>
<tr>
<td>6.00</td>
<td>Introduction to Computer Science and Programming</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
</tr>
<tr>
<td>5.12</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>5.60</td>
<td>Thermodynamics and Kinetics</td>
</tr>
<tr>
<td>or 20.110[J]</td>
<td>Thermodynamics of Biomolecular Systems</td>
</tr>
<tr>
<td><strong>Introductory Laboratory</strong></td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>15-18</td>
</tr>
<tr>
<td>6.129[J]</td>
<td>Biological Circuit Engineering Laboratory (CI-M)</td>
</tr>
<tr>
<td>7.02[J]</td>
<td>Introduction to Experimental Biology and Communication (CI-M)</td>
</tr>
<tr>
<td>20.109</td>
<td>Laboratory Fundamentals in Biological Engineering (CI-M)</td>
</tr>
</tbody>
</table>

Foundational Subjects
Three Computer Science subjects:
| 6.006                | Introduction to Algorithms | 12 |
| 6.009                | Fundamentals of Programming | 12 |
| 6.046[J]            | Design and Analysis of Algorithms | 12 |

Three Biological Science subjects:
| 7.03                | Genetics | 12 |
| 7.05                | General Biochemistry | 12 |
| 7.06                | Cell Biology | 12 |

Restricted Electives
Computational Biology
| 6.047            | Computational Biology: Genomes, Networks, Evolution | 12 |
| or 6.802[J]      | Foundations of Computational and Systems Biology | |

Biology
Select one subject from the list of Biology Restricted Electives | 12 |

Advanced Undergraduate Project
Select one of the following: | 9-12 |
| 6.UAR            | Seminar in Undergraduate Advanced Research (12 units, CI-M) | |
| 6.UAT            | Oral Communication (CI-M) | |

Units in Major | 168-174 |
Unrestricted Electives | 48 |
Units in Major That Also Satisfy the GIrS | (36) |
Total Units Beyond the GIrS Required for SB Degree | 180-186 |

The units for any subject that counts as one of the 17 GIrS subjects cannot also be counted as units required beyond the GIrS.

1. Students who enter MIT with sufficient programming experience may substitute 6.031 Elements of Software Construction (15 units) after taking 6.009.
2. 5.07[J] Biological Chemistry I is also an acceptable option.

Biology Restricted Electives
<p>| 7.08[J]            | Biological Chemistry II | 12 |
| 7.20[J]            | Human Physiology | 12 |
| 7.21                | Microbial Physiology | 12 |
| 7.22                | Developmental Biology | 12 |
| 7.23[J]            | Immunology | 12 |
| 7.26                | Molecular Basis of Infectious Disease | 12 |
| 7.27                | Principles of Human Disease | 12 |
| 7.28                | Molecular Biology | 12 |
| 7.29[J]            | Cellular and Molecular Neurobiology | 12 |</p>
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.31</td>
<td>Current Topics in Mammalian Biology: Medical Implications</td>
<td>12</td>
</tr>
<tr>
<td>7.32</td>
<td>Systems Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.37[J]</td>
<td>Molecular and Engineering Aspects of Biotechnology</td>
<td>12</td>
</tr>
<tr>
<td>7.371</td>
<td>Biological and Engineering Principles Underlying Novel Biotherapeutics</td>
<td>12</td>
</tr>
<tr>
<td>7.41</td>
<td>Principles of Chemical Biology</td>
<td>12</td>
</tr>
<tr>
<td>7.45</td>
<td>The Hallmarks of Cancer</td>
<td>12</td>
</tr>
<tr>
<td>7.49[J]</td>
<td>Developmental Neurobiology</td>
<td>12</td>
</tr>
</tbody>
</table>
COMPUTER SCIENCE, ECONOMICS, AND DATA SCIENCE (COURSE 6-14)

Computer Science, Economics, and Data Science (p. 339)

Bachelor of Science in Computer Science, Economics, and Data Science

General Institute Requirements (GI�)  
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<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 (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (12 units)</td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td>17</td>
</tr>
</tbody>
</table>

Physical Education Requirement

Swimming requirement, plus four physical education courses for eight points.

Departmental Program

Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Required Subjects

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.06</td>
<td>12</td>
</tr>
<tr>
<td>6.0001</td>
<td>6</td>
</tr>
<tr>
<td>6.009</td>
<td>12</td>
</tr>
<tr>
<td>6.06</td>
<td>12</td>
</tr>
<tr>
<td>6.042[J]</td>
<td>12</td>
</tr>
<tr>
<td>6.046[J]</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Economics</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.01</td>
<td>12</td>
</tr>
<tr>
<td>14.32</td>
<td>12</td>
</tr>
</tbody>
</table>

Introductory Probability and Statistics

Select one of the following:

- 6.041A & 6.041B Introduction to Probability I and II
- 14.30 Introduction to Statistical Methods in Economics
- 18.600 Probability and Random Variables

Data Science

- 6.036 Introduction to Machine Learning 12

Project-based

- 6.UAT Oral Communication (CI-M) 9-12
- or 15.276 Communicating with Data

Elective Subjects

Select one of the following computer science electives:

- 6.207[J] Networks 12
- 15.053 Optimization Methods in Business Analytics 12

Select three economics electives from the list below, including at least one subject from each group:

- 14.05 Intermediate Macroeconomics (CI-M) 12
- 14.18 Mathematical Economic Modeling (CI-M) 12
- 14.33 Research and Communication in Economics: Topics, Methods, and Implementation (CI-M) 12

Unrestricted Electives

48-57 units

Units in Major

183-186 units

Units in Major That Also Satisfy the GIRs

(48-60 units)

Total Units Beyond the GIRs Required for SB Degree

180-186 units

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1. 6.0002 Introduction to Computational Thinking and Data Science is also an acceptable option.
2. 14.03 Microeconomic Theory and Public Policy is also an acceptable option.
3. 6.UAR Seminar in Undergraduate Advanced Research is also an acceptable option.
4. Subject has prerequisites that are outside of the program.

