Department of Materials Science and Engineering

Educational Objectives

The Department of Materials Science and Engineering has accepted the following definitions for the educational outcomes of the department; these outcomes will allow our students to be successful in any career choice and achieve the long term objectives of our department.

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Curriculum

Minimum units required for B.S. in Materials Science & Engineering: 381 Units

Standard Program

Freshman Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>27-100 Engineering the Materials of the Future *</td>
<td>12</td>
</tr>
<tr>
<td>99-101 Computing @ Carnegie Mellon</td>
<td>3</td>
</tr>
<tr>
<td>xx-xxxx General Education Course</td>
<td>9</td>
</tr>
<tr>
<td>33-141 Physics I for Engineering Students</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>46</td>
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<tr>
<td>Spring</td>
<td></td>
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<tr>
<td>21-122 Integration and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>xx-xxxx Second Introductory Engineering Course</td>
<td>12</td>
</tr>
<tr>
<td>33-142 Physics II for Engineering and Physics Students</td>
<td>12</td>
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</tbody>
</table>
** These courses must be taken before the end of the sophomore year, but need not be taken in the same order or semester as listed above.

All mathematics (21-xxx) courses required for the engineering degree taken at Carnegie Mellon must have a minimum grade of C in order to be counted toward the graduation requirement for the BS engineering degree.

### Notes on the Curriculum

#### Academic Advising

Paige Houser is the academic advisor for all MSE students.

#### Quality Point Average

In addition to the College requirement of a minimum cumulative quality point average of 2.00 for all courses taken beyond the freshman year, the Department requires a quality point average of 2.00 or higher in courses taken in the MSE department. Students may repeat a course to achieve the GPA requirement. Only the higher grade will be used for this departmental calculation.

#### Biomedical Engineering Additional Major

Students pursuing the additional major in Biomedical Engineering are required to take the following as an elective.

- 27-709 Engineering Biomaterials

#### MSE Approved Technical Elective

Students are required to take at least 9 units of approved technical electives. Students may take a course from another CIT department to fulfill this requirement or choose an additional 9 units of MSE Restricted Electives. Courses on the exclusion list cannot be counted as a technical elective. Students who are pursuing an additional major or minor within CIT should check with their academic advisor regarding double counting of this course.

Courses on this list cannot be counted as a technical elective

<table>
<thead>
<tr>
<th>Courses on the exclusion list</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-426 Experimental Colloid Surface Science</td>
<td>9</td>
</tr>
<tr>
<td>06-466 Experimental Polymer Science</td>
<td>9</td>
</tr>
<tr>
<td>12-201 Geology</td>
<td>9</td>
</tr>
<tr>
<td>18-202 Mathematical Foundations of Electrical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-300 Fundamentals of Electromagnetics</td>
<td>12</td>
</tr>
<tr>
<td>24-311 Numerical Methods</td>
<td>12</td>
</tr>
<tr>
<td>42-202 Physiology</td>
<td>9</td>
</tr>
<tr>
<td>42-610 Introduction to Biomaterials</td>
<td>9</td>
</tr>
</tbody>
</table>

#### MSE Restricted Electives

Each student in the program must take at least 36 units of MSE restricted electives. All 27-3xx, 27-4xx, 27-5xx, 27-6xx (with the exception of 27-699) and 27-7xx level and cross listed courses will fulfill the MSE Restricted Elective Requirement along with the following non-MSE courses:

<table>
<thead>
<tr>
<th>Non-MSE courses that count as restricted electives</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-609 Physical Chemistry of Macromolecules</td>
<td>9</td>
</tr>
<tr>
<td>09-509 Physical Chemistry of Macromolecules</td>
<td>9</td>
</tr>
<tr>
<td>12-411 Project Management for Engineering and Construction</td>
<td>9</td>
</tr>
<tr>
<td>12-631 Structural Design</td>
<td>12</td>
</tr>
<tr>
<td>18-310 Fundamentals of Semiconductor Devices</td>
<td>12</td>
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<tr>
<td>24-262 Stress Analysis</td>
<td>10</td>
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<tr>
<td>24-341 Manufacturing Sciences</td>
<td>9</td>
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</tbody>
</table>

### Integrated B.S./M.S. Program

Undergraduates who excel academically have the unique opportunity to receive simultaneously or sequentially both B.S. and M.S. degrees from the department. The primary purpose of the Integrated Master and Bachelor (IMB) Degree Program is to provide students with superior breadth and depth in technical material, which will better prepare them for careers in industry. Students interested in pursuing the IMB Degrees are encouraged to begin taking some of the required graduate courses before their last year. The MSE department offers two M.S. degrees: one in Materials Science and Engineering (MSE), a coursework degree, and one in Materials Science (MS), a coursework + research degree. The IMB Degree Program to obtain an M.S. in MSE (MS) degree normally requires two (three to four) additional
full academic semesters of coursework (coursework + research) beyond the B.S. Degree Requirements (normally eight academic semesters). Experience has shown that students complete the IMB program in eight to ten full academic semesters after enrolling at CMU.

