Department of Materials Science and Engineering

Educational Objectives

The faculty of the Department of Materials Science and Engineering, in consultation with students, alumni and other interested parties, has decided that the overarching objective of the MSE curriculum is to provide an education that enables our graduates to be productive and fulfilled professionals throughout their careers.

Specifically, our program will produce graduates who:

1. are successful in a professional position and/or a top graduate school that builds upon their MSE background;
2. excel in professionalism and leadership in contemporary, interdisciplinary engineering practice based on materials, while accounting for the impact of their profession on an evolving, global society;
3. creatively advance our collective understanding of the principles of materials science and engineering and/or innovate the design of technological systems;
4. contribute effectively as an individual, team member, and/or a leader to effect global, economic, environmental, and/or societal impact.

Based on these objectives, our program is focused to allow our students to be successful regardless of their future career choice.

Student Outcomes

The Materials Science and Engineering Program has the following student outcomes to prepare graduates to attain the program educational objectives:

A. An ability to apply a knowledge of mathematics, science and engineering
B. An ability to design and conduct experiments, as well as to analyze and interpret data
C. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
D. An ability to function on multidisciplinary teams
E. An ability to identify, formulate, and solve engineering problems
F. An understanding of professional and ethical responsibility
G. An ability to communicate effectively
H. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
I. A recognition of the need for, and ability to engage in life-long learning
J. A knowledge of contemporary issues
K. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Curriculum

Minimum units required for B.S. in Materials Science & Engineering 379

Standard Program

Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>27-100</td>
<td>Engineering the Materials of the Future*</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing @ Carnegie Mellon</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
</tr>
<tr>
<td>33-141</td>
<td>Physics I for Engineering Students</td>
</tr>
</tbody>
</table>

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Spring

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-122</td>
</tr>
<tr>
<td>xx-xxx</td>
</tr>
</tbody>
</table>
**Sophomore Year**

**Fall**
- 27-201 Structure of Materials 9
- 27-210 Materials Engineering Essentials 6
- 27-215 Thermodynamics of Materials 12
- 21-259 Calculus in Three Dimensions 9
- 09-105 Introduction to Modern Chemistry I ** 10
- 15-110 Principles of Computing (or 15-102) 10
- 39-210 Experiential Learning I 0

**Spring**
- 27-202 Defects in Materials 9
- 27-205 Introduction to Materials Characterization 3
- 27-216 Transport in Materials 9
- 27-217 Phase Relations and Diagrams 12
- 21-260 Differential Equations 9
- 39-220 Experiential Learning II 0
- xx-xxx General Education Course 9

**Junior Year**

**Fall**
- 27-301 Microstructure and Properties I 9
- xx-xxx MSE Restricted Elective [1] 9
- xx-xxx Free Elective [1] 9
- 33-225 Quantum Physics and Structure of Matter (or 09-217) 9
- or 03-121 Organic Chemistry I or Modern Biology 9
- xx-xxx General Education Course 9
- 39-310 Experiential Learning III 0

**Spring**
- 27-367 Selection and Performance of Materials 6
- xx-xxx General Education Course 9
- 36-220 Engineering Statistics and Quality Control 9

**Senior Year**

**Fall**
- 27-401 MSE Capstone Course I 6
- xx-xxx General Education Course 9
- xx-xxx General Education Course 9

**Spring**
- 27-402 MSE Capstone Course II 6
- 27-xxx MSE Approved Technical Elective 9
- xx-xxx General Education Course 9

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The recommended Physics sequence is 33-141 / 33-142 for Engineering students. However, 33-121 / 33-122 or 33-151 / 33-152 will also meet the CIT Physics requirement.

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 QPA requirement. Only the higher grade will be used for this departmental calculation.

**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. Students who are pursuing an additional major or minor within CIT should check with their academic advisor regarding double counting of this course.