Economics Electives

Select three of the following, including at least one subject from each group:

Data Science

- 14.20 Industrial Organization and Competitive Strategy 12
- 14.27 Economics and E-Commerce 12
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.36</td>
<td>Advanced Econometrics</td>
</tr>
<tr>
<td>14.41</td>
<td>Public Finance and Public Policy</td>
</tr>
<tr>
<td>14.64</td>
<td>Labor Economics and Public Policy</td>
</tr>
<tr>
<td>14.74</td>
<td>Foundations of Development Policy</td>
</tr>
<tr>
<td>14.75</td>
<td>Political Economy and Economic Development</td>
</tr>
<tr>
<td>15.780</td>
<td>Stochastic Models in Business Analytics</td>
</tr>
</tbody>
</table>

### Theory

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.04</td>
<td>Intermediate Microeconomic Theory</td>
</tr>
<tr>
<td>14.12</td>
<td>Economic Applications of Game Theory</td>
</tr>
<tr>
<td>14.13</td>
<td>Psychology and Economics</td>
</tr>
<tr>
<td>14.15[]</td>
<td>Networks</td>
</tr>
<tr>
<td>14.16</td>
<td>Strategy and Information</td>
</tr>
<tr>
<td>14.19</td>
<td>Market Design</td>
</tr>
<tr>
<td>14.26</td>
<td>Economics of Incentives: Theory and Applications</td>
</tr>
<tr>
<td>14.54</td>
<td>International Trade</td>
</tr>
</tbody>
</table>
URBAN SCIENCE AND PLANNING WITH COMPUTER SCIENCE (COURSE 11-6)

Department of Urban Studies and Planning (p. 132)
Department of Electrical Engineering and Computer Science (p. 188)

Bachelor of Science in Urban Science and Planning with Computer Science

General Institute Requirements (GIRs)
The General Institute Requirements include a Communication Requirement that is integrated into both the HASS Requirement and the requirements of each major; see details below.

Summary of Subject Requirements

<table>
<thead>
<tr>
<th>Science Requirement</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities, Arts, and Social Sciences (HASS)</td>
<td>8</td>
</tr>
<tr>
<td>Requirement [two subjects satisfied by 11.001[J] and the required Policy/Ethics subjects (all HASS); additional HASS units may be included in urban science electives]; at least two of these subjects must be designated as communication-intensive (CI-H) to fulfill the Communication Requirement.</td>
<td></td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST)</td>
<td>2</td>
</tr>
<tr>
<td>Requirement [can be satisfied from among 6.00, 6.041A/6.041B, and 6.042[J] (if taken under joint number 18.062[J]) in the Departmental Program]</td>
<td></td>
</tr>
<tr>
<td>Laboratory Requirement (12 units) [can be satisfied from among 6.008, 6.009, and 11.188 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>

Physical Education Requirement
Swimming requirement, plus four physical education courses for eight points.

Departmental Program
Choose at least two subjects in the major that are designated as communication-intensive (CI-M) to fulfill the Communication Requirement.

Computer Science Requirements

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00</td>
</tr>
<tr>
<td>6.008</td>
</tr>
<tr>
<td>6.011</td>
</tr>
<tr>
<td>6.041A</td>
</tr>
<tr>
<td>6.041B</td>
</tr>
<tr>
<td>6.042A</td>
</tr>
</tbody>
</table>

Select one of the following options: 12-24

6.008  Introduction to Inference
6.011  Urban Planning and Social Science Laboratory (CI-M)

Urban Planning Requirements

| 11.001[J]  | 12 |
| 11.007     | 12 |
| 11.188     | 12 |

Select one of the following: 12

| 11.002[J] | Making Public Policy |
| 11.011    | The Art and Science of Negotiation |
| 11.165    | Urban Energy Systems and Policy |

Senior Thesis/Project
Select one of the following options: 18

Option 1

| 6.UR      | Undergraduate Research in Electrical Engineering and Computer Science |
| 6.UAR     | Seminar in Undergraduate Advanced Research (CI-M) |

Option 2

| 11.THU    | Undergraduate Thesis |

Electives
Select one Advanced Computer Science Elective from the list below 12

Select three Urban Science Electives for a minimum of 30 units from the list below 30

Units in Major 183-195

Unrestricted Electives 48-57

Units in Major That Also Satisfy the GIRs (48-60)

Total Units Beyond the GIRs Required for SB Degree 180-195

The units for any subject that counts as one of the 17 GIR subjects cannot also be counted as units required beyond the GIRs.

1 6.805[J] can count towards either the Urban Planning Requirements or the Urban Science Electives, but not both.

Advanced Computer Science Electives

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.803</td>
</tr>
<tr>
<td>6.805</td>
</tr>
<tr>
<td>6.809</td>
</tr>
<tr>
<td>6.811[J]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.809</td>
</tr>
<tr>
<td>6.811[J]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.811[J]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.811[J]</td>
</tr>
</tbody>
</table>

486 | 2018–2019 MIT Bulletin
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.813</td>
<td>User Interface Design and Implementation</td>
<td>12</td>
</tr>
<tr>
<td>6.815</td>
<td>Digital and Computational Photography</td>
<td>12</td>
</tr>
<tr>
<td>6.837</td>
<td>Computer Graphics</td>
<td>12</td>
</tr>
<tr>
<td>6.170</td>
<td>Software Studio</td>
<td>12</td>
</tr>
</tbody>
</table>