Degree Requirements

IMB students can be enrolled in either the M.S. in MSE (coursework) or the M.S. in MS (coursework + research) degree programs, depending on their preference. Students must meet the requirements of either the M.S. in MSE or the M.S. in MS degree programs, as well as any specially stated rules below.

Eligibility

The IMB Program is available to all undergraduates who maintain a cumulative GPA of 3.0 or better, including the freshman year and the years in which they are enrolled in the IMB. Exceptions can be made by the Department on the basis of other factors, including extenuating (e.g., medical) circumstances, improvement in grades, strong recommendation letters, etc. Students become eligible to apply to the program during the spring semester of their junior year (5th semester), or the semester in which they accumulate 280 or more units, whichever is earlier.

Enrollment

Students interested in the IMB program are not required to follow the formal application process for acceptance into the MSE graduate program. There is no requirement to provide a formal application, application fee, GRE scores, recommendation letters, official transcripts, or a statement of purpose. Interested students are encouraged to apply to the program by contacting the Department Head of MSE by email prior to the middle of the semester in which they become eligible.

Requirements to Enroll as a Graduate Student

If a student takes more than 8 semesters to complete both the B.S. and M.S. in MSE (coursework), then he or she must be a graduate student for at least one full-time 15-week academic semester (Fall or Spring) before graduating, whether or not they have already completed their B.S. degree.

If a student takes more than 8 semesters to complete both the B.S. and M.S. in MS (coursework + research), then he or she must be a graduate student for at least two full-time 15-week academic semesters (Fall or Spring) before graduating, whether or not they have already completed their B.S. degree.

Tuition Assistance

When a student is a full-time graduate student through the IMB program, the department is able to provide some tuition assistance through optional Teaching Assistantships.

Additional Information

Once the student has been accepted, the student should meet with his or her IMB academic advisor(s) to determine a course schedule. The student must indicate to the departmental program coordinator at which point they intend, if necessary, to register as a graduate student.

Once a student in the IMB program has completed all of the requirements for the B.S. degree, he or she should become a graduate student.

To determine the most appropriate time for an undergraduate student to become a graduate student, he or she should consult with Enrollment Services to understand how becoming a graduate student will affect financial aid.

Faculty

CHRISTOPHER BETTINGER, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2010-
MICHAELE BOCKSTALLER, Professor – Ph.D., Max-Planck Institute for Polymer Research; Carnegie Mellon, 2005-
ITZHAQ COHEN-KARNI, Associate Professor – Ph.D., Harvard University; Carnegie Mellon, 2013-
ELIZABETH C. DICKY, Professor and Department Head – Ph.D., Northwestern University; Carnegie Mellon, 2021-
MAR DE GRAEF, Professor – Ph.D., Catholic University Leuven (Belgium); Carnegie Mellon, 1993-
ADAM FEINBERG, Professor – Ph.D., University of Florida; Carnegie Mellon, 2010-
ROBERT HEARD, Teaching Professor – Ph.D., University of Toronto; Carnegie Mellon, 2003-
ELIZABETH A. HOLM, Professor – Ph.D., University of Michigan; Carnegie Mellon, 2012-
MOHAMMAD F. ISLAM, Professor of Materials Science and Engineering – Ph.D., Lehigh University; Carnegie Mellon, 2005-
AMANDA R. KRAUSE, Assistant Professor – Ph.D., Brown University; Carnegie Mellon, 2022-
RACHEL KURCHIN, Assistant Research Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2022-
NOA MAROM, Associate Professor – Ph.D., Weizmann Institute of Science; Carnegie Mellon, 2016-
MICHAEL E. MCHENRY, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989-
THOMAS O’CONNOR, Assistant Professor – Ph.D., Johns Hopkins University; Carnegie Mellon, 2021-
P. CHRIS PISTORIUS, Professor and Associate Department Head – Ph.D., University of Cambridge; Carnegie Mellon, 2008-
LISA M. PORTER, Professor – Ph.D., North Carolina State; Carnegie Mellon, 1997-
GREGORY S. ROHRER, Professor – Ph.D., University of Pennsylvania; Carnegie Mellon, 1990-
ANTHONY D. ROLLETT, Professor – Ph.D., Drexel University; Carnegie Mellon, 1995-
PAUL A. SALVADOR, Professor and Executive Director of the Masters program in Energy Science, Technology and Policy – Ph.D., Northwestern University; Carnegie Mellon, 1999-
MAREK SKOWRONSKI, Professor – Ph.D., Warsaw University; Carnegie Mellon, 1988-
VINCENT SOKALSKI, Teaching Professor – Ph.D., Carnegie Mellon; Carnegie Mellon, 2013-
S. MOHANDESH TAHERI-MOUSAHI, Assistant Professor – Ph.D., Ecole Polytechnique Federale de Lausanne; Carnegie Mellon, 2022-
ELIAS TOWE, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2001-
BRYAN A. WEBLER, Professor – Ph.D., Carnegie Mellon; Carnegie Mellon, 2013-
JAY WHITACRE, Professor and Director of the Wilton E. Scott Institute for Energy Innovation – Ph.D., University of Michigan; Carnegie Mellon, 2007-