**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>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-609 Physical Chemistry of Macromolecules</td>
<td>9</td>
</tr>
<tr>
<td>06-619 Semiconductor Processing Technology</td>
<td>9</td>
</tr>
<tr>
<td>09-509 Physical Chemistry of Macromolecules</td>
<td>9</td>
</tr>
<tr>
<td>12-111 Project Management for 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>
</tr>
<tr>
<td>24-262 Stress Analysis</td>
<td>12</td>
</tr>
<tr>
<td>24-341 Manufacturing Sciences</td>
<td>9</td>
</tr>
<tr>
<td>33-341 Thermal Physics I</td>
<td>10</td>
</tr>
<tr>
<td>33-448 Introduction to Solid State Physics</td>
<td>9</td>
</tr>
<tr>
<td>42-411 Engineering Biomaterials</td>
<td>9</td>
</tr>
</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 request acceptance into 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
CHRIS BETTINGER, Professor - Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2010-
MICHAELE BOCKSTÄLLER, Professor - Ph.D., Max-Planck Institute for Polymer Research; Carnegie Mellon, 2005-
ITZHAO COHEN-KARNI, Associate Professor - Ph.D., Harvard University; Carnegie Mellon, 2013-
ROBERT F. DAVIS, Professor - Ph.D., University of California, Berkeley; Carnegie Mellon, 2004-
MARC DEGRAF, Professor - Ph.D., Catholic University Leuven (Belgium); Carnegie Mellon, 1993-
ADAM FEINBERG, Professor - Ph.D., University of Florida; Carnegie Mellon, 2010-
WARREN M. GARRISON, Professor - Ph.D., University of California at Berkeley; Carnegie Mellon, 1984-
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-
DAVID E. LAUGHLIN, Professor - Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1974-
NOA MAROM, Assistant Professor - Ph.D., Weizmann Institute of Science; Carnegie Mellon, 2016-
MAREK SKOWRONSKI, Professor - Ph.D., Warsaw University; Carnegie Mellon, 1988-
ROBERT F. DAVIS, Professor – Ph.D., University of California, Berkeley; 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-
GREGORY S. ROHRER, Professor and Head - Ph.D., University of Pennsylvania; Carnegie Mellon, 1990-
JAMES BAIN, Professor, Electrical and Computer Engineering – Ph.D., Stanford University; Carnegie Mellon, 1995-
JACK BEUTH, Professor, Mechanical Engineering – Ph.D., Stanford University; Carnegie Mellon, 1992-
PHIL CAMPBELL, Research Professor, Institute for Complex Engineered Systems – Ph.D., The Pennsylvania State University; Carnegie Mellon, 2000-
KRISS NOEL DAHL, Associate Professor of Chemical Engineering and BioMedical Engineering and Materials Science and Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006-
KAUSHIK DAYAL, Associate Professor of Civil and Environmental Engineering - Ph.D., California Institute of Technology; Carnegie Mellon, 2008-
VINCENT SOKALSKI, Associate Professor - Ph.D., Carnegie Mellon; Carnegie Mellon, 2013-
ELIAS TOWE, Professor – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2001-
BRYAN A. WEBLER, Associate Professor - Ph.D., Carnegie Mellon; Carnegie Mellon, 2013-
JAY WHITACRE, Professor – 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, 1995-
JACK BEUTH, Professor, Mechanical Engineering – Ph.D., Stanford University; Carnegie Mellon, 1992-
PHIL CAMPBELL, Research Professor, Institute for Complex Engineered Systems – Ph.D., The Pennsylvania State University; Carnegie Mellon, 2000-
KRISS NOEL DAHL, Associate Professor of Chemical Engineering and BioMedical Engineering and Materials Science and Engineering – Ph.D., University of Pennsylvania; Carnegie Mellon, 2006-
MAARTEN DE BOER, Professor of Mechanical Engineering – Ph.D., University of Minnesota; Carnegie Mellon, 2007-
RANDALL FEEINSTRA, Professor, Physics – Ph.D., California Institute of Technology Carnegie Mellon; Carnegie Mellon, 1995-
STEPHEN GAROFF, Professor, 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, Assistant Professor, Mechanical Engineering – Ph.D., University of California at Austin; Carnegie Mellon, 2013-
DAVID KINDERLEHRER, Professor, Mathematical Sciences – Ph.D., University of California, Berkeley; Carnegie Mellon, 1990-
NOA MAROM, Assistant Professor of Chemical Engineering – Ph.D., Carnegie Mellon, 2006-
TOMEK KOWALIEWSKI, Professor of Chemistry – Ph.D., Polish Academy of Sciences; Carnegie Mellon, 2000-
SHAWN LITSTER, Professor, Mechanical Engineering – Ph.D., Stanford University; Carnegie Mellon, 2008–

SARA MAJETICH, Professor, Physics – Ph.D., University of Georgia; Carnegie Mellon, 1990–

CARMEL MAJIDI, Associate Professor of Mechanical Engineering – Ph.D., University of California; Carnegie Mellon, 2011–

JONATHAN MALEN, Professor – Ph.D., University of California, Berkeley; Carnegie Mellon, 2009–

KRZYSZTOF MATYJASZEWSKI, J.C. Warner Professor of Natural Sciences, Department of Chemistry and Materials Science and Engineering – Ph.D., Polytechnical University of Łódź, Poland; Carnegie Mellon, 1985–

MEAGAN MAUTER, Assistant Professor, Civil & Environmental Engineering and Public Policy – Ph.D., Yale University; Carnegie Mellon, 2015–

ALAN MCGAUGHEY, Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2005–

O. BURAK OZDOGANLAR, Professor of Mechanical Engineering – Ph.D., University of Michigan; Carnegie Mellon, 2004–

RAHUL PANAT, Associate Professor of Mechanical Engineering – Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 2017–

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

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

VENKAT VISWANATHAN, Assistant Professor, Mechanical Engineering - Ph.D., Stanford University; Carnegie Mellon, 2013–

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–

LEE WEISS, Research Professor, ICES – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983–

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

DI XIAO, Associate Professor of Physics – Ph.D., University of Texas, Austin; Carnegie Mellon, 2012–

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

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

Emeriti Faculty

RICHARD J. FRUEHAN, Professor – Ph.D., University of Pennsylvania; Carnegie Mellon, 1981–

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–