**Urban Science Electives**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00A</td>
<td>Fundamentals of Engineering Design: Explore Space, Sea and Earth</td>
<td>9</td>
</tr>
<tr>
<td>4.032</td>
<td>Design Studio: Information and Visualization</td>
<td>12</td>
</tr>
<tr>
<td>4.432</td>
<td>Modeling Urban Energy Flows for Sustainable Cities and Neighborhoods</td>
<td>12</td>
</tr>
<tr>
<td>6.805[J]</td>
<td>Foundations of Information Policy (^1)</td>
<td>12</td>
</tr>
<tr>
<td>11.123</td>
<td>Big Plans and Mega-Urban Landscapes</td>
<td>9</td>
</tr>
<tr>
<td>11.137</td>
<td>Financing Economic Development</td>
<td>12</td>
</tr>
<tr>
<td>11.148</td>
<td>Environmental Justice: Law and Policy</td>
<td>12</td>
</tr>
<tr>
<td>11.156</td>
<td>Healthy Cities: Assessing Health Impacts of Policies and Plans</td>
<td>12</td>
</tr>
<tr>
<td>11.158</td>
<td>Behavior and Policy: Connections in Transportation</td>
<td>12</td>
</tr>
<tr>
<td>12.010</td>
<td>Computational Methods of Scientific Programming</td>
<td>12</td>
</tr>
<tr>
<td>15.276</td>
<td>Communicating with Data</td>
<td>12</td>
</tr>
<tr>
<td>IDS.012[J]</td>
<td>Statistics, Computation and Applications</td>
<td>12</td>
</tr>
<tr>
<td>IDS.060[J]</td>
<td>Environmental Law, Policy, and Economics: Pollution Prevention and Control</td>
<td>12</td>
</tr>
</tbody>
</table>

\(^1\) 6.805[J] can count towards either the Urban Planning Requirements or the Urban Science Electives, but not both.
COMPUTER SCIENCE AND MOLECULAR BIOLOGY (COURSE 6-7P)

Computer Science and Molecular Biology (p. 370)

Master of Engineering in Computer Science and Molecular Biology

The Master of Engineering degree is awarded only to students who have already received, or who will simultaneously receive, the Bachelor of Science in Computer Science and Molecular Biology (Course 6-7). Refer to the undergraduate degree chart (p. 482) for requirements.

The graduate component of the MEng program is described below.

**Course 6-7P Graduate Requirements**

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6.THM Master of Engineering Program</td>
<td>24</td>
</tr>
<tr>
<td>Thesis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Restricted Electives</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Four graduate subjects totaling at least 42 units, which includes two concentration subjects plus a third graduate subject in electrical engineering and computer science and/or biology.²</td>
<td>42-48</td>
</tr>
<tr>
<td>Two subjects from a restricted departmental list of mathematics electives.</td>
<td>24</td>
</tr>
</tbody>
</table>

Total Units 90-96

² The required graduate subjects are selected with departmental review and approval to ensure that the combination, including two subjects in biology and/or computational biology plus a third subject in electrical engineering and computer science and/or biology, forms a distinct and appropriate area of graduate concentration.
Interdisciplinary Doctoral Program in Statistics (p. 376)

Common Core
All students in the Interdisciplinary Doctoral Program in Statistics are required to complete the common core for a total of 27 units.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.436[J] or 18.175</td>
<td>Fundamentals of Probability</td>
<td>12</td>
</tr>
<tr>
<td>18.655</td>
<td>Theory of Probability</td>
<td></td>
</tr>
<tr>
<td>IDS.190</td>
<td>Doctoral Seminar in Statistics and Data Science</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Units 27

Program-specific Requirements
Each student must complete the requirements specified by their home department in the lists below by taking one subject from the Computation and Statistics category and one subject from the Data Analysis category.

Aeronautics and Astronautics

Computation and Statistics
Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.438</td>
<td>Algorithms for Inference</td>
<td>12</td>
</tr>
<tr>
<td>6.867</td>
<td>Machine Learning</td>
<td></td>
</tr>
<tr>
<td>9.520[J]</td>
<td>Statistical Learning Theory and Applications</td>
<td></td>
</tr>
<tr>
<td>16.391[J]</td>
<td>Statistics for Engineers and Scientists</td>
<td></td>
</tr>
<tr>
<td>16.940</td>
<td>Numerical Methods for Stochastic Modeling and Inference</td>
<td></td>
</tr>
</tbody>
</table>

Data Analysis
Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.393</td>
<td>Statistical Communication and Localization Theory</td>
<td></td>
</tr>
<tr>
<td>16.470</td>
<td>Statistical Methods in Experimental Design</td>
<td></td>
</tr>
<tr>
<td>IDS.131[J]</td>
<td>Statistics, Computation and Applications</td>
<td></td>
</tr>
</tbody>
</table>

Total Units 24

Economics

Computation and Statistics
Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.520[J]</td>
<td>Statistical Learning Theory and Applications</td>
<td></td>
</tr>
<tr>
<td>6.867</td>
<td>Machine Learning</td>
<td></td>
</tr>
</tbody>
</table>

Data Analysis
Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.802</td>
<td>Quantitative Research Methods II: Causal Inference</td>
<td></td>
</tr>
</tbody>
</table>

1. Students may substitute a more advanced subject with permission of the program director.

Mathematics

Computation and Statistics
Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.252[J]</td>
<td>Nonlinear Optimization</td>
<td>12</td>
</tr>
<tr>
<td>6.256</td>
<td>Algebraic Techniques and Semidefinite Optimization</td>
<td></td>
</tr>
<tr>
<td>6.438</td>
<td>Algorithms for Inference</td>
<td></td>
</tr>
<tr>
<td>6.867</td>
<td>Machine Learning</td>
<td></td>
</tr>
<tr>
<td>9.520[J]</td>
<td>Statistical Learning Theory and Applications</td>
<td></td>
</tr>
<tr>
<td>18.337[J]</td>
<td>Numerical Computing and Interactive Software</td>
<td></td>
</tr>
<tr>
<td>18.338</td>
<td>Eigenvalues of Random Matrices</td>
<td></td>
</tr>
<tr>
<td>18.415[J]</td>
<td>Advanced Algorithms</td>
<td></td>
</tr>
<tr>
<td>18.416[J]</td>
<td>Randomized Algorithms</td>
<td></td>
</tr>
<tr>
<td>18.657</td>
<td>Topics in Statistics</td>
<td></td>
</tr>
</tbody>
</table>