Affiliated Faculty

ROSALYN ABBOT, Assistant Professor of Biomedical Engineering – Ph.D., University of Vermont;
AMIT ACHARYA, Professor, Civil and Environmental Engineering – Ph.D., University of Illinois, Urbana-Champaign; Carnegie Mellon, 2000-
JAMES BAIN, Professor, Electrical and Computer Engineering – Ph.D., Stanford University; Carnegie Mellon, 1993-
JACK BEUTH, Professor, Mechanical Engineering – Ph.D., Harvard University; Carnegie Mellon, 1992-
PHIL CAMPBELL, Research Professor, Institute for Complex Engineered Systems - Ph.D., The Pennsylvania State University; Carnegie Mellon, 2000-
KRISE NOEL DAHL, Professor of Chemical Engineering and BioMedical Engineering and Materials Science and Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006-
KAUSHIK DAYAL, Professor of Civil and Environmental Engineering – Ph.D., California Institute of Technology; Carnegie Mellon, 2008-
MAARTEN DE BOER, Professor of Mechanical Engineering – Ph.D., University of Minnesota; Carnegie Mellon, 2007-
AMIR BARATI FARIMANI, Assistant Professor – Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 2018-
RANDBALL FEENSTRA, Professor, Physics – Ph.D., California Institute of Technology; Carnegie Mellon, 1995-
ERICA FUCHS, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2007-
STEPHEN GAROFF, Professor Emeritus, Physics – Ph.D., Harvard University; Carnegie Mellon, 1988–

ANDREW GELLMAN, Lord Professor, Chemical Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 1992–

REEJA JAYAN, Associate Professor, Mechanical Engineering – Ph.D., University of Texas at Austin; Carnegie Mellon, 2015–

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ROBERT SEKERKA, University Professor Emeritus, Physics, Mathematics and Materials Science – Ph.D., Harvard; Carnegie Mellon, 1969–

ROBERT SUTER, Professor Emeritus – Ph.D., Clark University; Carnegie Mellon University; Carnegie Mellon, 1978, 1981–

ZACHARY ULISSI, Associate Professor, Chemical Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon University; Carnegie Mellon, 2016–

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LYNN WALKER, Professor of Chemical Engineering – Ph.D., University of Delaware; Carnegie Mellon, 1997–

NEWELL R. WASHBURN, Associate Professor of Chemistry, Biomedical Engineering and Materials Science and Engineering – Ph.D., University of California, Berkeley; Carnegie Mellon, 2004–

MICHAEL WIDOM, Professor of Physics – Ph.D., University of Chicago; Carnegie Mellon, 1985–

LINING YAO, Assistant Professor of Human-Computer Interaction Institute and College of Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2017–

JIANGANG ZHU, Professor, Electrical and Computer Engineering – Ph.D., University of California at San Diego; Carnegie Mellon, 1997–

Emeriti Faculty

ROBERT F. DAVIS, Professor Emeritus – Ph.D., University of California, Berkeley; Carnegie Mellon, 2004–

WARREN M. GARRISON, Professor Emeritus of Materials Science and Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 1984–

DAVID E. LAUGHLIN, Professor Emeritus – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1974–

THADDEUS B. MASSALSKI, Professor Emeritus of Physics, Materials Science and Engineering – Ph.D., D.Sc., University of Birmingham, England D.Sc. (h), University of Warsaw, Poland; Carnegie Mellon, 1959–

PAUL WYNBLATT, Professor Emeritus of Materials Science and Engineering – Ph.D., University of California at Berkeley; Carnegie Mellon, 1981–