Data Analysis
Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.555[J]</td>
<td>Biomedical Signal and Image Processing</td>
<td></td>
</tr>
<tr>
<td>6.869</td>
<td>Advances in Computer Vision</td>
<td></td>
</tr>
<tr>
<td>9.272[J]</td>
<td>Topics in Neural Signal Processing</td>
<td></td>
</tr>
<tr>
<td>18.367</td>
<td>Waves and Imaging</td>
<td></td>
</tr>
<tr>
<td>IDS.131[J]</td>
<td>Statistics, Computation and Applications</td>
<td></td>
</tr>
</tbody>
</table>

Total Units 24

Political Science

Computation and Statistics
Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.867</td>
<td>Machine Learning</td>
<td></td>
</tr>
<tr>
<td>9.520[J]</td>
<td>Statistical Learning Theory and Applications</td>
<td></td>
</tr>
<tr>
<td>14.381</td>
<td>Statistical Method in Economics</td>
<td></td>
</tr>
</tbody>
</table>

Data Analysis
Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.802</td>
<td>Quantitative Research Methods II: Causal Inference</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>17.804</td>
<td>Quantitative Research Methods III: Generalized Linear Models and Extensions</td>
<td></td>
</tr>
<tr>
<td>17.806</td>
<td>Quantitative Research Methods IV: Advanced Topics</td>
<td></td>
</tr>
</tbody>
</table>

**Total Units:** 24

### Social and Engineering Systems

#### Computation and Statistics

Select one of the following: 12

- **6.434[J]** Statistics for Engineers and Scientists
- **6.438** Algorithms for Inference
- **6.867** Machine Learning
- **9.520[J]** Statistical Learning Theory and Applications
- **14.381** Statistical Method in Economics
- **14.382** Econometrics
- **15.077[J]** Statistical Learning and Data Mining
- **17.802** Quantitative Research Methods II: Causal Inference
- **17.804** Quantitative Research Methods III: Generalized Linear Models and Extensions
- **17.806** Quantitative Research Methods IV: Advanced Topics

### Data Analysis

Select one of the following: 12-15

- **6.555[J]** Biomedical Signal and Image Processing
- **6.869** Advances in Computer Vision
- **9.073[J]** Statistics for Neuroscience Research
- **9.272[J]** Topics in Neural Signal Processing
- **14.386** New Econometric Methods
- **14.387** Applied Econometrics
- **14.389** and Econometrics Paper
- **14.389** and Econometrics Paper
- **18.367** Waves and Imaging
- **IDS.131[J]** Statistics, Computation and Applications

**Total Units:** 24-27
### SUPPLY CHAIN MANAGEMENT (MENG AND MASC)

Supply Chain Management Program (p. 376)

**Master of Applied Science in Supply Chain Management (Residential Program)**

The Master of Applied Science in Supply Chain Management degree is an intensive, 10-month residential program requiring 90 units of graduate subjects. Students complete at least 81 units of required and elective subjects and complete a 9-unit capstone project. The subject requirements for this program are described below.

#### Subject Requirements

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.250</td>
<td>Analytical Methods for Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.259</td>
<td>Business Writing for Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.260[J]</td>
<td>Logistics Systems</td>
<td>12</td>
</tr>
<tr>
<td>SCM.264</td>
<td>Databases and Data Analysis for Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.280</td>
<td>Supply Chain Communications Workshop</td>
<td>1</td>
</tr>
<tr>
<td>SCM.800</td>
<td>Capstone Project in Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.262</td>
<td>Leading Global Teams</td>
<td>4</td>
</tr>
<tr>
<td>SCM.282</td>
<td>Supply Chain Leadership Workshop</td>
<td>3</td>
</tr>
<tr>
<td>SCM.254</td>
<td>Introduction to Programming and Data Analysis in Python</td>
<td>3</td>
</tr>
<tr>
<td>or SCM.272</td>
<td>Supply Chain Specialty Workshop</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.263</td>
<td>Advanced Writing Workshop for SCM</td>
<td>3</td>
</tr>
<tr>
<td>SCM.268</td>
<td>Data Science for Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.270</td>
<td>Current Challenges in Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.281</td>
<td>Supply Chain Public Speaking Workshop</td>
<td>1</td>
</tr>
<tr>
<td>SCM.295</td>
<td>Supply Chain Study Trek</td>
<td>3</td>
</tr>
<tr>
<td>SCM.800</td>
<td>Capstone Project in Supply Chain Management</td>
<td>6</td>
</tr>
</tbody>
</table>

#### IAP Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.266[J]</td>
<td>Case Studies in Logistics and Supply Chain Management</td>
<td>9</td>
</tr>
<tr>
<td>SCM.265[J]</td>
<td>Global Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.266</td>
<td>Freight Transportation</td>
<td>6</td>
</tr>
<tr>
<td>SCM.267</td>
<td>Global Supply Chain Applications</td>
<td>3</td>
</tr>
<tr>
<td>SCM.283</td>
<td>Humanitarian Logistics</td>
<td>6</td>
</tr>
<tr>
<td>SCM.284</td>
<td>Humanitarian Logistics Project</td>
<td>12</td>
</tr>
<tr>
<td>SCM.290</td>
<td>Sustainable Supply Chain Management</td>
<td>6</td>
</tr>
</tbody>
</table>

#### Spring Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.269</td>
<td>Advanced Writing Workshop for SCM</td>
<td>3</td>
</tr>
<tr>
<td>SCM.272</td>
<td>Data Science for Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.274</td>
<td>Current Challenges in Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.281</td>
<td>Supply Chain Public Speaking Workshop</td>
<td>1</td>
</tr>
<tr>
<td>SCM.295</td>
<td>Supply Chain Study Trek</td>
<td>3</td>
</tr>
<tr>
<td>SCM.800</td>
<td>Capstone Project in Supply Chain Management</td>
<td>6</td>
</tr>
</tbody>
</table>

#### Finance Choices

Select one of the following:

- 15.011 Economic Analysis for Business Decisions
- 15.401 Managerial Finance

### Required Electives

From the list of electives, select 6 units in each of the following categories:

- SCM Electives: 6 units
- Analysis Electives: 6 units
- Management Electives: 6 units

#### Electives

The subjects listed below are recommended but other choices can be approved by the graduate advisor.

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.261[J]</td>
<td>Case Studies in Logistics and Supply Chain Management</td>
<td>9</td>
</tr>
<tr>
<td>SCM.265[J]</td>
<td>Global Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.266</td>
<td>Freight Transportation</td>
<td>6</td>
</tr>
<tr>
<td>SCM.267</td>
<td>Global Supply Chain Applications</td>
<td>3</td>
</tr>
<tr>
<td>SCM.283</td>
<td>Humanitarian Logistics</td>
<td>6</td>
</tr>
<tr>
<td>SCM.284</td>
<td>Humanitarian Logistics Project</td>
<td>12</td>
</tr>
<tr>
<td>SCM.290</td>
<td>Sustainable Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>1.200[J]</td>
<td>Transportation Systems Analysis: Performance and Optimization</td>
<td>12</td>
</tr>
<tr>
<td>15.093[J]</td>
<td>Optimization Methods</td>
<td>12</td>
</tr>
<tr>
<td>15.774</td>
<td>The Analytics of Operations Management</td>
<td>12</td>
</tr>
<tr>
<td>15.871</td>
<td>Introduction to System Dynamics</td>
<td>6</td>
</tr>
<tr>
<td>15.872</td>
<td>System Dynamics II</td>
<td>6</td>
</tr>
<tr>
<td>IDS.145[J]</td>
<td>Data Mining: Finding the Models and Predictions that Create Value</td>
<td>6</td>
</tr>
<tr>
<td>IDS.147[J]</td>
<td>Statistical Learning and Data Mining</td>
<td>12</td>
</tr>
<tr>
<td>IDS.330</td>
<td>Real Options for Product and Systems Design</td>
<td>6</td>
</tr>
<tr>
<td>IDS.333</td>
<td>Risk and Decision Analysis</td>
<td>6</td>
</tr>
<tr>
<td>IDS.338[J]</td>
<td>Multidisciplinary System Design Optimization</td>
<td>12</td>
</tr>
</tbody>
</table>

#### Total Units

90 units

1. Students who have already successfully completed one of the required subjects at a graduate level elsewhere may petition to replace that subject with another elective.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.762[J]</td>
<td>Supply Chain Planning</td>
<td>6</td>
</tr>
<tr>
<td>15.763[J]</td>
<td>Manufacturing System and Supply Chain Design</td>
<td>6</td>
</tr>
<tr>
<td>15.768</td>
<td>Management of Services: Concepts, Design, and Delivery</td>
<td>9</td>
</tr>
<tr>
<td>15.769</td>
<td>Operations Strategy</td>
<td>9</td>
</tr>
<tr>
<td>15.784</td>
<td>Operations Laboratory</td>
<td>9</td>
</tr>
</tbody>
</table>
Supplies Chain Management Program (p. 376)

Master of Engineering in Supply Chain Management (Residential Program)

The Master of Engineering in Supply Chain Management degree is an intensive, 10-month residential program requiring 90 units of graduate subjects. Students complete at least 78 units of required and elective subjects, and complete a 12-unit thesis. The subject requirements for this program are described below.

### Subject Requirements

#### Fall Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.250</td>
<td>Analytical Methods for Supply Chain Management</td>
<td>6</td>
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<tr>
<td>SCM.260[J]</td>
<td>Logistics Systems</td>
<td>12</td>
</tr>
<tr>
<td>SCM.264</td>
<td>Databases and Data Analysis for Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.280</td>
<td>Supply Chain Communications Workshop</td>
<td>1</td>
</tr>
<tr>
<td>SCM.THG</td>
<td>Graduate Thesis</td>
<td>3</td>
</tr>
</tbody>
</table>

#### IAP Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.262</td>
<td>Leading Global Teams</td>
<td>4</td>
</tr>
<tr>
<td>SCM.282</td>
<td>Supply Chain Leadership Workshop</td>
<td>3</td>
</tr>
<tr>
<td>SCM.254</td>
<td>Introduction to Programming and Data Analysis in Python</td>
<td>3</td>
</tr>
<tr>
<td>or SCM.272</td>
<td>Supply Chain Specialty Workshop</td>
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</tr>
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#### Spring Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.263</td>
<td>Advanced Writing Workshop for SCM</td>
<td>3</td>
</tr>
<tr>
<td>SCM.268</td>
<td>Data Science for Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.270</td>
<td>Current Challenges in Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.281</td>
<td>Supply Chain Public Speaking Workshop</td>
<td>1</td>
</tr>
<tr>
<td>SCM.295</td>
<td>Supply Chain Study Trek</td>
<td>3</td>
</tr>
<tr>
<td>SCM.THG</td>
<td>Graduate Thesis</td>
<td>9</td>
</tr>
</tbody>
</table>

#### Finance Choices

Select one of the following:

- 15.011 Economic Analysis for Business Decisions
- 15.401 Managerial Finance
- 15.521 Cost Analysis and Accounting for the Manager, Entrepreneur, and Investor
- SCM.251 Supply Chain Financial Analysis
- SCM.253 & SCM.253 and Case Studies in Supply Chain Financial Analysis

#### Required Electives

*From the list of electives, select 6 units in each of the following categories:

<table>
<thead>
<tr>
<th>Category</th>
<th>Subject Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM Electives</td>
<td>SCM.261[J]</td>
<td>Case Studies in Logistics and Supply Chain Management</td>
<td>9</td>
</tr>
<tr>
<td>or SCM.265[J]</td>
<td>Global Supply Chain Management</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>or SCM.266</td>
<td>Freight Transportation</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>or SCM.267</td>
<td>Global Supply Chain Applications</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>or SCM.283</td>
<td>Humanitarian Logistics</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>or SCM.284</td>
<td>Humanitarian Logistics Project</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>or SCM.290</td>
<td>Sustainable Supply Chain Management</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

#### Analysis Electives

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.200[J]</td>
<td>Transportation Systems Analysis: Performance and Optimization</td>
<td>12</td>
</tr>
<tr>
<td>15.093[J]</td>
<td>Optimization Methods</td>
<td>12</td>
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<td>15.774</td>
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<td>IDS.145[J]</td>
<td>Data Mining: Finding the Models and Predictions that Create Value</td>
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<td>IDS.147[J]</td>
<td>Statistical Learning and Data Mining</td>
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<tr>
<td>IDS.330</td>
<td>Real Options for Product and Systems Design</td>
<td>6</td>
</tr>
<tr>
<td>IDS.333</td>
<td>Risk and Decision Analysis</td>
<td>6</td>
</tr>
<tr>
<td>IDS.338[J]</td>
<td>Multidisciplinary System Design Optimization</td>
<td>12</td>
</tr>
</tbody>
</table>

#### Management Electives

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.762[J]</td>
<td>Supply Chain Planning</td>
<td>6</td>
</tr>
<tr>
<td>15.763[J]</td>
<td>Manufacturing System and Supply Chain Design</td>
<td>6</td>
</tr>
<tr>
<td>15.768</td>
<td>Management of Services: Concepts, Design, and Delivery</td>
<td>9</td>
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<tr>
<td>15.769</td>
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<td>9</td>
</tr>
<tr>
<td>15.784</td>
<td>Operations Laboratory</td>
<td>9</td>
</tr>
</tbody>
</table>
Supply Chain Management Program (p. 376)

Master of Applied Science in Supply Chain Management (Blended Program)

The Master of Applied Science in Supply Chain Management degree is an intensive, five-month blended program requiring 90 units of graduate subjects. The MASc degree is only available to students who have successfully completed the MITx MicroMasters credential in Supply Chain Management. Students receive 42 units of advance standing credit for completion of the MicroMasters Credential, complete at least 39 units of required and elective subjects, and complete a 9-unit capstone project. The subject requirements for this program are described below.

Subject Requirements

Students receive advanced standing credit for completion of the MicroMasters Credential, which constitutes the first semester of the program.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.500</td>
<td>Studies in Supply Chain Management</td>
<td>42</td>
</tr>
</tbody>
</table>

Students complete the following subjects in residence, constituting the second semester of the program.

IAP Required Subjects

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.254</td>
<td>Introduction to Programming and Data Analysis in Python</td>
<td>3</td>
</tr>
<tr>
<td>or SCM.272</td>
<td>Supply Chain Specialty Workshop</td>
<td></td>
</tr>
<tr>
<td>SCM.259</td>
<td>Business Writing for Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.262</td>
<td>Leading Global Teams</td>
<td>4</td>
</tr>
<tr>
<td>SCM.280</td>
<td>Supply Chain Communications Workshop</td>
<td>1</td>
</tr>
<tr>
<td>SCM.282</td>
<td>Supply Chain Leadership Workshop</td>
<td>3</td>
</tr>
</tbody>
</table>

Spring Required Subjects

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.253</td>
<td>Case Studies in Supply Chain Financial Analysis</td>
<td>3</td>
</tr>
<tr>
<td>SCM.263</td>
<td>Advanced Writing Workshop for SCM</td>
<td>3</td>
</tr>
<tr>
<td>SCM.270</td>
<td>Current Challenges in Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.281</td>
<td>Supply Chain Public Speaking Workshop</td>
<td>1</td>
</tr>
<tr>
<td>SCM.295</td>
<td>Supply Chain Study Trek</td>
<td>3</td>
</tr>
</tbody>
</table>

Capstone Requirement

A capstone report, presentation, and executive summary of the project are required.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.800</td>
<td>Capstone Project in Supply Chain Management</td>
<td>9</td>
</tr>
</tbody>
</table>

Electives

The subjects listed below are recommended. Students may select other subjects with the approval of the advisor.

SCM Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.261[I]</td>
<td>Case Studies in Logistics and Supply Chain Management</td>
<td>9</td>
</tr>
<tr>
<td>SCM.266</td>
<td>Freight Transportation</td>
<td>6</td>
</tr>
<tr>
<td>SCM.267</td>
<td>Global Supply Chain Applications</td>
<td>3</td>
</tr>
<tr>
<td>SCM.283</td>
<td>Humanitarian Logistics</td>
<td>6</td>
</tr>
<tr>
<td>SCM.284</td>
<td>Humanitarian Logistics Project</td>
<td>12</td>
</tr>
<tr>
<td>SCM.290</td>
<td>Sustainable Supply Chain Management</td>
<td>6</td>
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Analysis Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.871</td>
<td>Introduction to System Dynamics</td>
<td>6</td>
</tr>
<tr>
<td>15.872</td>
<td>System Dynamics II</td>
<td>6</td>
</tr>
<tr>
<td>IDS.145[I]</td>
<td>Data Mining: Finding the Models and Predictions that Create Value</td>
<td>6</td>
</tr>
<tr>
<td>IDS.147[I]</td>
<td>Statistical Learning and Data Mining</td>
<td>12</td>
</tr>
<tr>
<td>IDS.330</td>
<td>Real Options for Product and Systems Design</td>
<td>6</td>
</tr>
<tr>
<td>IDS.338[I]</td>
<td>Multidisciplinary System Design Optimization</td>
<td>12</td>
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</table>

Management Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.762[I]</td>
<td>Supply Chain Planning</td>
<td>6</td>
</tr>
<tr>
<td>15.763[I]</td>
<td>Manufacturing System and Supply Chain Design</td>
<td>6</td>
</tr>
<tr>
<td>15.768</td>
<td>Management of Services: Concepts, Design, and Delivery</td>
<td>9</td>
</tr>
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<td>15.769</td>
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</tr>
<tr>
<td>15.784</td>
<td>Operations Laboratory</td>
<td>9</td>
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</table>

Total Units 90

Required Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
</table>

From the list of electives, select subjects in each of the following categories:

SCM Electives 6
Analysis Electives 6

Total Units 90

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Supply Chain Management Program (p. 376)

Master of Engineering in Supply Chain Management (Blended Program)

The Master of Engineering in Supply Chain Management degree is an intensive, five-month blended program requiring 90 units of graduate subjects. The MEng degree is only available to students who have successfully completed the MITx MicroMasters credential in Supply Chain Management. Students receive 42 units of advance standing credit for completion of the MicroMasters Credential, complete at least 36 units of required and elective subjects, and complete a 12-unit thesis. The subject requirements for this program are described below.

Subject Requirements

Students receive advanced standing credit for completion of the MicroMasters Credential, which constitutes the first semester of the program.

SCM.500 Studies in Supply Chain Management 42

Students complete the following subjects in residence, constituting the second semester of the program.

IAP Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.254</td>
<td>Introduction to Programming and Data Analysis in Python</td>
<td>3</td>
</tr>
<tr>
<td>or SCM.272</td>
<td>Supply Chain Specialty Workshop</td>
<td></td>
</tr>
<tr>
<td>SCM.259</td>
<td>Business Writing for Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.262</td>
<td>Leading Global Teams</td>
<td>4</td>
</tr>
<tr>
<td>SCM.280</td>
<td>Supply Chain Communications Workshop</td>
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</tr>
<tr>
<td>SCM.282</td>
<td>Supply Chain Leadership Workshop</td>
<td>3</td>
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</table>

Spring Required Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.253</td>
<td>Case Studies in Supply Chain Financial Analysis</td>
<td>3</td>
</tr>
<tr>
<td>SCM.263</td>
<td>Advanced Writing Workshop for SCM</td>
<td>3</td>
</tr>
<tr>
<td>SCM.270</td>
<td>Current Challenges in Supply Chain Management</td>
<td>3</td>
</tr>
<tr>
<td>SCM.281</td>
<td>Supply Chain Public Speaking Workshop</td>
<td>1</td>
</tr>
<tr>
<td>SCM.295</td>
<td>Supply Chain Study Trek</td>
<td>3</td>
</tr>
</tbody>
</table>

Thesis Requirement

A master’s thesis, presentation, and executive summary of the thesis are required.

SCM.THG Graduate Thesis 12

Required Electives

From the list of electives, select subjects in each of the following categories:

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM Electives</td>
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</tr>
<tr>
<td>Analysis Electives</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Total Units</td>
<td></td>
<td>90</td>
</tr>
</tbody>
</table>

Electives

The subjects listed below are recommended. Students may select other subjects with the approval of the advisor.

SCM Electives

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCM.261(J)</td>
<td>Case Studies in Logistics and Supply Chain Management</td>
<td>9</td>
</tr>
<tr>
<td>SCM.266</td>
<td>Freight Transportation</td>
<td>6</td>
</tr>
<tr>
<td>SCM.267</td>
<td>Global Supply Chain Applications</td>
<td>3</td>
</tr>
<tr>
<td>SCM.283</td>
<td>Humanitarian Logistics</td>
<td>6</td>
</tr>
<tr>
<td>SCM.284</td>
<td>Humanitarian Logistics Project</td>
<td>12</td>
</tr>
<tr>
<td>SCM.290</td>
<td>Sustainable Supply Chain Management</td>
<td>6</td>
</tr>
</tbody>
</table>

Analysis Electives

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.764(J)</td>
<td>The Theory of Operations Management</td>
<td>12</td>
</tr>
<tr>
<td>15.871</td>
<td>Introduction to System Dynamics</td>
<td>6</td>
</tr>
<tr>
<td>15.872</td>
<td>System Dynamics II</td>
<td>6</td>
</tr>
<tr>
<td>IDS.145(J)</td>
<td>Data Mining: Finding the Models and Predictions that Create Value</td>
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<td>Statistical Learning and Data Mining</td>
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<td>IDS.330</td>
<td>Real Options for Product and Systems Design</td>
<td>6</td>
</tr>
<tr>
<td>IDS.338(J)</td>
<td>Multidisciplinary System Design Optimization</td>
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</tbody>
</table>

Management Electives

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.762(J)</td>
<td>Supply Chain Planning</td>
<td>6</td>
</tr>
<tr>
<td>15.763(J)</td>
<td>Manufacturing System and Supply Chain Design</td>
<td>6</td>
</tr>
<tr>
<td>15.768</td>
<td>Management of Services: Concepts, Design, and Delivery</td>
<td>9</td>
</tr>
<tr>
<td>15.769</td>
<td>Operations Strategy</td>
<td>9</td>
</tr>
<tr>
<td>15.784</td>
<td>Operations Laboratory</td>
<td>9</td>
</tr>
</tbody>
</table>
The Master of Science in Technology and Policy, designed to be completed in two years, requires 84–90 units of coursework plus a master’s thesis that builds on the student’s concentration.

**Core Subjects**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDS.411</td>
<td>Concepts and Research in Technology and Policy</td>
<td>9</td>
</tr>
<tr>
<td>6.867</td>
<td>Machine Learning</td>
<td>12</td>
</tr>
<tr>
<td>14.381</td>
<td>Statistical Method in Economics</td>
<td></td>
</tr>
<tr>
<td>17.800</td>
<td>Quantitative Research Methods I: Regression</td>
<td></td>
</tr>
<tr>
<td>IDS.131[J]</td>
<td>Statistics, Computation and Applications</td>
<td></td>
</tr>
</tbody>
</table>

Select one of the following:

- 15.011    Economic Analysis for Business Decisions 9-12
- or 14.003 Microeconomic Theory and Public Policy 9-12
- IDS.412[J] Science, Technology, and Public Policy 12

One Restricted elective in Law, Social Science, or Statistics 9-12

**Framework Subjects**

- Engineering Systems Concentration
  - Select three graduate subjects that form a coherent sequence in technology and policy/social sciences. Concentration requires approval from both the research supervisor and TPP administration. 30

**Thesis Requirement**

Students must complete a research-based thesis on a topic of their choice that has been approved by the thesis supervisor.

**Total Units**

105–111

1 A list of candidate subjects is maintained by the program.

2 TPP academic advisors may suggest subjects, depending on a student’s background, research interests, and academic goals.
TRANSPORTATION (SM)

Master of Science in Transportation Program Description (p. 377)

A Master of Science degree at MIT requires a minimum of 66 units of graduate subjects, plus a thesis. The subject and thesis requirements for this program are described below.

**Subject Requirements**

### Core Subjects

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>and Optimization</td>
<td></td>
</tr>
<tr>
<td>1.201[J]</td>
<td>Transportation Systems Analysis: Demand</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>and Economics</td>
<td></td>
</tr>
</tbody>
</table>

### Individually Designed Program

Select three subjects from the MST Program Areas, listed separately below.

Select one subject from the Policy and Technology Subjects, listed separately below.

### Computer Programming Requirement

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.001</td>
<td>Engineering Computation and Data Science</td>
<td>12</td>
</tr>
</tbody>
</table>

**Total Units**

66

1. Requests to waive this requirement based on prior coursework must be submitted in writing to the Transportation Education Committee (TEC) executive director.

2. Recommended for most students. See the MST website (http://cee.mit.edu/graduate/transportation/degerequirements) for information about acceptable substitutions.

**Thesis Requirement**

Students must complete a research-based thesis on a topic of their choice that has been approved by the thesis supervisor.

1.THG Graduate Thesis 24

**MST Program Areas**

Select from the subjects below to fulfill the Individually Designed Program Requirement.

### Air Transportation

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.71[J]</td>
<td>The Airline Industry</td>
<td>12</td>
</tr>
<tr>
<td>16.72</td>
<td>Air Traffic Control</td>
<td>12</td>
</tr>
<tr>
<td>16.75[J]</td>
<td>Airline Management</td>
<td>12</td>
</tr>
<tr>
<td>16.763[J]</td>
<td>Air Transportation Operations</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Research</td>
<td></td>
</tr>
<tr>
<td>16.781[J]</td>
<td>Planning and Design of Airport</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Systems</td>
<td></td>
</tr>
</tbody>
</table>

### Analysis and Planning Methods

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.202</td>
<td>Demand Modeling</td>
<td>12</td>
</tr>
<tr>
<td>1.205</td>
<td>Advanced Demand Modeling</td>
<td>12</td>
</tr>
</tbody>
</table>

### Data Sciences for Transportation

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.268</td>
<td>Network Science and Models ¹</td>
<td>12</td>
</tr>
<tr>
<td>11.205</td>
<td>Introduction to Spatial Analysis</td>
<td>6</td>
</tr>
<tr>
<td>15.060</td>
<td>Data, Models, and Decisions</td>
<td>9</td>
</tr>
<tr>
<td>15.077[J]</td>
<td>Statistical Learning and Data Mining</td>
<td>12</td>
</tr>
</tbody>
</table>

### Intelligent Transportation Systems, Safety, and Security

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.208</td>
<td>Resilient Infrastructure Networks</td>
<td>12</td>
</tr>
<tr>
<td>16.412[J]</td>
<td>Cognitive Robotics ¹</td>
<td>12</td>
</tr>
<tr>
<td>16.413</td>
<td>Principles of Autonomy and Decision Making ¹</td>
<td>12</td>
</tr>
<tr>
<td>16.422</td>
<td>Human Supervisory Control of Automated Systems ¹</td>
<td>12</td>
</tr>
</tbody>
</table>

### IDS.340[J] System Safety Concepts 12

### STS.487 Foundations of Information Policy 12

### Logistics and Supply Chain Management

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.260[J]</td>
<td>Logistics Systems</td>
<td>12</td>
</tr>
<tr>
<td>1.261[J]</td>
<td>Case Studies in Logistics and Supply Chain</td>
<td>9</td>
</tr>
<tr>
<td>1.265[J]</td>
<td>Global Supply Chain Management</td>
<td>6</td>
</tr>
<tr>
<td>SCM.266</td>
<td>Freight Transportation</td>
<td>6</td>
</tr>
</tbody>
</table>

### Transportation Planning, Policy, and Sustainability

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.65[J]</td>
<td>Sustainable Energy ¹</td>
<td>12</td>
</tr>
<tr>
<td>11.478</td>
<td>Behavior and Policy: Connections in Transportation ³</td>
<td>12</td>
</tr>
<tr>
<td>11.527</td>
<td>Advanced Seminar in Transportation Finance</td>
<td>12</td>
</tr>
</tbody>
</table>

### IDS.435[J] Law, Technology, and Public Policy 12

### Urban Transportation ²

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.251[J]</td>
<td>Comparative Land Use and Transportation Planning ³</td>
<td>12</td>
</tr>
</tbody>
</table>

¹ Also satisfies the Technology requirement.

² Special subjects offered by the Department of Urban Studies and Planning (Course 11) may satisfy this requirement if content satisfies MST criteria. Contact program office for available offerings.

³ Also satisfies the Policy requirement.
**Policy and Technology Subjects**

Select from the subjects below to satisfy the Policy / Technology Requirement.

<table>
<thead>
<tr>
<th>Transportation Policy Subjects ¹</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11.478</td>
<td>Behavior and Policy: Connections in Transportation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transportation Subjects with Substantial Policy Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.526[J]</td>
</tr>
<tr>
<td>16.71[J]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Policy Subjects with Modest or No Transportation Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.255</td>
</tr>
<tr>
<td>11.481[J]</td>
</tr>
<tr>
<td>11.482[J]</td>
</tr>
<tr>
<td>IDS.412[J]</td>
</tr>
<tr>
<td>IDS.435[J]</td>
</tr>
<tr>
<td>STS.487</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.65[J]</td>
</tr>
<tr>
<td>6.268</td>
</tr>
<tr>
<td>16.422</td>
</tr>
<tr>
<td>16.72</td>
</tr>
<tr>
<td>MAS.552[J]</td>
</tr>
<tr>
<td>MAS.836</td>
</tr>
</tbody>
</table>

¹ Special subjects offered by the Department of Urban Studies and Planning (Course 11) may satisfy this requirement if content satisfies MST criteria. Contact program office for available offerings.
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